R&S®SMCV100B
Vector Signal Generator
User Manual



1179059702
Version 10

ROHDE&SCHWARZ
Make ideas real

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

- R&S®SMCVB-B103/-KB106/-KB107
- R&S®SMCVB-K19
- R&S®SMCVB-K31
- R&S®SMCVB-K62
- R&S®SMCVB-K197/-K198/-K199
- R&S®SMCVB-K200
- R&S®SMCVB-K505
- R&S®SMCVB-K511/-K512
- R&S®SMCVB-K519
- R&S®SMCVB-K521/-K522/-K523
- R&S®SMCVB-K547
- R&S®SMCVB-K709
- R&S®SMCVB-K980

This manual describes firmware version FW 5.30.175.xx and later of the R&S®SMCV100B.

© 2025 Rohde & Schwarz
Muehldorfstr. 15, 81671 Muenchen, Germany
Phone: +49 89 41 29 - 0
Email: info@rohde-schwarz.com
Internet: www.rohde-schwarz.com
Subject to change – data without tolerance limits is not binding.
R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG.
The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by Rohde & Schwarz is under license.
The terms HDMI, HDMI High-Definition Multimedia Interface, HDMI trade dress and the HDMI Logos are trademarks or registered trademarks of HDMI Licensing Administrator, Inc.
All other trademarks are the properties of their respective owners.

1179.0597.02 | Version 10 | R&S®SMCV100B

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

Contents

1 Safety and regulatory information....15
1.1 Safety instructions....15
1.2 Labels on R&S SMCV100B....18
1.3 Warning messages in the documentation....18
1.4 Where to find key documents on Rohde & Schwarz....19
1.5 Korea certification class B....19
2 Welcome to the R&S SMCV100B....20
2.1 Key features....20
2.2 What's new....21
2.3 Documentation overview....21
2.3.1 Getting started manual....21
2.3.2 User manuals and help....21
2.3.3 Service manual....22
2.3.4 Instrument security procedures....22
2.3.5 Printed safety instructions....22
2.3.6 Specifications and product brochures....22
2.3.7 Calibration certificate....22
2.3.8 Release notes and open source acknowledgment....23
2.3.9 Application notes, application cards, white papers, etc....23
2.3.10 Videos....23
3 Getting started....24
3.1 Preparing for use....24
3.1.1 Lifting and carrying....24
3.1.2 Unpacking and checking....24
3.1.3 Choosing the operating site....24
3.1.4 Setting up the R&S SMCV100B....25
3.1.5 Considerations for test setup....26
3.1.6 Connecting to power....27
3.1.7 Connecting to LAN....27
3.1.8 Connecting a monitor....28
3.1.9 Connecting USB devices....28

3.1.10 Connecting to RF coaxial connectors 29
3.1.11 Connecting to RF 50 Ω 31
3.1.12 Connecting to Ref In/Ref Out 31
3.1.13 Connecting to Dig. IQ HS x 31
3.1.14 Connecting to IP Data 32
3.1.15 Switching on or off 33
3.2 Instrument tour 35
3.2.1 Front panel tour 35
3.2.2 Rear panel tour 39
3.3 Trying out the instrument 41
3.3.1 Generating an unmodulated carrier 42
3.3.2 Generating a digitally modulated signal 44
3.3.3 Triggering the instrument with an external signal 46
3.3.4 Enabling and configuring a marker signal 50
3.3.5 Verifying the generated signal 52
3.3.6 Saving and recalling settings 54
3.3.7 Generating a DAB signal 56
3.4 System overview 58
3.4.1 Brief introduction to the instrument's concept 58
3.4.2 Signal flow at a glance 58
3.4.3 Internal baseband source ("Baseband" block) 60
3.4.4 Digital baseband input/output ("BB input"/ "I/Q digital" block) 60
3.4.5 Additional white gaussian noise ("AWGN" block) 61
3.4.6 "I/Q stream mapper" block 61
3.4.7 I/Q modulator ("I/Q mod" block) 61
3.4.8 RF ("RF" block) 61
3.4.9 Applications examples of the R&S SMCV100B 61
3.5 Operating the instrument 62
3.5.1 Means of manual interaction 62
3.5.2 Understanding the display information 63
3.5.3 Accessing the functionality 68
3.5.4 Entering data 69
3.5.5 Undo and redo actions 70

3.5.6 Getting information and help....70

4 Configuring internal baseband signals....73

4.1 Overview of the signal generation modes....73

4.2 Accessing the functions in the baseband domain....74

4.3 Generating signals according to broadcast standards....75

4.4 Common characteristics of the baseband domain....77

4.4.1 About common baseband characteristics....78

4.4.2 Common baseband settings....98

4.5 Generating custom digital modulation signals....106

4.5.1 Required options....106

4.5.2 About custom digital modulation....106

4.5.3 Custom digital modulation settings....106

4.5.4 How to create data and control lists....124

4.5.5 References....127

4.6 Using the arbitrary waveform generator (ARB)....138

4.6.1 Required options....138

4.6.2 About ARB....139

4.6.3 ARB settings....144

4.6.4 Playing waveform files....154

4.6.5 Working with waveform libraries....169

4.6.6 Streaming waveforms from an external storage device....173

4.6.7 Tags for waveforms, data and control lists....175

4.7 Reducing the crest factor....192

4.8 Generating multi-segment waveform files....192

4.8.1 Required options....193

4.8.2 About the multi-segment waveforms....193

4.8.3 Multi-segment settings....198

4.8.4 Working with multi-segment waveform files....214

4.8.5 Reference to triggering of multi-segment waveforms....220

4.9 Generating multicarrier waveform signals....223

4.9.1 Required options....223

4.9.2 About the multicarrier waveforms....223

4.9.3 Multicarrier settings....225

4.9.4 Using the multicarrier function....238
4.10 Generating FM/PhiM/AM/Pulse Modulation signals....241
4.10.1 FM/PhiM/AM configuration and settings....241
4.10.2 Pulse modulation configuration and settings....245
4.11 Shifting the baseband signal....247
4.11.1 About baseband offsets....247
4.11.2 Baseband offset settings....250
4.11.3 Improving signal characteristics by shifting the baseband signal....251
5 Configuring external baseband signals....252
5.1 Overview of the input and output signals and interfaces....252
5.1.1 Overview of the baseband signal sources....253
5.1.2 Overview of the baseband and RF output signals....253
5.1.3 Interdependencies....254
5.1.4 Important signal parameters and interface characteristics....254
5.2 System configuration settings....257
5.2.1 I/Q stream mapper settings....257
5.2.2 External RF and I/Q settings....258
5.2.3 External instrument configuration settings....263
5.2.4 Overview....269
5.3 Digital baseband input settings....270
5.3.1 General settings....272
5.3.2 Signal input settings....273
5.4 I/Q digital output settings....275
5.4.1 General settings....276
5.4.2 Channels settings....277
5.4.3 Signal output settings....279
5.5 Generating time-aligned baseband signals....281
5.5.1 Triggering several instruments with a common trigger signal....281
6 Adding noise to and impairing the signal....283
6.1 Adding noise to the signal....283
6.1.1 Required options....283
6.1.2 About the AWGN generator....283
6.1.3 AWGN block....287

6.1.4 AWGN settings....288
6.1.5 How to configure the noise generator for receiver tests....295
6.2 Impairing the signal....297
6.2.1 Required options....297
6.2.2 About the linear I/Q impairments....297
6.2.3 Digital impairments settings....299
7 Applying I/Q vector modulation....302
7.1 Required options....302
7.2 About the I/Q modulator....302
7.3 I/Q modulator settings....302
7.4 Optimizing I/Q modulation performance....305
8 Configuring the RF signal....307
8.1 Required options....308
8.2 How to access the RF settings....308
8.3 How to activate the RF signal output....308
8.4 How to set the frequency and level....309
8.5 RF frequency settings....311
8.6 RF level settings....313
8.7 RF phase settings....316
8.8 Reference oscillator....317
8.8.1 Required options....317
8.8.2 Reference frequency settings....317
8.8.3 Reference output settings....320
8.8.4 Adjustment settings....321
8.9 Varying the RF signal in list or sweep mode....322
8.9.1 Signal generation and triggering in the sweep and list modes....324
8.9.2 About sweep mode....331
8.9.3 About list mode....334
8.9.4 Significant parameters and functions....335
8.9.5 Sweep mode settings....337
8.9.6 List mode settings....345
8.9.7 List editor....352
8.9.8 How to generate a signal in list or sweep mode....355

8.10 Improving level performance 357
8.10.1 Attenuator 358
8.10.2 User correction 360
8.10.3 Using power sensors 372
8.10.4 Improving the RF signal performance 388

9 Monitoring baseband signal characteristics 392
9.1 Required options 392
9.2 About the graphical signal display 392
9.2.1 Available diagrams 392
9.2.2 Signal acquisition points 397
9.2.3 Display functions 398
9.3 Graphics configuration settings 399
9.4 Graphical signal display settings 403
9.5 Checking the generated signal graphically 404

10 Configuring a multi-instrument setup 411
10.1 Synchronizing instruments 411
10.2 Connecting to R&S SMW 411
10.3 Configuring the setup 413
10.4 Multi-instrument settings 416

11 File and data management 418
11.1 Accessing, retrieving and handling data 418
11.2 About the file system 419
11.3 Restoring an instrument configuration 422
11.3.1 Preset, set to default and factory preset settings 424
11.3.2 Identifying parameters with non-default values 424
11.3.3 Presetting the instrument to a user-defined state 425
11.3.4 Reference 426
11.4 Protecting data 426
11.5 Saving and recalling settings 427
11.5.1 Save/Recall settings 428
11.5.2 Saving and recalling instrument settings 431
11.6 Accessing files with user data 432

11.6.1 File select settings....432
11.7 Exporting and importing remote command lists....434
11.8 Loading, importing and exporting lists....434
11.9 Using the file manager....434
11.9.1 File manager settings....435
11.9.2 Map network share settings....436
11.9.3 Displaying all saved files....438
11.9.4 Mapping a network folder....438
11.10 Transferring files from and to the instrument....440
11.10.1 Removing file system protection....440
11.10.2 Accessing the file system using FTP....442
11.10.3 Accessing the R&S SMCV100B file system using SMB (Samba)....443
11.10.4 Using a USB storage device for file transfer....444
11.10.5 Using a file server for test files exchange....445
11.11 Creating screenshots of current settings....446
11.11.1 Hardcopy settings....446
11.11.2 Creating a hardcopy of the display....449

12 General instrument functions....451
12.1 Customizing the user interface....451
12.1.1 Display and keyboard settings....452
12.1.2 Display update settings....454
12.1.3 Defining the RF signal state on power on....454
12.1.4 How to set the initial instrument settings....455
12.2 Configuring global connectors....456
12.2.1 Required options....456
12.2.2 About global connectors....457
12.2.3 Trigger marker clock settings....459
12.2.4 RF connectors settings....460
12.2.5 Global connectors settings....462
12.2.6 Routing signals to the connectors....465
12.3 Checking parameters and dependencies....466
12.4 Organizing frequently used settings as favorites....467
12.4.1 User menu settings....469

12.4.2 How to use the user menu for fast adjustments....470
12.4.3 Define user key actions settings....472
12.4.4 How to assign actions to the [★ (User)] key....474
12.5 Managing licenses and license keys....474
12.5.1 Manage license keys settings....475
12.5.2 Using the license server....478
12.5.3 How to move a portable license....488
12.6 Using the security settings....490
12.6.1 Protection level settings....491
12.6.2 Setting security parameters....492
12.6.3 Configuring LAN services....496
12.6.4 Password management....500
12.6.5 Preventing unauthorized access....503
12.7 Undoing or restoring actions....507
12.8 Shutting down and rebooting the instrument....508
13 Network operation and remote control....509
13.1 Overview of remote access modes....510
13.2 Remote control interfaces and protocols....511
13.2.1 LAN interface....512
13.2.2 LXI browser interface....513
13.3 Remote control programs and libraries....514
13.4 Status reporting system....517
13.4.1 Overview of the status registers....517
13.4.2 Instrument-specific status operation register....519
13.4.3 Instrument-specific status questionable register....519
13.4.4 Reset values of the status reporting system....520
13.5 Remote access settings....520
13.5.1 Network settings....522
13.5.2 VISA resource strings....526
13.5.3 Instrument emulations settings....527
13.5.4 Remote connections settings....528
13.5.5 HUMS settings....530
13.5.6 HUMS enhanced settings....531

13.5.7 QR code....540
13.6 LXI settings....541
13.6.1 LXI status settings....541
13.6.2 LXI browser settings....542
13.7 To configure the instrument for remote access....548
13.7.1 To find the VISA resource string....548
13.7.2 To configure the access over LAN....549
13.8 To establish a remote control session over LAN....553
13.8.1 To establish the connection with the LXI web browser....553
13.8.2 To establish the connection using VXI-11 protocol....554
13.8.3 To establish the connection using socket communication....559
13.9 To trace messages with the LXI web browser interface....560
13.10 To return to manual operation....561
13.11 To automate tasks with remote command scripts....561
13.11.1 Show SCPI command settings....564
13.11.2 Displaying a SCPI list....564
13.11.3 SCPI recording export settings....565
13.11.4 How to record / create SCPI lists....567
13.11.5 How to convert and save SCPI lists....570
13.11.6 How to find out the SCPI commands for GUI functions....572
13.12 To operate the instrument using VNC....573
13.12.1 Enabling VNC service....573
13.12.2 How to set up remote operation from a desktop system....573
13.12.3 How to set up remote operation from a smart device....576
13.13 References....579
13.13.1 LXI functionality....579
13.13.2 Code generator templates....579
13.13.3 Remote control states....581
14 Remote control commands....582
14.1 Conventions used in SCPI command descriptions....582
14.2 Programming examples....583
14.3 Common commands....584
14.4 Preset commands....588

14.5 MMEMory subsystem ... 590
14.5.1 File naming conventions ... 590
14.5.2 Handling files in the default or in a specified directory ... 591
14.5.3 Programming examples ... 592
14.5.4 Remote control commands ... 594
14.6 CALibration subsystem ... 602
14.7 DIAGnostic subsystem ... 606
14.8 HUMS remote control commands ... 609
14.9 DISPlay subsystem ... 617
14.10 FORMat subsystem ... 621
14.11 HCOPy subsystem ... 623
14.11.1 Hard copy settings ... 624
14.11.2 Automatic naming ... 625
14.12 KBOard subsystem ... 628
14.13 OUTPut subsystem ... 629
14.14 SENSe, READ, INITiate and SLISt subsystems ... 632
14.15 SCONfiguration subsystem ... 646
14.15.1 Multi-instrument configuration commands ... 649
14.15.2 I/Q stream mapper commands ... 650
14.15.3 External RF and I/Q instruments commands ... 651
14.16 SOURce subsystem ... 660
14.16.1 Connector settings ... 661
14.16.2 SOURce:AWGN subsystem ... 665
14.16.3 SOURce:BBIN subsystem ... 673
14.16.4 SOURce:BB subsystem ... 680
14.16.5 SOURce:CORRection subsystem ... 768
14.16.6 SOURce:FREQuency subsystem ... 776
14.16.7 SOURce:INPut subsystem ... 782
14.16.8 SOURce:IQ subsystem ... 782
14.16.9 SOURce:IQ:OUTPut subsystem ... 783
14.16.10 SOURce:LIST subsystem ... 788
14.16.11 SOURce:PHASe subsystem ... 801
14.16.12 SOURce:POWer subsystem ... 802

14.16.13 SOURce:ROSCillator subsystem....814
14.16.14 SOURce:SWEep subsystem....817
14.17 SYSTem subsystem....825
14.18 STATus subsystem....853
14.19 TEST subsystem....857
14.20 TRIGger subsystem....860
14.21 UNIT subsystem....862
15 Troubleshooting and notifications....864
15.1 Notifications....864
15.1.1 Volatile notifications....864
15.1.2 Permanent notifications....865
15.2 SCPI notifications....865
15.3 Device-specific notifications....865
15.4 Querying notifications....867
15.5 Resolving network connection failures....869
15.6 Resolving errors during internal adjustments....869
15.7 Measuring USB cable quality....870
15.8 Checking the instrument configuration....871
15.8.1 Hardware configuration settings....872
15.8.2 Versions and options settings....873
15.9 Collecting information for technical support....874
15.10 Contacting customer support....876
16 Transporting....878
17 Maintenance, storage and disposal....879
17.1 Cleaning....879
17.2 Changing fuses....879
17.3 Storage....880
17.4 Performing maintenance tasks....880
17.4.1 Date and time....881
17.4.2 Check front panel....884
17.4.3 Check display screen....886
17.4.4 Internal adjustments....887

17.4.5 Selftest ... 892
17.4.6 FPGA/uC update settings ... 895
17.5 Disposal ... 897

Annex ... 898

A Available user files and file extensions ... 898

B ARB *.csv file format ... 900

C Unit shortcuts ... 901

Glossary: Terms and abbreviations ... 903

Glossary: Publications and references ... 908

List of remote commands (base unit) ... 909

Index ... 925

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 generates radio frequency (RF) signals for the development, production and verification of electronic components, modules or devices. The product is intended for industrial use, for example for production and conformance testing, maintenance and engineering laboratories.

Use the product only for its designated purpose. Any other use is considered improper use. Observe the operating conditions and performance limits stated in the specifications document.

Target audience

This document targets at all users, including technicians, operators, administrators and maintenance personnel. The required skills and experience of the users depend on the test setup and application of the product.

Where do I find safety information?

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

- In Section 1.1, "Safety instructions", on page 15. The same information is provided in many languages in printed format. The printed "Safety Instructions" for "Mains-Powered Products, Not Heavy" (document number 1171.1771.99) are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

1.1 Safety instructions

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

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

Using the product requires 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 specifications document. Any other modifications can affect safety and are not permitted.

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

Lifting and carrying the product

The maximum weight of the product is provided in the specifications document. 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 outdoor use of your product, e.g. a protective cover, you can use the product outdoors.

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

Setting up the product

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

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

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

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

Connecting the product

Before connecting the interfaces and measuring inputs of the product to other products or electrical circuits, make sure that the other products or electrical circuits provide

special protection against electric shock. This protection principle is referred to as SELV (safety extra-low voltage) and is based on a low voltage level and increased insulation. Exceptions are indicated by a measurement category on the product and given in the specifications document.

Connecting to power

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

Take the following measures for your safety:

- Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source. If the power adapter does not adjust automatically, set the correct value and check the rating of the fuse.
- If a product has an exchangeable fuse, its type and characteristics are indicated next to the fuse holder. Before changing the fuse, switch off the product and disconnect it from the power source. How to change the fuse is described in the product documentation.
- Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.
- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- 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 SMCV100B

Labels on the casing inform about:

- Personal safety, see "Connecting to power" on page 17.
- Product and environment safety, see Table 1-1.
- Identification of the product, see the serial number on the rear panel.

Table 1-1: Labels regarding R&S SMCV100B and environment safety

	Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its service life. For more information, see Section 17.5, "Disposal", on page 897.

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 Where to find key documents on Rohde & Schwarz

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

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

1.5 Korea certification class B



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

2 Welcome to the R&S SMCV100B

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

The R&S SMCV100B options concept is fully software defined. You can fully upgrade the R&S SMCV100B without installation of additional hardware options. Upgrading also includes the upgrade of the RF frequency, memory, I/Q modulation bandwidth and all further R&S SMCV100B options for the whole variety of applications.

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

2.1 Key features

Outstanding key features of the R&S SMCV100B are:

- First multi-standard platform for broadcast, navigation, cellular and wireless applications
- Fully software-defined vector signal generator
- Modern RF signal generation concept from 8 kHz to 7.125 GHz
- High RF output power of up to 25 dBm
- Modulation bandwidth up to 240 MHz with internal baseband
- Powerful internal baseband generator with internal broadcast real-time coder, Custom Digital Modulation and internal baseband signal generation with ARB
- Support of various broadcast standards covering multiple fields of application:
  - Terrestrial broadcast: ATSC 3.0, ATSC-M/H, DTMB, DVB-T2, DVB-T, ISDB-T, ISDB-T_{SB}, T-DMB/DAB
  - Satellite broadcast: DVB-S2, DVB-S
  - Cable broadcast: DVB-C, J.83/B
  - Audio broadcast: DRM/DRM+, Audio AM/FM, RDS/RDBS/DARC
- Support of digital standard waveforms such as 5G NR, LTE including eMTC/NB-IoT, WLAN IEEE 802.11a/b/g/n/j/p/ac/ax/be, GNSS
- Intuitive operation via 5" touchscreen with block diagram as key element
- Graphical signal monitoring at practically every point in the signal flow
- SCPI macro recorder and code generator for generating executable remote control code from manual operating steps (for MATLAB®, CVI, etc.)
- Easily extendable with software options
- Full remote compatibility with R&S SFE/R&S SFE100

For more information, refer to the specifications document.

2.2 What's new

This manual describes firmware version FW 5.30.175.xx and later of the R&S®SMCV100B.

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

- In ARB mode, additional support for loading and playing `*iq.tar`, `*.csv` and MATLAB `*.mat` file formats, see Section 4.6.2.1, "About ARB file formats", on page 139.
- Test function to check the display screen added, see Section 17.4.3, "Check display screen", on page 886.
- Glossary for publications and references added.
- Editorial changes

2.3 Documentation overview

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

www.rohde-schwarz.com/manual/smcv100b

2.3.1 Getting started manual

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

2.3.2 User manuals and help

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

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Software option manual
  Contains the description of the specific functions of an option. Basic information on operating the R&S SMCV100B is not included.

The contents of the user manuals are available as help in the R&S SMCV100B. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.

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

2.3.3 Service manual

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

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

https://gloris.rohde-schwarz.com

2.3.4 Instrument security procedures

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

2.3.5 Printed safety instructions

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

2.3.6 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S SMCV100B. It also lists the firmware applications and their order numbers, and optional accessories.

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

See www.rohde-schwarz.com/brochure-datasheet/smcv100b

2.3.7 Calibration certificate

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

2.3.8 Release notes and open source acknowledgment

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

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

www.rohde-schwarz.com/firmware/smcv100b

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

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

For some application sheets, see also:

www.rohde-schwarz.com/application/smcv100b

2.3.10 Videos

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

3 Getting started

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

3.1 Preparing for use

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

3.1.1 Lifting and carrying

For safety information, see "Lifting and carrying the product" on page 16.

3.1.2 Unpacking and checking

1. Unpack the R&S SMCV100B carefully.
2. Retain the original packing material. Use it to protect the control elements and connectors when transporting or shipping the R&S SMCV100B later.
   See also Section 16, "Transporting", on page 878.
3. Using the delivery notes, check the equipment for completeness.
4. Check the equipment for damage.

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

3.1.3 Choosing the operating site

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

For safety information, see "Choosing the operating site" on page 16.

Electromagnetic compatibility classes

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

- Class B equipment is suitable for use in:
  - Residential environments
  - Environments that are directly connected to a low-voltage supply network that supplies residential buildings

- Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments.
  If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

3.1.4 Setting up the R&S SMCV100B

See also:

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

3.1.4.1 Placing the R&S SMCV100B on a bench top

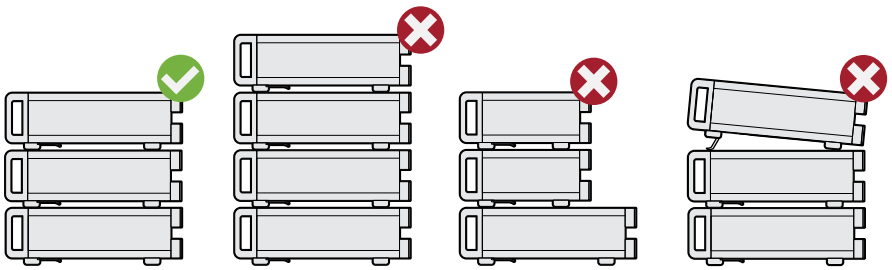
To place the product on a bench top

1. Place the product on a stable, flat and level surface. Ensure that the surface can support the weight of the product. For information on the weight, see the specifications document.
2. **CAUTION!** Foldable feet can collapse. For safety information, see "Setting up the product" on page 16.

   Always fold the feet completely in or out. With folded-out feet, do not place anything on top or underneath the product.
3. **WARNING!** A stack of products can fall over and cause injury. Never stack more than three products on top of each other. Instead, mount them in a rack.

   Stack as follows:

   - If the products have foldable feet, fold them in completely.
   - All products must have the same dimensions (width and length).
   - Do not exceed a total load of 50 kg placed on the product at the bottom of the stack.



Left = Stacked correctly
Middle left = Stacked incorrectly, too many products
Middle right = Stacked incorrectly, different dimensions
Right = Stacked incorrectly, folded-out feet

4. **NOTICE!** Overheating can damage the product.

Prevent overheating as follows:

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

3.1.4.2 Mounting the R&S SMCV100B in a rack

To prepare the rack

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

To mount the R&S SMCV100B in a rack

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

To unmount the R&S SMCV100B from a rack

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

3.1.5 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, for example, double-shielded RF, LAN and USB cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.
- Use the cable R&S DIGIQ-HS for connection to the Dig. IQ HS x interfaces of the instrument. The cable is available under order number 3641.2948.03.
  How to: Section 3.1.13, "Connecting to Dig. IQ HS x", on page 31
- Use an SFP+ to RJ-45 adapter and an RJ-45 cable for connection to the IP Data interface of the instrument. We recommend that you use the adapter "FCLF850P2BTL" from Finisar available under order number 3627.0570.00.
  How to: Section 3.1.14, "Connecting to IP Data", on page 32

Signal input and output levels

Keep the signal levels within the specified ranges to avoid damage to the R&S SMCV100B and connected devices.

For more information, refer to the specifications document.

3.1.6 Connecting to power

For safety information, see "Connecting to power" on page 17.

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

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

For more information, refer to the specifications document.

3.1.7 Connecting to LAN

Network environment

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

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

To connect to LAN

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

Using DHCP (dynamic host configuration protocol), the R&S SMCV100B assigns the IP address automatically.

If connected to the LAN, the R&S SMCV100B displays the IP address and the hostname at the left bottom of the block diagram.



1 = IP address
2 = Hostname

If disconnected from the LAN, the R&S SMCV100B displays the IP address *0.0.0.0*.

See also Section 13.7, "To configure the instrument for remote access", on page 548.

3.1.8 Connecting a monitor

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

1. Connect the monitor to the "Display Port" socket of the R&S SMCV100B on the rear panel.
   The "Display Port" socket does not support a dual-mode Display Port (DP++). Use an active adapter if you connect to HDMI cables, for example.
2. At the monitor, connect the cable to one of the following sockets:
   - Display Port: Connect it to the Display Port socket of the monitor.
   - HDMI: You need an active adapter Display Port to HDMI. Passive adapters do not work.
   - VGA: You need an active adapter, Display Port to VGA. Passive adapters do not work.

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

3.1.9 Connecting USB devices

You can connect or disconnect all USB devices from the R&S SMCV100B during operation.

To connect USB storage devices

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

1. Connect the USB storage device to the USB type A connector on the front panel.
2. Connect the device directly, without a connecting cable.
   Connecting cables can cause electromagnetic radiation and impair a measurement result.

To connect USB devices with an external power supply

1. **NOTICE!** Connected devices with external power supply can feed back current into the 5 V power supply of the USB interface and thus damage the R&S SMCV100B.
   Ensure that there is no connection between the positive pole of the power supply and the +5 V power pin of the USB interface (VBUS).
2. Connect the USB storage device to a USB connector on the rear panel.

To connect a keyboard

► Connect the USB storage device to a USB connector on the rear panel.

When connected, the R&S SMCV100B detects the keyboard automatically. A detected keyboard has the default layout English – US.

To connect a mouse

► Connect the USB storage device to a USB connector on the rear panel.

When connected, the R&S SMCV100B detects the mouse automatically.

To connect power sensors

Connect power sensors of the R&S NRP families to a USB connector on the rear panel.

See Section 8.10.3, "Using power sensors", on page 372.

3.1.10 Connecting to RF coaxial connectors

Here, you find information on how to prepare and to connect to RF coaxial connectors of the R&S SMCV100B. Use these RF connectors, for example, for output of the RF signal or for input of an external reference signal.

To prepare for connecting

1. **NOTICE!** Damaged or not clean connections can lead to RF insertion loss and mismatch, and even premature wear of the connectors.
   Before connecting to the port, inspect the RF connector visually. Check that it is clean, undamaged and mechanically compatible.

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

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

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

4. Use a high-quality RF cable that matches the RF connector type. See also "Cable selection and electromagnetic interference (EMI)" on page 26.

5. You can connect to two kinds of connectors:
   - "To connect to screwable connectors" on page 30
   - "To connect to pluggable connectors" on page 30

To connect to screwable connectors

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

The R&S SMCV100B provides screwable RF connectors as in Table 3-1.

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

Connector		Torque limit		Nut opening	
Type	Name	lb-Inch	Nm	Inch	mm
N	RF 50 Ω	13.3	1.5	3/4	20

To connect to pluggable connectors

The R&S SMCV100B provides pluggable Bayonet Neill-Concelman (BNC) connectors.

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

a) Carefully align the connector of the cable and the BNC 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 BNC connector.

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

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

3.1.11 Connecting to RF 50 Ω

Before connecting, disable the RF output. In the block diagram, select the block "Off". For connection, the R&S SMCV100B provides "RF 50 Ω" on the front panel, see "To connect to screwable connectors" on page 30.

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 SMCV100B to switch off the RF output.

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

3.1.12 Connecting to Ref In/Ref Out

For connection, the R&S SMCV100B provides BNC connectors or SMA connectors on the rear panel. See "To connect to pluggable connectors" on page 30 and "To connect to screwable connectors" on page 30.

3.1.13 Connecting to Dig. IQ HS x

To connect to the QSFP+ interface

1. For connection, use the cable R&S DIGIQ-HS.
   See "Cable selection and electromagnetic interference (EMI)" on page 26.
2. Hold the QSFP+ plug of the cable by its panes.
3. Turn the QSFP+ cable, so that the release tab shows upwards.
4. Insert and push the QSFP+ plug into the QSFP+ cage.

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

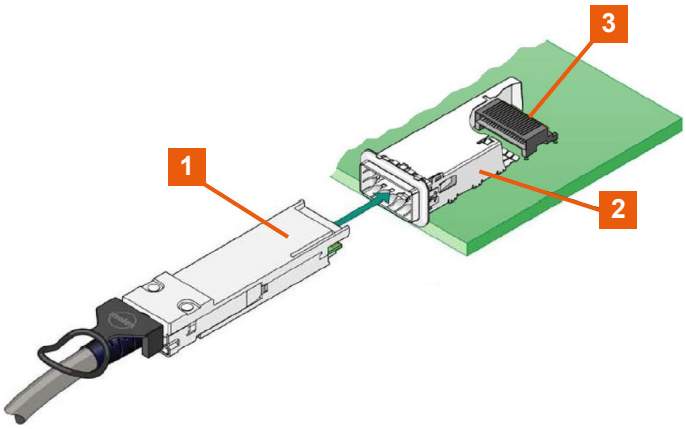
To disconnect from the QSFP+ interface

1. **NOTICE!** If you pull the cable, you can damage the cable and the Dig. IQ HS x connector.

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

About the QSFP+ interface

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



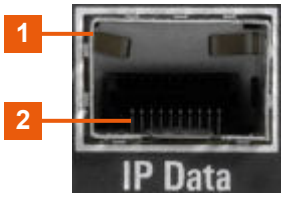
1 = QSFP+ plug
2 = QSFP+ cage
3 = QSFP+ connector

See also:

- Section 5.3, "Digital baseband input settings", on page 270.
- Section 5.4, "I/Q digital output settings", on page 275.

3.1.14 Connecting to IP Data

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



1 = SFP+ cage
2 = SFP+ connector

To connect to IP Data interface

1. For connection, use an SFP+ to RJ-45 adapter and an RJ-45 cable.
   See "Cable selection and electromagnetic interference (EMI)" on page 26.
2. Connect the SFP+ to RJ-45 adapter (**3**) to the SFP+ socket of the IP Data connector (**4**) on the rear panel.

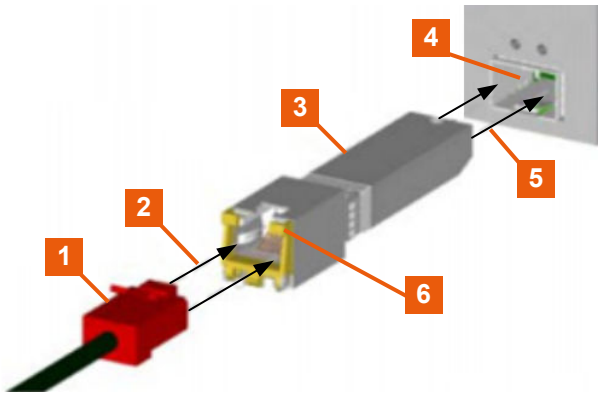


Figure 3-1: Connecting to the IP Data interface

1 = RJ-45 cable and plug
2, 5 = Axis of connection
3 = SFP+ to RJ-45 adapter
4 = SFP+ socket of the IP Data connector
6 = Bracket for mounting and releasing the adapter

a) Turn the adapter, so that the joints of the release bracket (**6**) show upwards.
b) Open the release bracket, so that the bracket shows upward.
c) Insert and push the adapter into the cage of the SFP+ socket of the IP Data connector.
d) To mount the adapter, push the release bracket down to close the bracket.

The adapter is connected to the IP Data connector.

3. Plug the RJ-45 cable into the RJ-45 socket of the adapter.

To disconnect from IP Data interface

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

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

See also chapter "Local IP data network settings" in the corresponding broadcast standard user manuals.

3.1.15 Switching on or off

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

Table 3-2: Overview of power states

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

To switch on the R&S SMCV100B

The R&S SMCV100B is off but connected to power. See Section 3.1.6, "Connecting to power", on page 27.

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

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

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

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

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

   After booting, the R&S SMCV100B starts up displaying the block diagram on the screen on the front panel.

To check startup functions

When starting for the first time, the R&S SMCV100B starts with the default settings. When restarting, the R&S SMCV100B recalls the instrument configuration before shut-down.

See Section 11.5.2, "Saving and recalling instrument settings", on page 431.

When switched on, the R&S SMCV100B monitors the main functions and logs erroneous functions. See the following:

See Section 15.4, "Querying notifications", on page 867.

To handle surges

Surges at the AC power connector can force a restart of the R&S SMCV100B. The R&S SMCV100B restarts with the instrument configuration of the last startup and looses intermediate configurations. Save intermediate configurations, if needed. To avoid instrument restart, make sure that peak power levels are within the specified ranges in the specifications document.

To shut down the product

The product is in the ready state.

► Press the [On/Standby] key.

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

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

To disconnect from power

The R&S SMCV100B is in the standby state.

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

   Set the toggle switch on the power supply to position [0].

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

2. Disconnect the R&S SMCV100B from the power source.

3.2 Instrument tour

This chapter explains the control elements and the connectors of the R&S SMCV100B. The views of the front panel and the rear panel help you to get familiar with the instrument and to perform the first steps. For specifications of the interfaces, see the specifications document.

The meanings of the labels on the R&S SMCV100B are described in Section 1.2, "Labels on R&S SMCV100B", on page 18.

3.2.1 Front panel tour

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

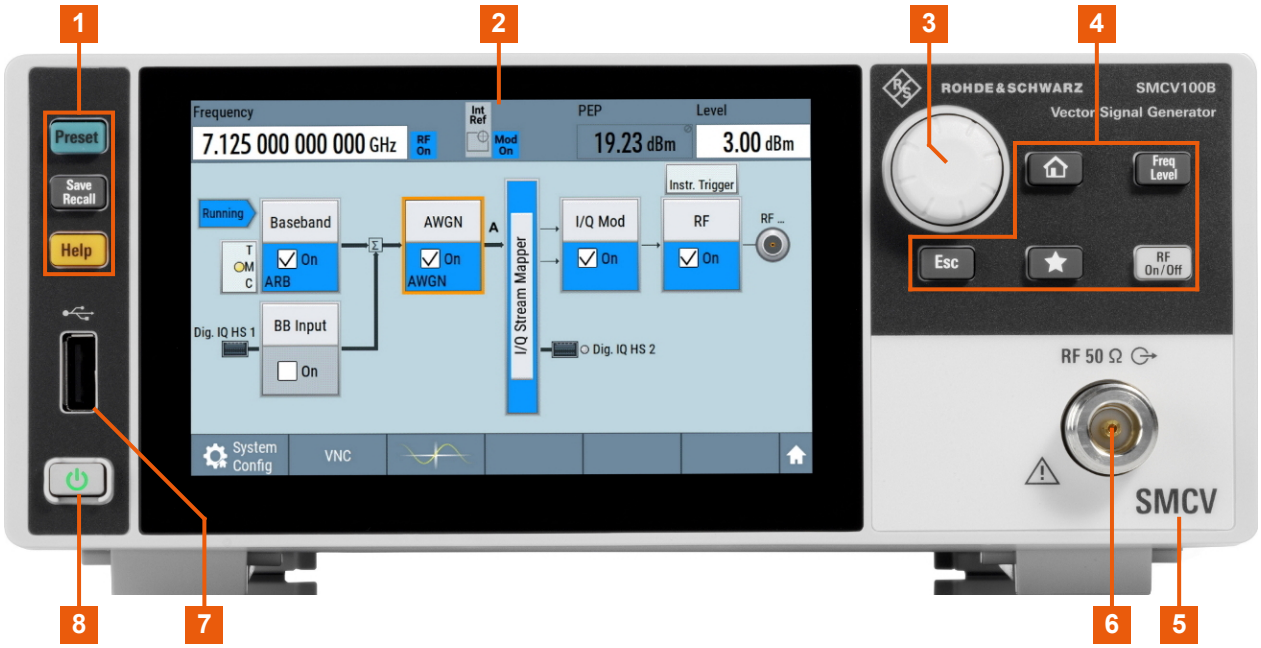


Figure 3-2: Front panel view

1 = Utility keys
2 = Touchscreen
3 = Rotary knob
4 = Function keys
5 = Product family name
6 = RF 50 Ω
7 = USB
8 = On/Standby key

3.2.1.1 Touchscreen

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

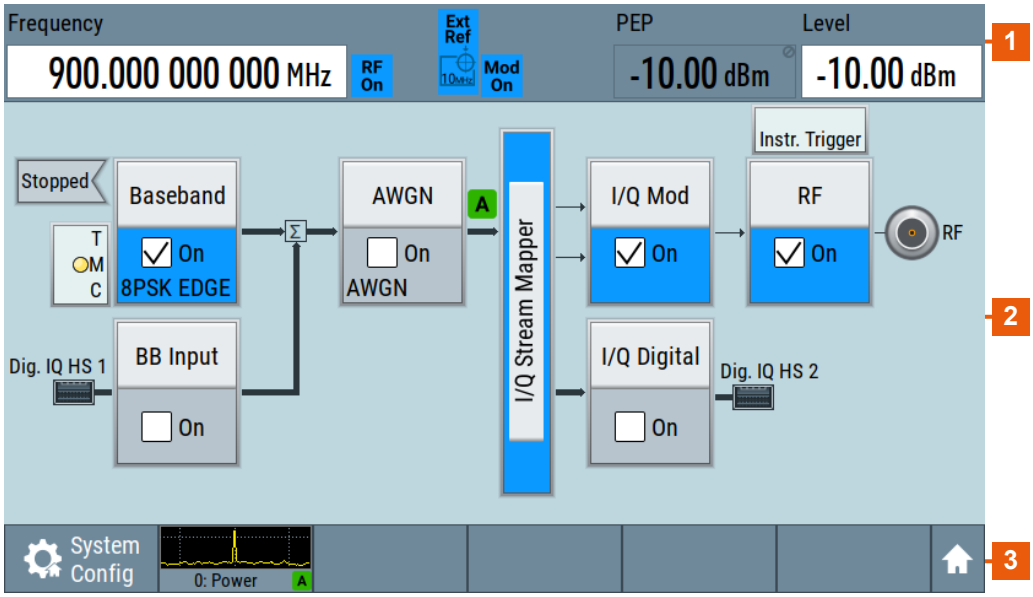


Figure 3-3: Touchscreen elements

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

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

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

See also:

- Section 3.5.1, "Means of manual interaction", on page 62, for operating the touchscreen.
- Section 17.1, "Cleaning", on page 879, for cleaning the screen.

3.2.1.2 Keys

On/Standby key

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

The LED below the [On/Standby] key indicates the instrument state, see Section 3.1.15, "Switching on or off", on page 33.

Utility keys

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

For more information, see Section 12, "General instrument functions", on page 451.

Table 3-3: Utility keys

Utility key	Assigned functions
[Preset]	Sets the instrument to a defined state.
[Save/Recall]	Opens the file manager to save or load an instrument configuration. Accesses the file manager
[Help]	Opens the "Help" dialog and displays the description for a context-sensitive help topic.

Function keys

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

Table 3-4: Function keys

Function key	Assigned functions
[Home]	Brings the block diagram to the foreground and minimizes opened dialogs.
[Freq/Level]	Pressing once: Enables frequency entry. Pressing twice: Enables level entry. Toggles between frequency and level entry.
[★ (User)]	User key with a customizable function.
[RF On/Off]	Switches the RF output on and off. The status bar above the block diagram displays the current RF output state.
[Esc]	For non-edit mode, closes all kinds of dialog boxes analogous to tapping the "Cancel" button. In edit mode, quits this mode and keeps the last entry during editing.

Rotary knob

The rotary knob has several functions:

- Increments (clockwise direction) or decrements (counterclockwise direction) numeric instrument parameters at a defined step size.
- Moves the selection, e.g. to a function block in the block diagram.
- Shifts the selection bar within focused areas (e.g. lists).
- Activates editing of entries or confirms and terminates entries.
- Opens a context-sensitive menu, if you press and hold the knob.

3.2.1.3 Connectors

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

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

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

How to: Section 3.1.9, "Connecting USB devices", on page 28

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

How to: Section 3.1.11, "Connecting to RF 50 Ω", on page 31

3.2.2 Rear panel tour

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

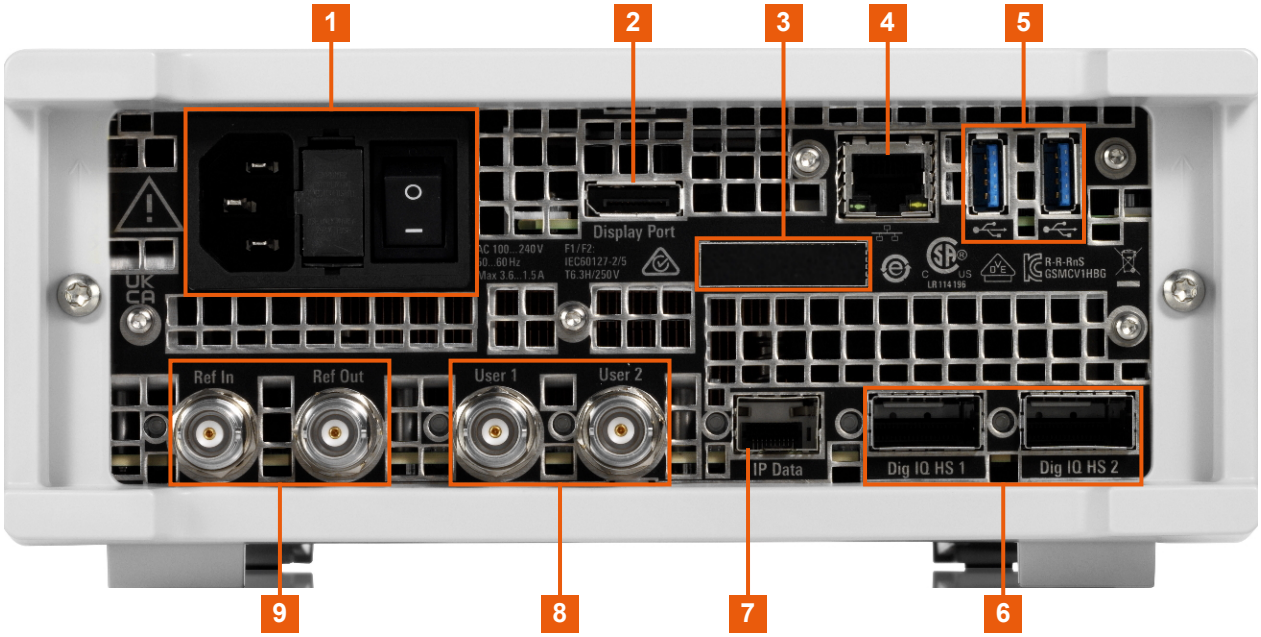


Figure 3-4: Rear panel

1 = AC power supply connector and switch
2 = Display Port
3 = Serial number (six digits in the string 1432.7000.02-<serial number>-<checksum>)
4 = LAN
5 = USB
6 = Dig. IQ HS x
7 = IP Data
8 = User x
9 = Ref In/Ref Out

3.2.2.1 Connectors

AC power supply connector and switch
Mains power switch for performing the following tasks:

- Connecting the internal power supply to the power source

- Disconnecting the internal power supply from the power source

How to: Section 3.1.6, "Connecting to power", on page 27.

Display Port
Display Port monitor connector.

How to: Section 3.1.8, "Connecting a monitor", on page 28

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

How to: Section 3.1.7, "Connecting to LAN", on page 27

USB
Two female USB (universal serial bus) 3.0 connectors of type A (host USB). They have the same functionality as the USB connectors on the front panel, but provide higher data rates. See "USB" on page 38.

How to: Section 3.1.9, "Connecting USB devices", on page 28.

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

Table 3-5 lists the interface designation (input/output) and the required option.

For more information, refer to the specifications document.

Table 3-5: Overview of Dig. IQ HS x interfaces and required options

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

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

How to: Section 3.1.13, "Connecting to Dig. IQ HS x", on page 31

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

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

How to: "To connect to IP Data interface" on page 32

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

Table 3-6 lists the signals assigned to the User x connectors in the default instrument state.

Table 3-6: Default configuration of the User x connectors

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

A dedicated LED indicates the connector status:

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

See also Section 12.2, "Configuring global connectors", on page 456.

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

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

How to: Section 3.1.12, "Connecting to Ref In/Ref Out", on page 31

3.3 Trying out the instrument

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

The complete description of the functionality and its usage is given in the R&S SMCV100B user manual. Basic instrument operation is described in Section 3.5, "Operating the instrument", on page 62.

Prerequisites

- R&S SMCV100B equipped with its minimum configuration:
  - Base unit
  - Frequency option R&S SMCVB-B103
- The R&S SMCV100B is connected to the power supply, and started up as described in Section 3.1, "Preparing for use", on page 24.

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

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

Touchscreen operation

For detailed information on touchscreen operation, see Section 3.5.1, "Means of manual interaction", on page 62.

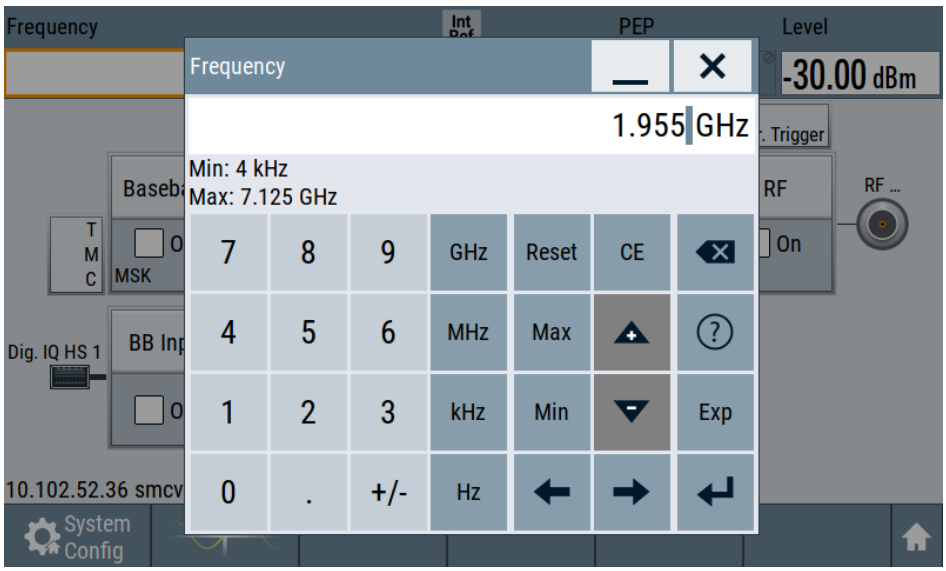
The following sections provide introductory operation examples using the touchscreen.

- Generating an unmodulated carrier 42
- Generating a digitally modulated signal 44
- Triggering the instrument with an external signal 46
- Enabling and configuring a marker signal 50
- Verifying the generated signal 52
- Saving and recalling settings 54
- Generating a DAB signal 56

3.3.1 Generating an unmodulated carrier

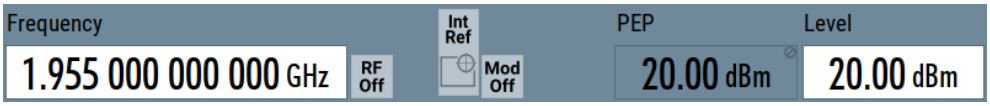
We start out by generating a simple unmodulated signal. The R&S SMCV100B has a minimum configuration as in "Prerequisites" on page 41.

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



The on-screen keypad closes. The status bar displays the frequency of 1.955 GHz.

3. On the status bar, tap the "Level" field to enter the level in the same way.



4. In the block diagram, select "RF" > "On" to enable the output of the generated unmodulated signal.

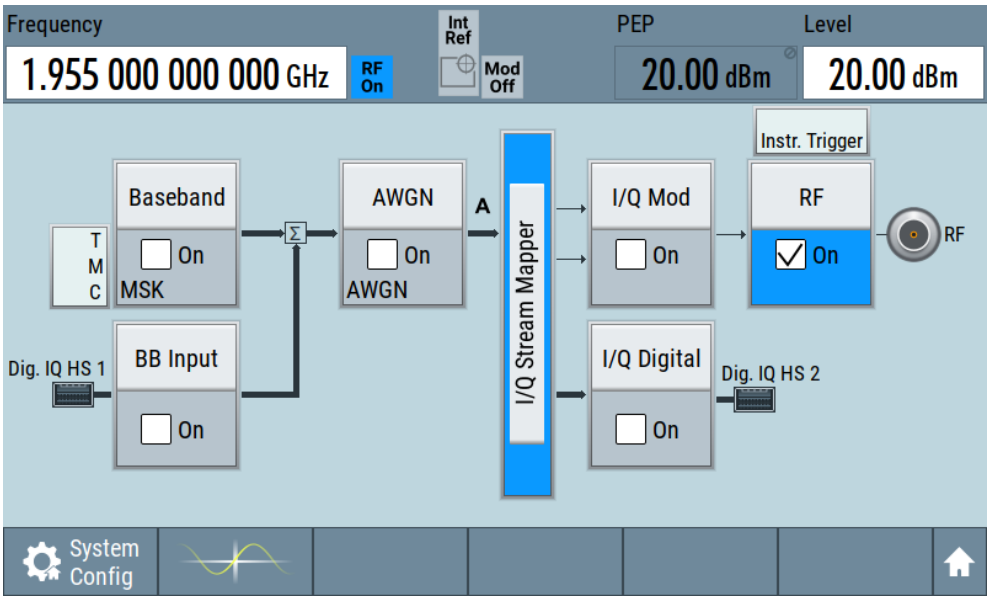


Figure 3-5: Block diagram: Generating an unmodulated signal

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

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

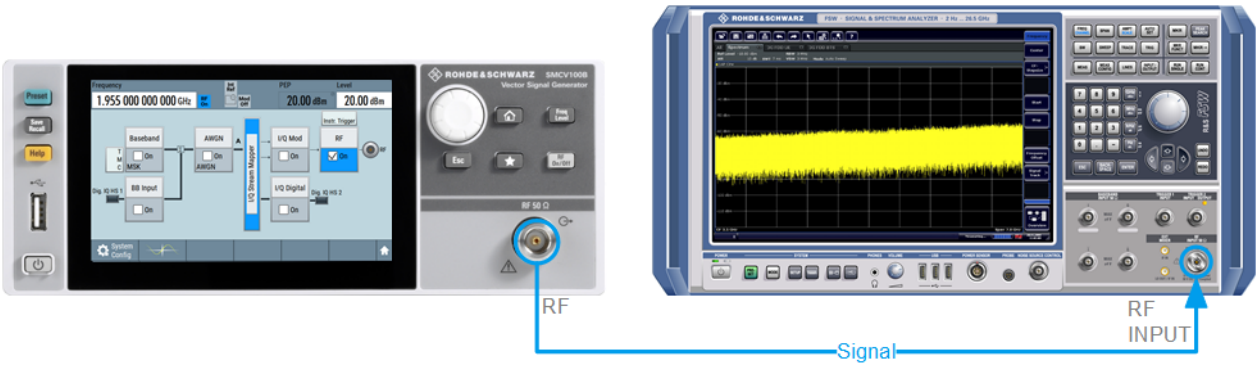


Figure 3-6: Simplified test setup

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

3.3.2 Generating a digitally modulated signal

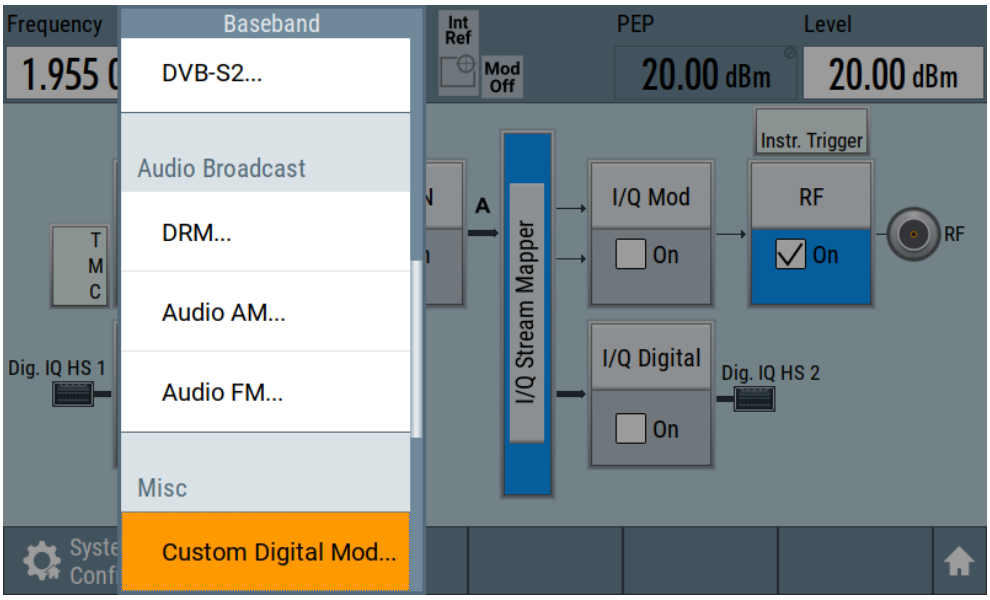
This example shows you how to generate a simple WCDMA-3GPP (QPSK 45° offset) signal with the help of the "Custom Digital Modulation" functionality.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 41
- Option custom digital modulation R&S SMCVB-K199

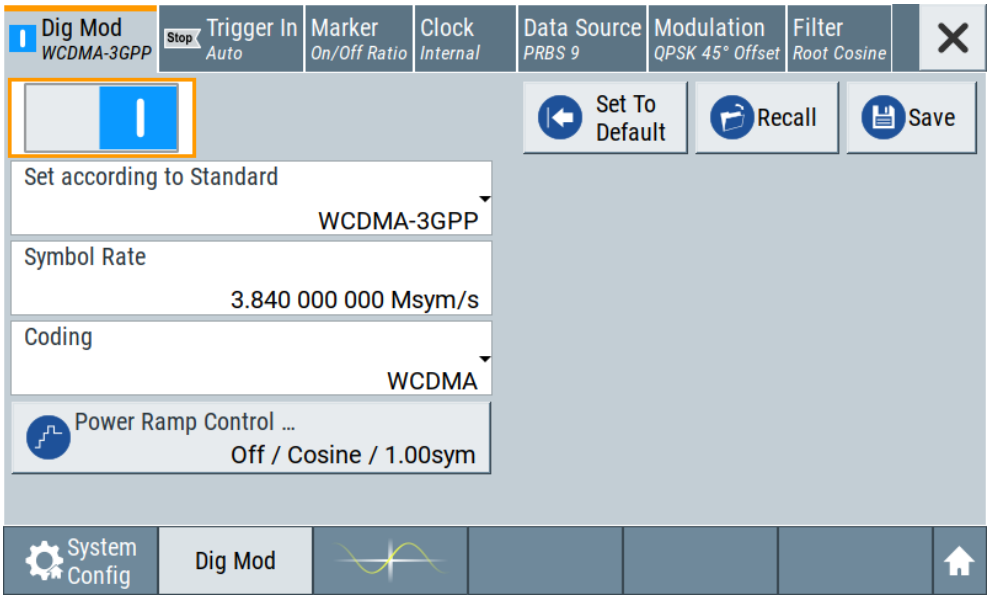
The initial situation is not the instrument's preset state but rather the configuration described in Section 3.3.1, "Generating an unmodulated carrier", on page 42.

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



   The "Dig Mod" dialog opens.

2. In this dialog, select "Set according to Standard" > "WCDMA-3GPP".
3. Select "State" > "On" to enable signal generation.



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

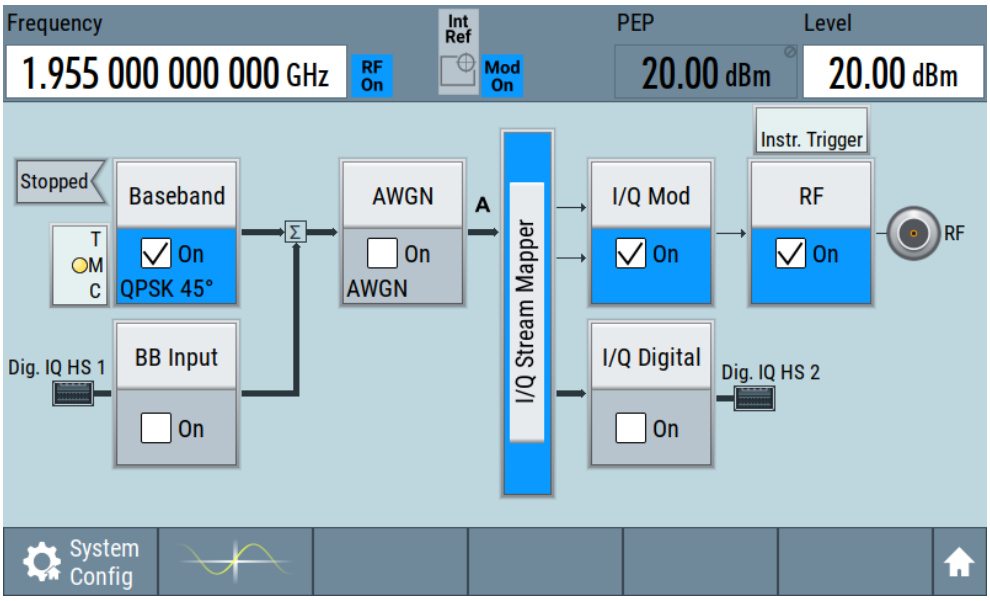


Figure 3-7: Block diagram: Generating a digitally modulated signal

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

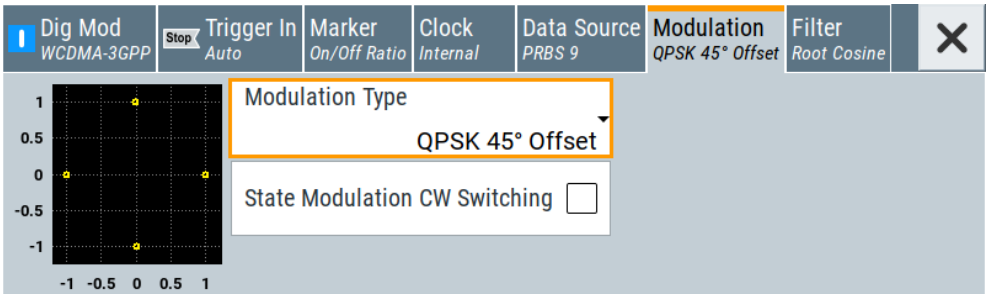


Figure 3-8: Display of the modulation type

3.3.3 Triggering the instrument with an external signal

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

Prerequisites

- Minimum configuration as in "Prerequisites" on page 41
- Option custom digital modulation R&S SMCVB-K199

As a rule, whenever a test setup requires two or more devices, provide them with a common reference frequency. Some test setups require control of the signal generation start and an exact generation start time, determined by a defined trigger event. For example, by triggering the instrument internally or externally from the DUT.

The example below illustrates the general principle of external triggering and extends the configuration performed in Section 3.3.2, "Generating a digitally modulated signal", on page 44 by the configuration of the required trigger signal and connector settings.

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

To start signal generation synchronous to an external global trigger signal

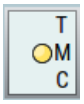
The configuration requires three main steps with the following goals:

1. Observe the current connector configuration. Define an input connector for the external global trigger signal.
   See "To verify the current connector configuration" on page 47
2. Configure the baseband to use the external global trigger signal as the trigger source.
   See "To reconfigure the trigger settings" on page 48
3. Connect the instrument and the external trigger source.
   See "To connect the instrument and the external trigger source" on page 49

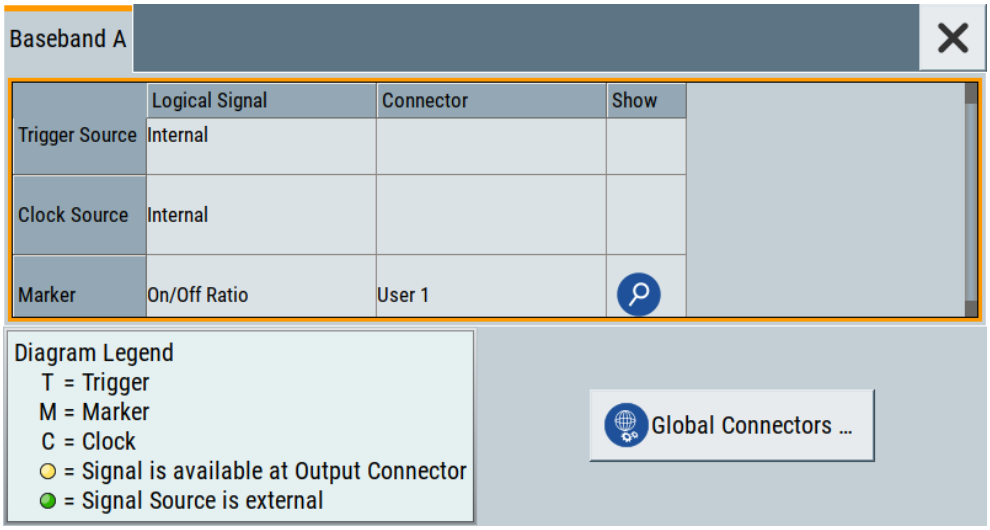
To verify the current connector configuration

The R&S SMCV100B is equipped with multipurpose bi-directional User connectors. Because the signal direction, input or output, and the signal mapping are configurable, we recommend that you check the current configuration before cabling or further instrument's configurations.

1. To display an overview of the current mapping of the logical signals to the connectors, perform one of the following:
   - In the block diagram, select the "T/M/C" status LEDs on the left side of the "Baseband" block.

   - Select "Baseband" > "Trigger / Marker / Clock".

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

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

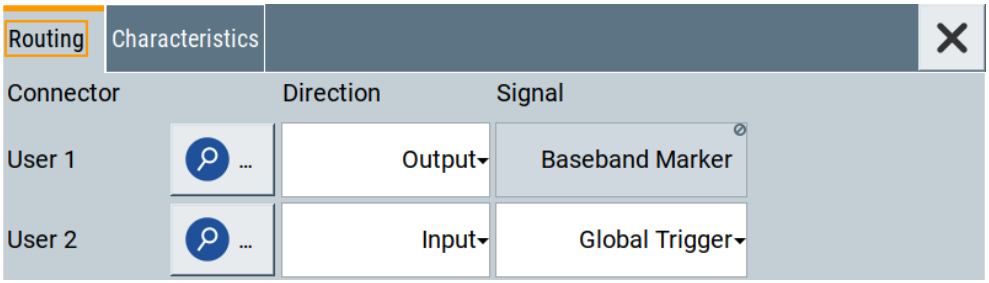
     

Figure 3-9: Signal mapping to the global connectors

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

3. Alternatively, proceed as follows:
   a) Select "Baseband" > "Misc" > "Custom Digital Mod".
   b) Select the "Trigger In" tab.
   c) Select "Global Connector Settings".

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

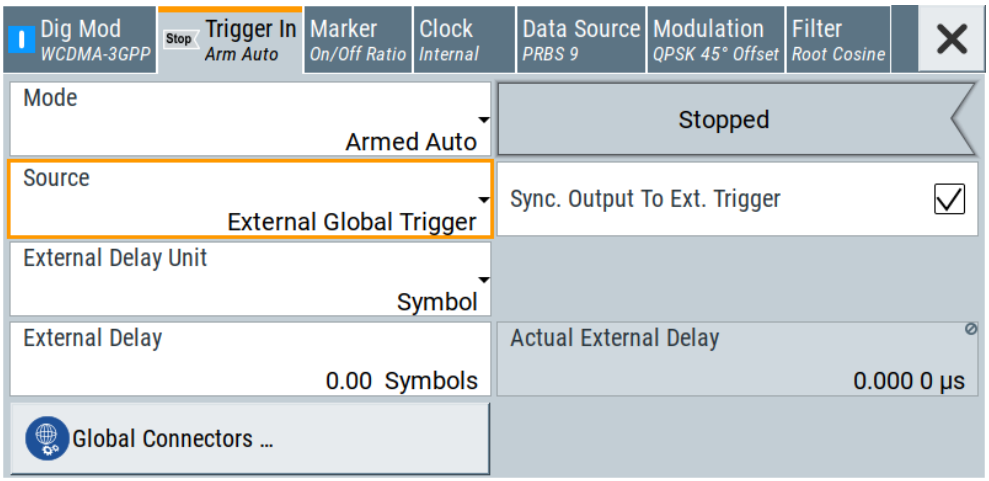
Find the physical location of each connector

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

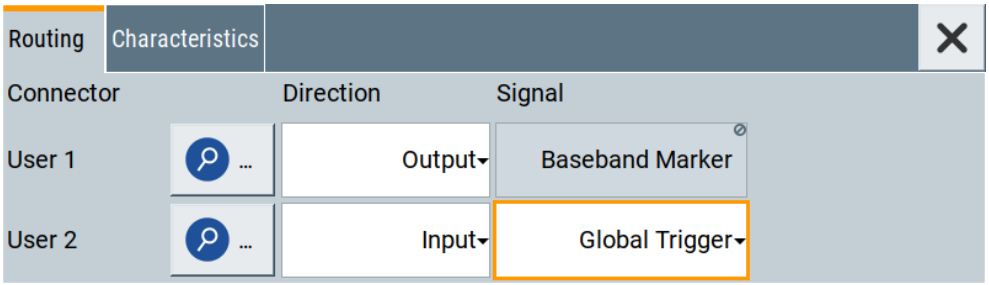
To reconfigure the trigger settings

We assume that the instrument is configured as described in Section 3.3.2, "Generating a digitally modulated signal", on page 44 and the default connector mapping is maintained (see Figure 3-9).

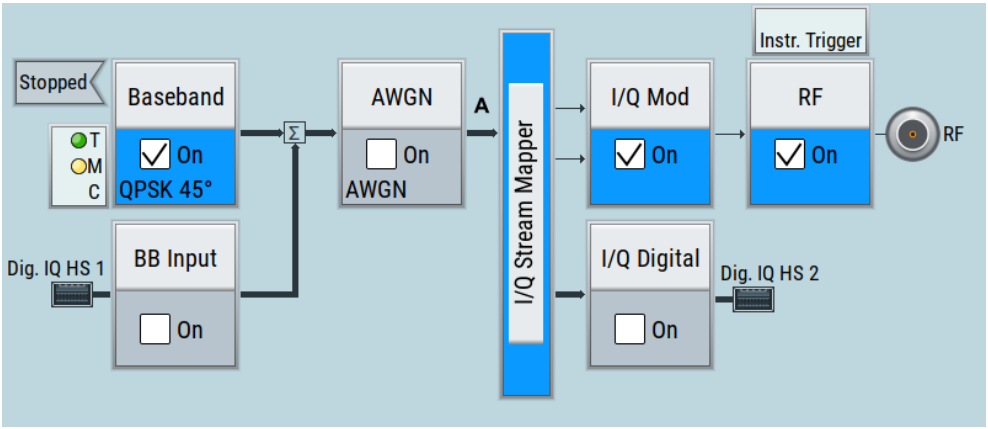
1. In the block diagram, select "Baseband" > "Misc" > "Custom Digital Mod" > "Trigger In".
2. Select the following settings:
   a) "Mode" > "Armed Auto"
   b) "Source" > "External Global Trigger".



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



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



To connect the instrument and the external trigger source

1. Use a suitable cable to connect the external trigger source to the "User 2" connector of the R&S SMCV100B. See Figure 3-10.

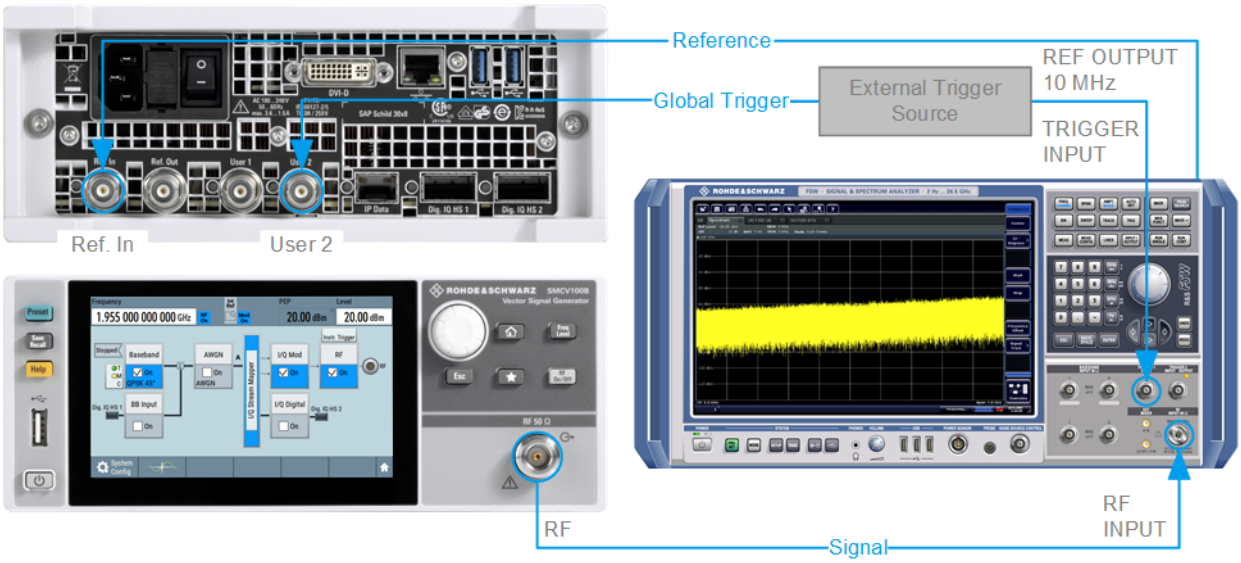


Figure 3-10: Simplified representation of a test setup*

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

The Figure 3-10 depicts the location of the connectors and explains the connection as principle. In practice, the analyzer is the DUT, for example a base station. Other than in the example, the DUT can be the source for the reference signal. Instead of using an external trigger source, the DUT can also send, for example, a frame trigger signal to the R&S SMCV100B. The R&S SMCV100B acts still as the signal source.

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

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

See also the following:

- Section 4.4.1.5, "About trigger signals", on page 84
- Section 12.2, "Configuring global connectors", on page 456

3.3.4 Enabling and configuring a marker signal

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

The R&S SMCV100B provides one marker signal. You can output this marker signal at the "User 1" and/or "User 2" connectors on the rear panel. With suitable marker set-

tings, you can mark slot or frame boundaries or mark the start of a particular modulation symbol.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 41
- Option custom digital modulation R&S SMCVB-K199

This example extends further the configurations performed in Section 3.3.2, "Generating a digitally modulated signal", on page 44. We assume a default connector mapping (see Figure 3-9).

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

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

   Generated is a periodic marker with marker frequency of 120 kHz. The signal is output at the User 1 connector of the R&S SMCV100B, see Figure 3-9.
3. Use a suitable cable to connect the User 1 connector of the R&S SMCV100B to the monitoring instrument, for example an oscilloscope like R&S®RTO. See Figure 3-11.

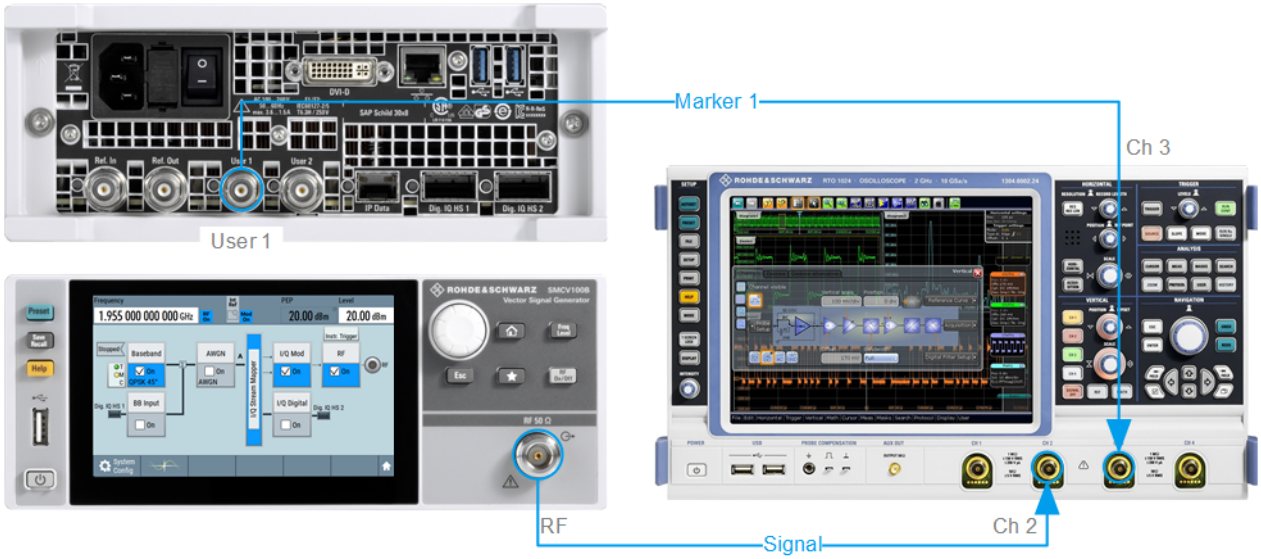


Figure 3-11: Simplified representation of a test setup for signal monitoring*

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

4. Use a suitable cable to connect the "RF 50 Ω" on page 39 connector of the R&S SMCV100B to the monitoring instrument.

For more information, see Section 4.4.1.4, "About marker signals", on page 82.

3.3.5 Verifying the generated signal

It is often useful to check the spectra of the configured signals, before you enable the RF output of the instrument. The R&S SMCV100B has a minimum configuration as in "Prerequisites" on page 41.

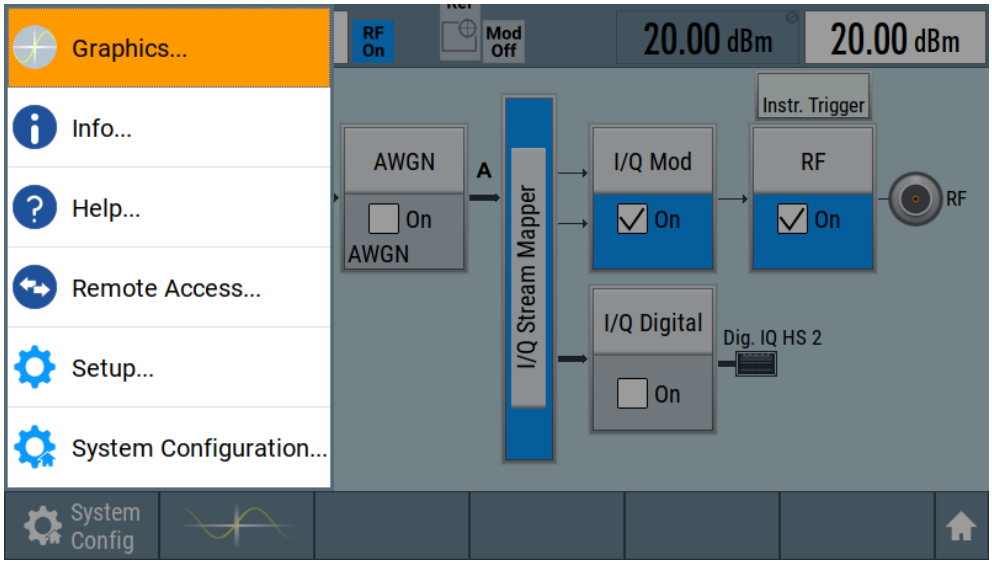
The R&S SMCV100B provides a build-in function to represent the generated signal on a graphical signal display. We demonstrate this feature by showing the characteristics at one particular point of the signal processing chain. You can, however, display the signal characteristics at other different stages.

This example shows you how to use this graphical display to verify the generated signal. Use the signal generated in Section 3.3.4, "Enabling and configuring a marker signal", on page 50.

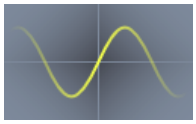
To access the graphical signal display functionality

► Perform one of the following:

- In the taskbar, select "System Config" > "Graphics".



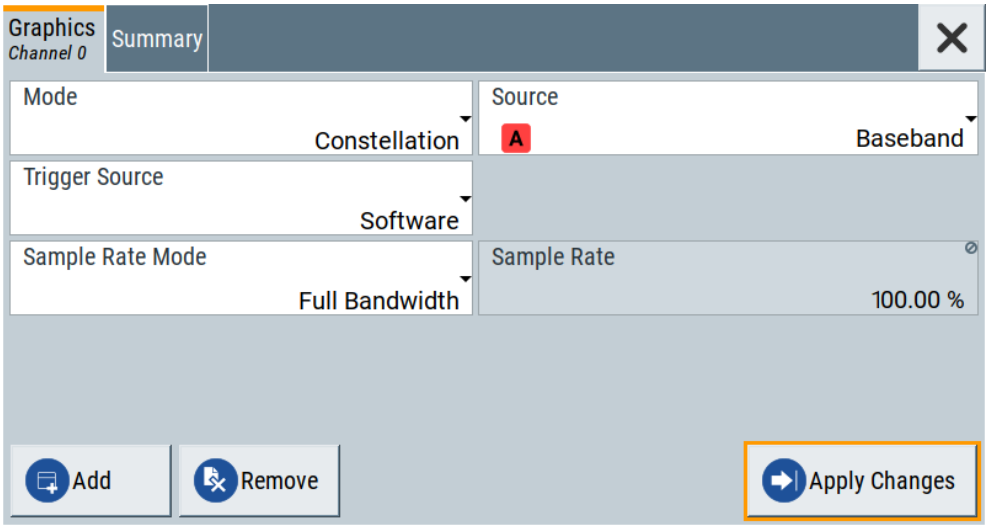
- On the "Taskbar", tap the wave icon.



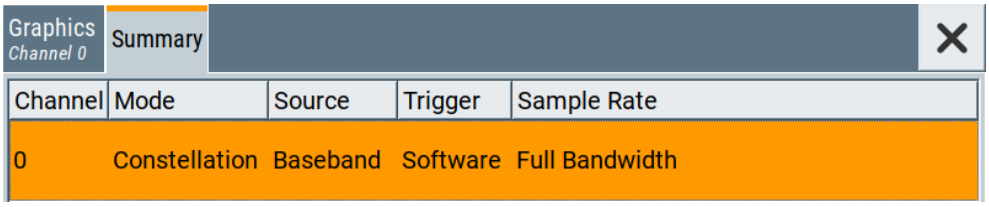
The "Graphics Configuration" dialog opens.

To visualize the signal

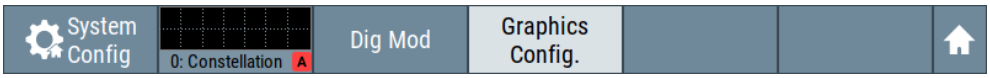
1. In the "Graphics Configuration" dialog, select "Mode" > "Constellation".
2. Select "Source" > "Baseband".
3. Select "Add" to enable signal display.



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

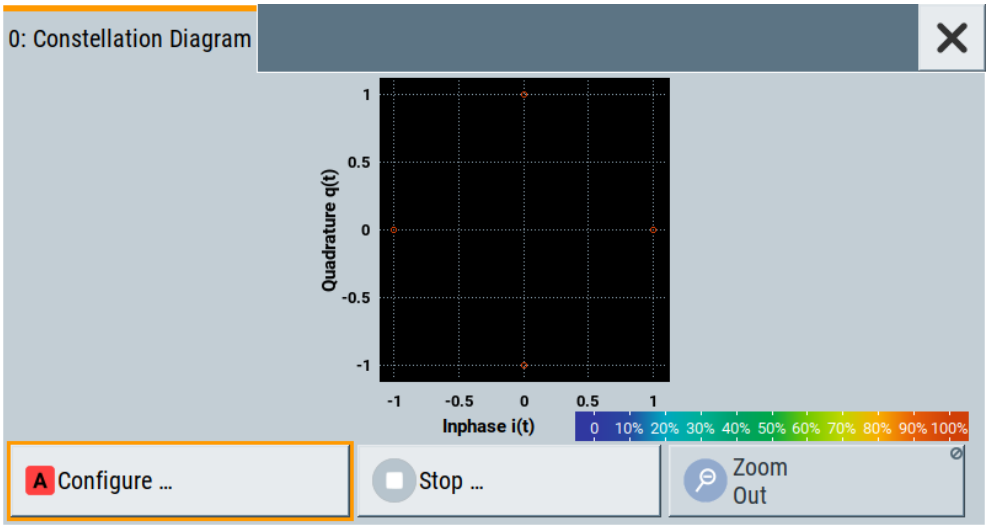


A new thumbnail (minimized view) indicating the active diagram appears in the "Taskbar".



4. Press the thumbnail graphic.

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



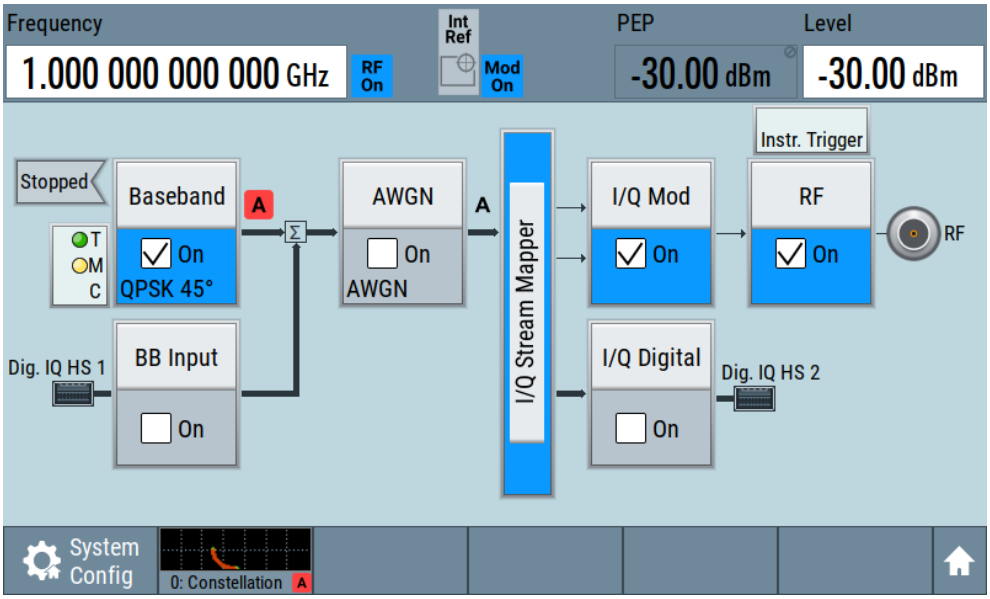
The "Constellation Diagram" displays the 3GPP FDD signal.

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

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

   This action has no effect on the configured graphics but on the dialog itself.

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



See also Section 9, "Monitoring baseband signal characteristics", on page 392.

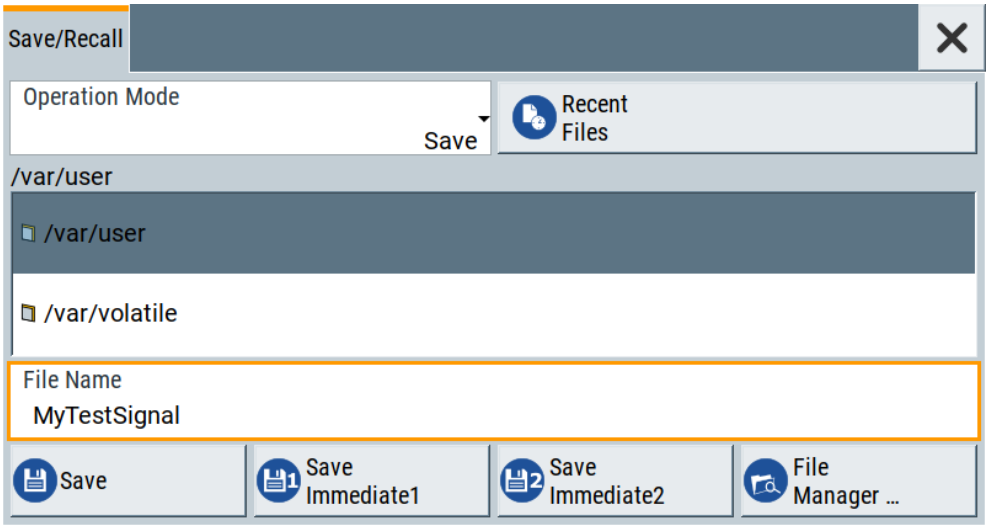
3.3.6 Saving and recalling settings

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

To save the instrument settings to a file

We assume a test configuration as described in Section 3.3.4, "Enabling and configuring a marker signal", on page 50.

1. Press the [Save/Recall] key on the front panel.
2. In the "Save"/"Recall" dialog box, select "Operation Mode" > "Save".
3. Tap "File Name".
4. Use the on-screen keyboard to enter the filename *MyTestSignal*



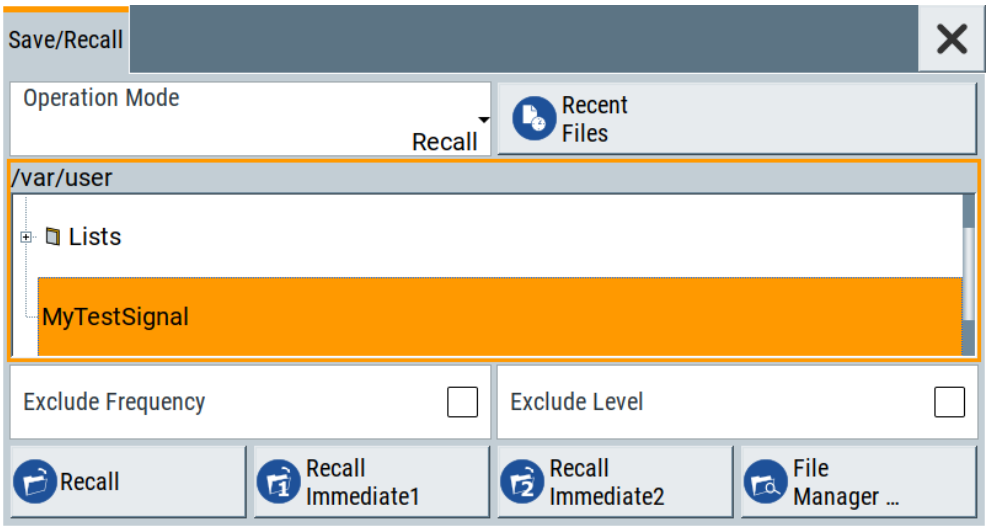
5. Tap the "Save" button.

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

To load saved instrument settings

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

1. Press the Preset button to restore the default instrument settings.
2. Press the Save/Recall key.
3. In the "Save"/"Recall" dialog, select "Recall" operation.
   Navigate to the directory of the saved file. Select the `MyTestSignal` file.



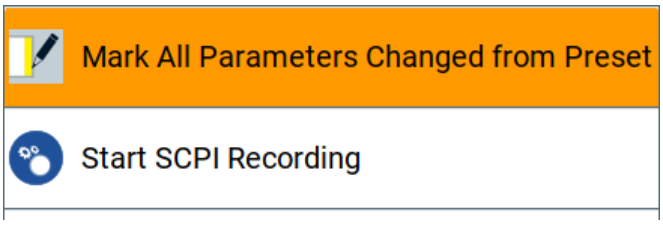
4. Tap the "Recall" button.

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

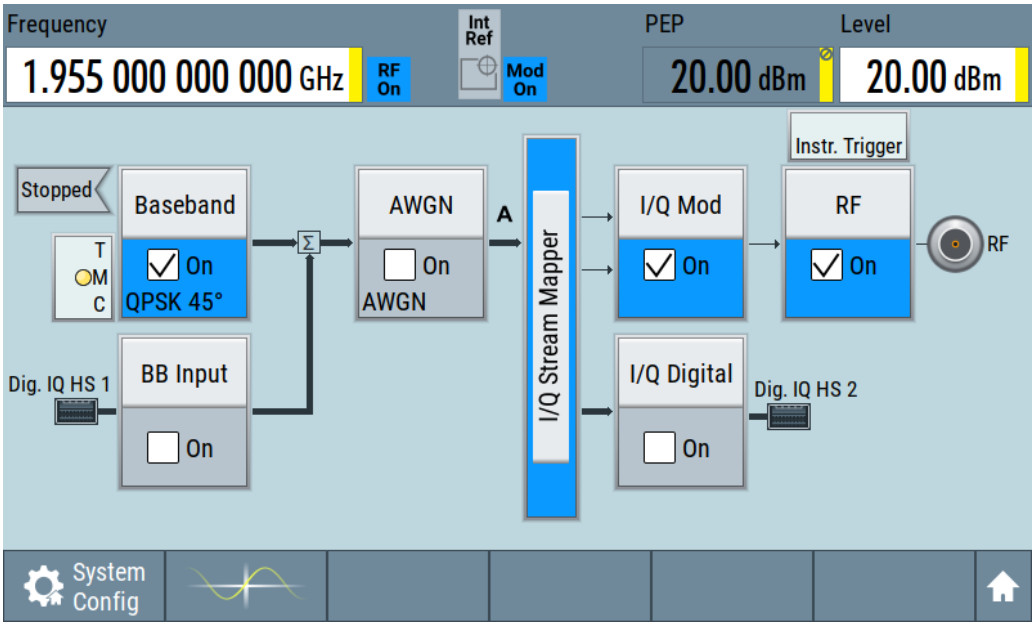
To display parameters different to their preset values

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

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



All changed parameters are highlighted.



See also Section 11, "File and data management", on page 418.

3.3.7 Generating a DAB signal

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

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

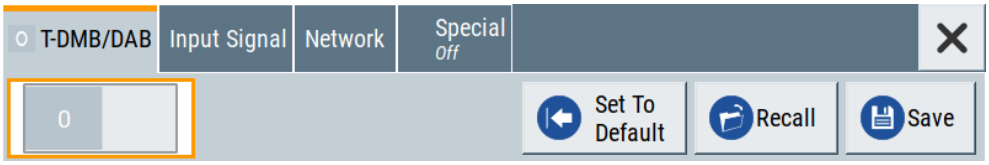
Prerequisites

- Minimum configuration as in "Prerequisites" on page 41
- Option Enable Broadcast Standard R&S SMCVB-K519
- Option DAB/T-DMB R&S SMCVB-K156

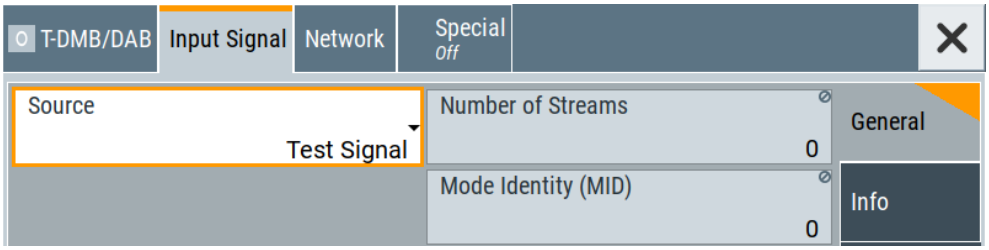
To generate a DAB test signal

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

   The dialog provides the general settings for the digital standard.



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



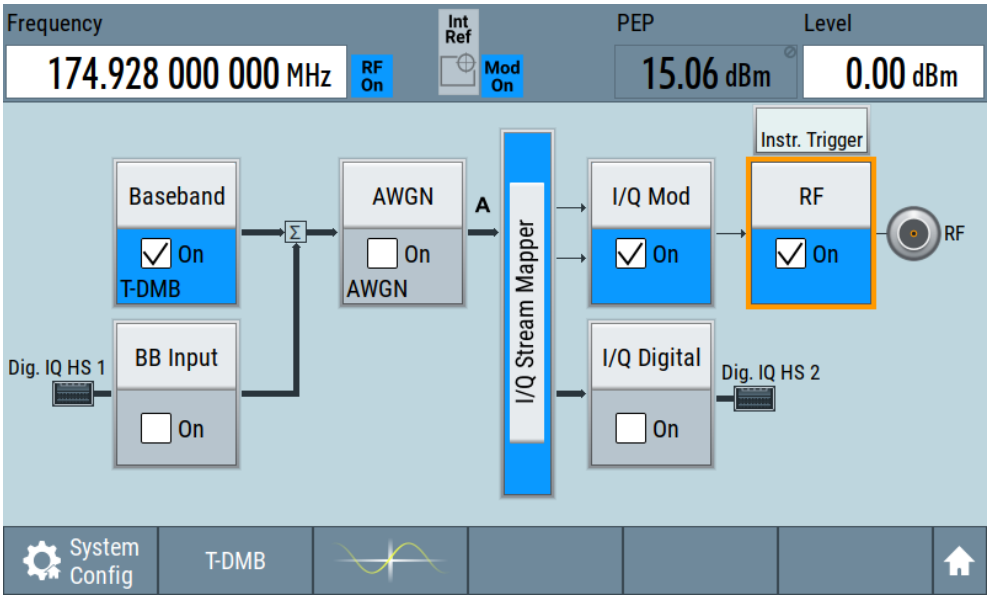
   The test signal is a signal with audio content.

   Tip: On the front panel, press the Help key to retrieve detailed information on the current settings and on the contents of the predefined files.
4. In the "T-DMB/DAB" tab, select "State" > "On".



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

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



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

For a comprehensive description of the full range of capabilities, refer to the user manual R&S SMCVB-K156 T-DMB/DAB.

3.4 System overview

This section helps you to get familiar with the R&S SMCV100B. It provides an introduction to the general concept of the instrument. This section also introduces the main blocks in the signal generation flow.

For information on how to access functions and interact with the R&S SMCV100B, refer to Section 3.5, "Operating the instrument", on page 62.

3.4.1 Brief introduction to the instrument's concept

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

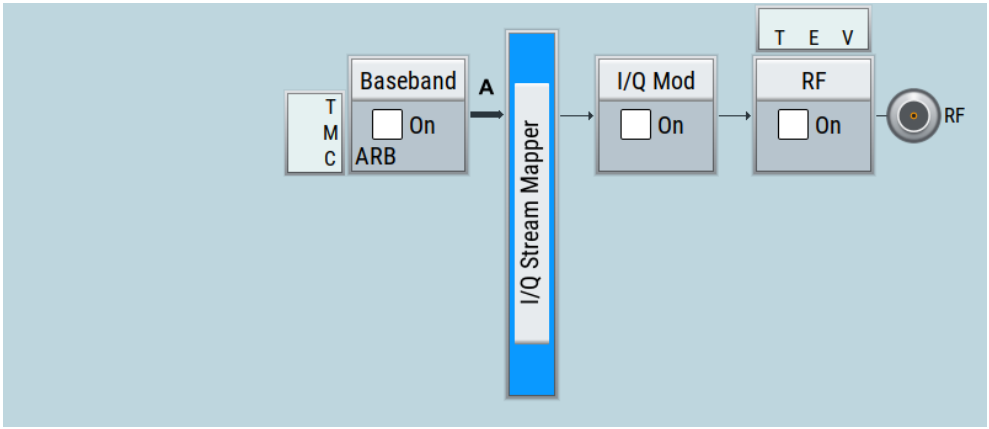
3.4.2 Signal flow at a glance

The R&S SMCV100B is equipped with a large touchscreen, that displays a block diagram. The block diagram represents the signal flow and the general stages the signal

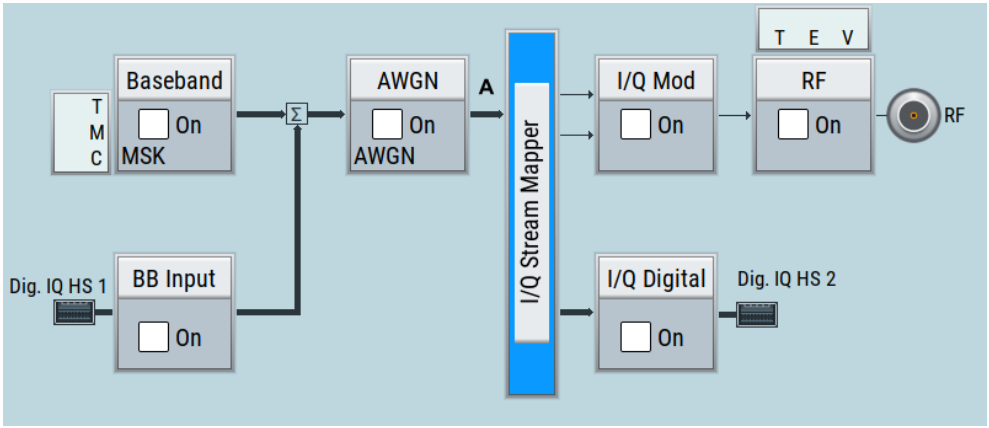
generation goes through. Depending on the options the R&S SMCV100B is equipped with, the appearance of the block diagram changes.

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

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



- An example of a fully equipped instrument.
  The block diagram displays all blocks for installed software options. Arrows within the block diagram indicate the signal flow.



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

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

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

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

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

3.4.3 Internal baseband source ("Baseband" block)

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

This functional block is the access point to:

- *The internal baseband generator*
  The baseband generator contains modules for real-time signal generation ("Custom Digital Modulation" requires R&S SMCVB-K199) and an arbitrary waveform generator (ARB).
- *The available digital standards*
  Generation of digital signals in accordance with the supported standards requires additional software options. For example, option R&S SMCVB-K162 generates signals according to the ATSC 3.0 standard.
- *The baseband offsets function*
  Signals from the baseband generator can be shifted in frequency and phase.

3.4.4 Digital baseband input/output ("BB input"/ "I/Q digital" block)

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

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

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

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

- *The external digital I/Q signals*
  The external digital I/Q signals are further processed in the baseband section.
- *The baseband offsets function*

The external and internal baseband signals can be shifted in frequency and phase.

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

3.4.5 Additional white gaussian noise ("AWGN" block)

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

3.4.6 "I/Q stream mapper" block

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

3.4.7 I/Q modulator ("I/Q mod" block)

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

This functional block is the access point to:

- The I/Q modulation of the internal baseband signal
- The digital I/Q impairments

3.4.8 RF ("RF" block)

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

This block is the access point to:

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

3.4.9 Applications examples of the R&S SMCV100B

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

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

- Generation of signals with up to 240 MHz signal bandwidth (R&S SMCVB-K523)

3.5 Operating the instrument

This chapter provides an overview on basic operating tasks. There are three ways to operate the R&S SMCV100B.

Manual operation

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

Remote control

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

This way of operation is described in Section 13.1, "Overview of remote access modes", on page 510.

Remote operation

For remote monitoring and operation of the instrument, a VNC server is installed on the R&S SMCV100B. You need a LAN connection to the computer, and a VNC client or browser to connect to the instrument.

This way of operation is described in Section 13.1, "Overview of remote access modes", on page 510.

The following sections show how to operate the instrument manually.

- Means of manual interaction....62
- Understanding the display information....63
- Accessing the functionality....68
- Entering data....69
- Undo and redo actions....70
- Getting information and help....70

3.5.1 Means of manual interaction

For the manual interaction with the R&S SMCV100B, you have several methods that you can use as an alternative to perform a task:

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

  Tapping the screen works like clicking mouse buttons:

  – Touch quickly = click: Selects a parameter or provokes an action.

  - Touch and hold = right-click: Opens a context-sensitive menu.
  - Touch and swipe = drag: Scrolls through the contents of a display element larger than the screen, e.g. a list or a table.
- Function keys and rotary knob:
  The front panel provides nearly all functions and controls to operate the instrument in the classic way, without touchscreen.
- Optional mouse and/or keyboard:
  These devices work like known from PCs. The navigation keys on the front panel correspond to the keys on the keyboard.

This manual describes the manual interaction with the instrument via the touchscreen. It mentions the alternative methods using the keys on the instrument or the on-screen keypads if it deviates from the standard operating procedures. The usage of the touch-screen and navigation keys is described in Section 3.5.3, "Accessing the functionality", on page 68.

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

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

3.5.2 Understanding the display information

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

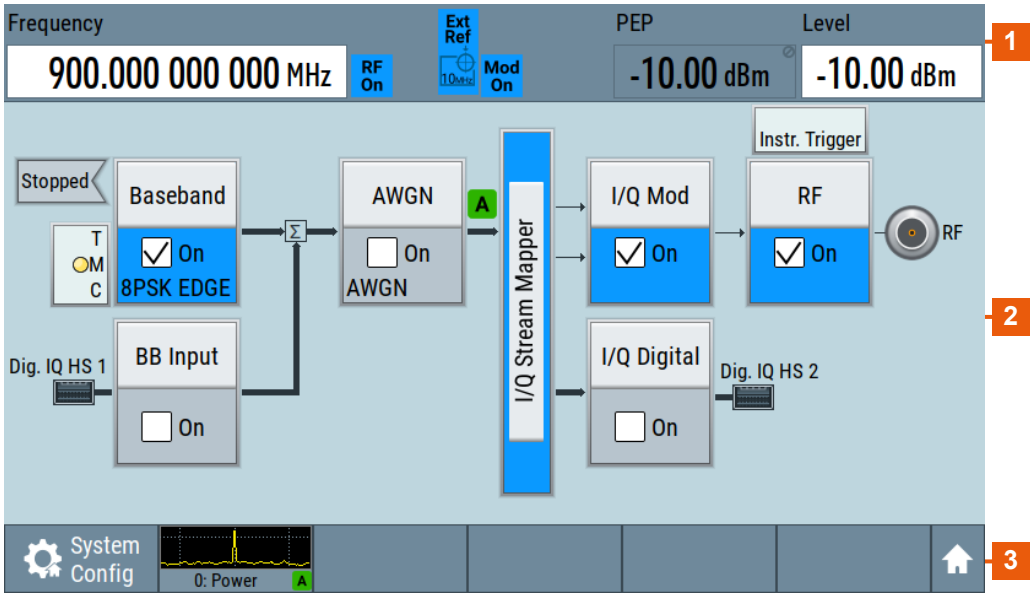


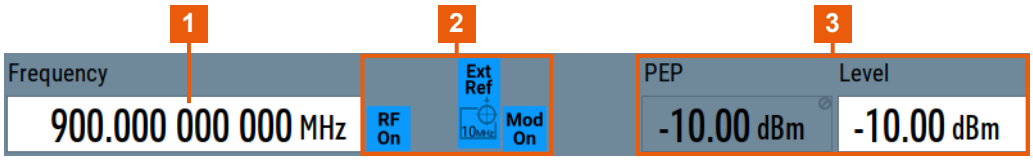
Figure 3-12: Block diagram

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

- Status bar.....64
- Block diagram.....64
- Taskbar.....65
- Additional display characteristics.....66

3.5.2.1 Status bar

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

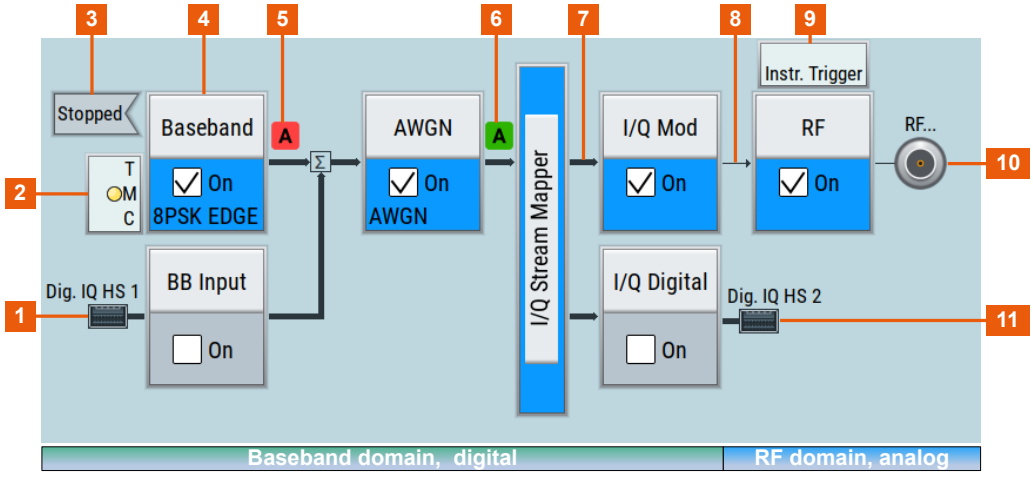


1 = Frequency display
2 = Status buttons
3 = Level display

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

3.5.2.2 Block diagram

The block diagram shows the current configuration and the signal flow in the generator with the aid of function blocks, connected by signal lines. The following figure displays the most common elements that can appear in the block diagram. However, it does not necessarily represent a useful configuration.



1, 10, 11 = Connector icons (digital, RF)
2, 9 = Control signal block
3 = Status indicator
4 = Functional block

5, 6 = Graphics indicator
7 = Signal line (digital)
8 = Signal line (analog)

Starting from the left up to the "I/Q Mod" functional block, you can see the functional blocks provided in the baseband domain. After the I/Q modulation on the analog RF carrier, the analog section implies the routing to the "RF" functional block.

Legend	Item	Description
1, 10, 11	Connector icon	Represents the interfaces for signal input and output. • Digital I/Q HS signal connector input and output (1, 11) • RF signal connector output (10) Icons vary depending on the frequency.
2, 9	Control signal block	Indicates information on the control signals like signal content, input or output and provides quick access to the corresponding configuration dialog. A dedicated control block is displayed to the left of the baseband block (2) and above the RF block (9).
3	Status indicator	Indicates whether the signal is running or waiting for a trigger.
4	Functional block	Represents a basic task in signal generation. The push button provides access to any number of associated actions to accomplish the task. The On/Off (checkbox) and the block label quickly enables the basic task.
5, 6	Graphics indicator	Denotes that the signal is displayed graphically: • Baseband signal after the baseband block (5) • Stream signal before mapping (6)
7, 8	Signal line • digital • analog	Shows the currently configured signal flow: • Thick lines represent digital I/Q streams (7). • Thin lines represent analog signals (8).

3.5.2.3 Taskbar

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

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



Figure 3-13: Taskbar in default state

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

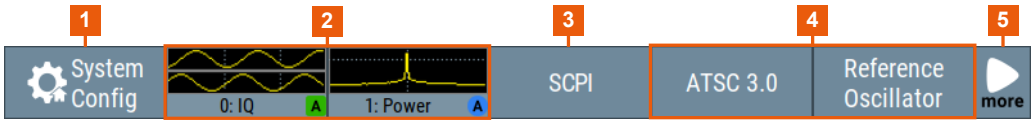


Figure 3-14: Taskbar fully assigned

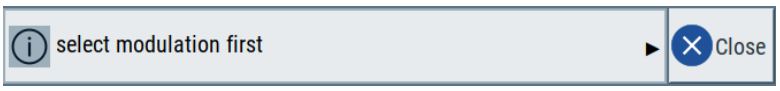
1 = System configuration
2 = Graphics
3 = Remote control connections
4 = Dialogs
5 = Diagram / more

1	System Config	Provides access to general system configurations like setup, display, or remote.
2	Graphics	Shows that a signal is represented graphically.
3	Remote	Shows the established remote connections when the instrument is remotely controlled. **Tip:** An indicator in the status bar shows the current remote control status.
4	Dialogs	Shows a dialog as a thumbnail, the dialog name, and the name of the signal channel.
5	Diagram / more	The diagram icon as shown in Figure 3-13 minimizes all dialogs indicated on the screen. The block diagram is in the foreground. The "More" softkey indicates that more dialogs are open than can be displayed in the taskbar. Use this softkey to open a selection list with the remaining active dialogs, and the "Diagram" function.

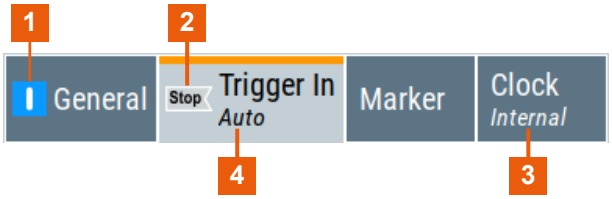
3.5.2.4 Additional display characteristics

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

- **Appearance of active elements**
  - *Active* elements like On/Off switches, state buttons have a **blue** background.
  - *Selected* elements are framed or highlighted **orange**.
  - *Inactive* elements are **gray**.
- **On-screen keypads**
  As an additional means of interacting with the instrument without having to connect an external keyboard, either a numerical or alphanumerical on-screen keypad appears when you enable an entry field (see Section 3.5.4, "Entering data", on page 69).
- **Info line**
  The "Info line" shows brief status information and error messages. It appears when an event generates a message. If selected, the R&S SMCV100B shows information on static errors and the error history.

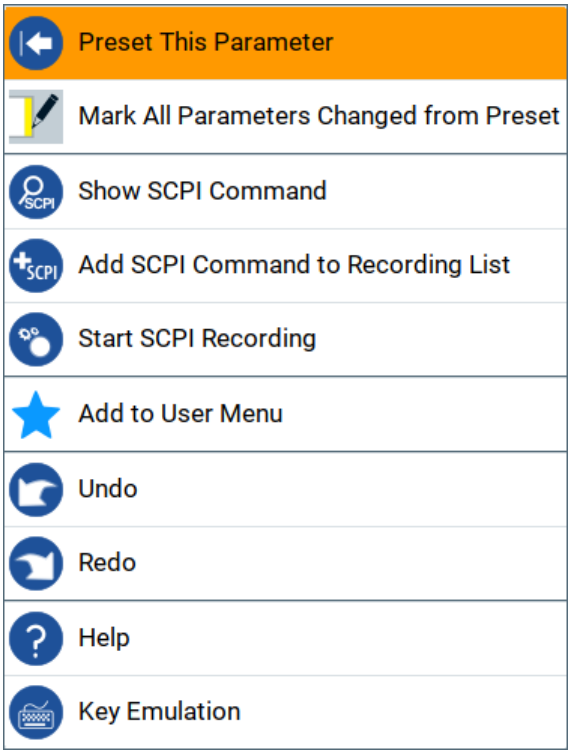


- **Key parameters indicated in tab labels**
  Most dialogs are divided into tabs with logically grouped parameters. The tab label expresses the content and can also contain status indicators or the set value of a key parameter.



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

- **Scrollbar handle**
  An arrow icon that appears when you touch a scrollbar helps you to scroll in a dialog or list.
- **Progress indicators**
  A busy icon indicates a currently running process. If a process takes some time, a progress bar shows the current state.
- **Context-sensitive menus**
  Within the entire screen display, including single parameters, you can access context-sensitive menus that provide some additional functions.



3.5.3 Accessing the functionality

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

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

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

To open a dialog box

► Perform one of the following actions:

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

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

To minimize a dialog box

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

To close a dialog box

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

► Perform one of the following actions:

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

To select an option in a dialog box

► Select the required option.

To select an option in a list

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

1. Select in the list.
2. To navigate through the list, try out the following:
   - Using a mouse, scroll in the list to select the required option.

- Use the rotary knob.

3.5.4 Entering data

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

To enter numeric values with the on-screen keypad

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

1. Enter the numeric value.

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

2. Tap the unit button to complete the entry.

   The unit is added to the entry.

   Tip: For a quick unit change, you can enter shortcuts, for example for a frequency value *1e8h* for *100 MHz*.
   For an overview of shortcuts supported by the R&S SMCV100B, see Section C, "Unit shortcuts", on page 901.

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

If you edit numeric data in tables, enable edit mode first. Press the rotary knob to enable the edit mode.

To enter alphanumeric values

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

To complete an entry

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

To correct an entry

1. Using the arrow keys, move the cursor to the right of the entry you want to delete.
2. On the on-screen keyboard, press "Clear".
3. Enter your correction.

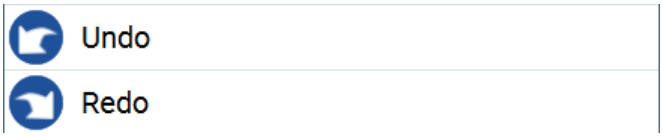
To abort an entry

► Press the [Esc] key.

The dialog box closes without changing the settings.

3.5.5 Undo and redo actions

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



"Redo" restores a previously undone action.

3.5.6 Getting information and help

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

For further information, you can use the following sources:

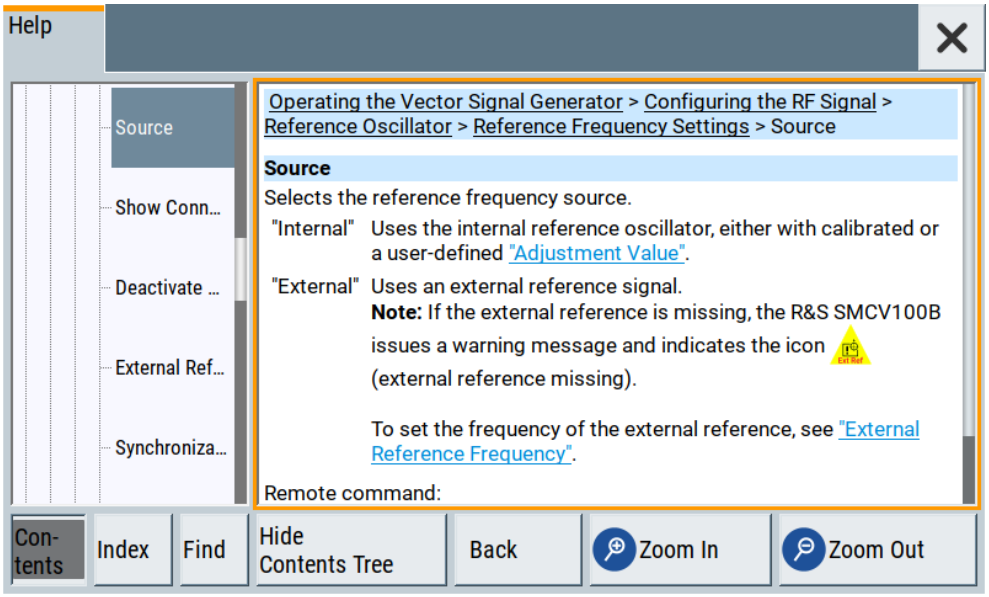
- Tooltips give the value range of the parameter.
- The context help provides a functional description on a setting.
- The general help explains a dialog box, provides instructions, and general information.

To display context help

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

a) Tap and hold the parameter for which you need information and tap "Help" in the context menu.
b) Tap the parameter and press the [Help] key.

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



Contents of the help dialog box

The help dialog box covers two main areas:

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

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

To open general help

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

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

Navigating in the table of contents and in the help topics

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

Using the index

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

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

   The corresponding help topic is displayed.

4 Configuring internal baseband signals

The R&S SMCV100B is a vector signal generator with internal signal generation and real-time functionality and with an integrated arbitrary waveform generator.

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

4.1 Overview of the signal generation modes

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

- "Generating digital modulated signals according to various broadcast standards" on page 73
- Generating a real-time signal
- Playing a waveform

Generating digital modulated signals according to various broadcast standards

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

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

See also Section 4.3, "Generating signals according to broadcast standards", on page 75.

Generating a real-time signal

- While utilizing the *internal* signal generator, the R&S SMCV100B generates the digital modulation signals with user-definable characteristics in real time.
  See also Section 4.5, "Generating custom digital modulation signals", on page 106.
- If the required options are installed, the *internal* signal generator of the R&S SMCV100B also generates frequency, phase, amplitude and pulse modulation signals in real time.
  See also Section 4.10, "Generating FM/PhiM/AM/Pulse Modulation signals", on page 241.
- If the required options are installed, *externally supplied real-time* baseband signals can be added to the internally generated signals.
  See also Section 5.3, "Digital baseband input settings", on page 270.

Playing a waveform

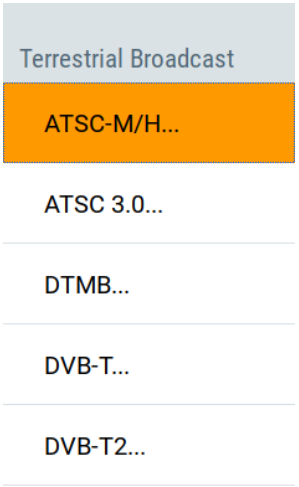
The R&S SMCV100B is equipped with an arbitrary waveform generator (ARB) used to generate test signals and to process waveform files. Waveforms are files with settings provided for repeatable tests with the same test signal. Irrespectively of the way these waveform files are generated, they are always played from the instrument. That is, the signal calculation is performed in advance and the instrument reacts as a player.

- Externally computed waveform files can be loaded in the instrument over the LAN or USB.
  Create waveforms, for example, with the signal generation software R&S WinIQSIM2 or the R&S®Pulse Sequencer software.
- The instrument provides different functions to generate waveforms *internally*.
  - Some of the digital standards firmware options provide the possibility to save the current signal settings into a waveform file. These waveform files can be loaded in and processed as multicarrier or multi-segment signals by the ARB.
    See also Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 138.
  - Multicarrier waveforms consisting of carriers modulated by different baseband signals can be configured and created internally. Such multicarrier waveform files are required to simulate complex multicarrier scenarios with different baseband signals, e.g. CDMA2000®, 3GPP FDD, or signals in accordance with the LTE-Advanced specifications.
    See also Section 4.9, "Generating multicarrier waveform signals", on page 223.

4.2 Accessing the functions in the baseband domain



1. In the block diagram, select the "Baseband" block.
2. Navigate through the context menu.



The "Baseband" block provides all functions and settings concerning the baseband signal. The functions and settings include all generation modes as described in the Section 4.1, "Overview of the signal generation modes", on page 73.

By default, baseband signal generation is off.

3. To enable the baseband generator, set "Baseband" > "On".

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

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

   For more information, see the following sections:
   - Section 4.5, "Generating custom digital modulation signals", on page 106
   - Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 138
   - The description of the digital standards.
   - Section 4.11, "Shifting the baseband signal", on page 247

4.3 Generating signals according to broadcast standards

The R&S SMCV100B generates digital signals in accordance with the specifications of the main audio broadcast standards, terrestrial broadcast standards and satellite broadcast standards.

Since the signals are digital baseband signals, broadcast standards in this chapter are also denoted digital standards. For the required digital standard option, see the corresponding sections of the digital standards below.

ATSC-M/H

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

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

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

ATSC 3.0

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

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

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

DTMB

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

The option provides functionality to generate signals in accordance with the DTMB (Digital Terrestrial Multimedia Broadcast) standard.

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

DVB-T

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

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

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

DVB-T2

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

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

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

ISDB-T

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

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

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

T-DMB/DAB

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

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

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

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

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

DVB-S/DVB-S2/DVB-S2X

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

- DVB-S / DVB-S2 option R&S SMCVB-K167
- DVB-S2X option R&S SMCVB-K168.

These options provide functionality to generate signals in accordance with DVB-S, DVB-S2 and DVB-S2x digital video broadcast standards. They also provide functionality to generate basic DVB-S, DVB-S2 or DVB-S2x signals.

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

DVB-C

The digital standard requires an instrument equipped with the DVB-C/ISDB-C option R&S SMCVB-K157.

The option provides functionality to generate signals in accordance with DVB-C standard. The standard complies with specification ETSI EN 300 429.

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

J.83/B

The digital standard requires an instrument equipped with the J.83/B option R&S SMCVB-K158.

The option provides functionality to generate signals in accordance with DVB-C standard. The standard complies with specification ITU-T J.83.

For details, see the R&S SMCV100B J.83/B user manual.

DRM

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

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

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

AM/FM/RDS

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

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

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

4.4 Common characteristics of the baseband domain

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

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

4.4.1 About common baseband characteristics

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

Signal sources

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

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

Signal types

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

- "Internal modulation data" on page 79
- Section 4.4.1.3, "About control signals", on page 80

See also Section 12.2, "Configuring global connectors", on page 456.

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

The selection in the dialogs at any given time depends on the parameter and standard concerned. It is clear from the selection list offered in the dialog. Some parameters are therefore not available in certain cases. Characteristics specific to particular standards are described in the corresponding user manual.

- About data signals....78
- Clock signals....80
- About control signals....80
- About marker signals....82
- About trigger signals....84
- Supported modulation signals....92
- Supported coding schemes....93
- Supported baseband filters....94
- Methods for optimizing the crest factor....96

4.4.1.1 About data signals

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

- "Internal modulation data" on page 79
- Section 4.4.1.3, "About control signals", on page 80

Internal modulation data

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

- **Data lists**
  Data lists are externally or internally created binary lists with modulation data.
  The instrument provides a standard file select function for loading of existing data lists, creating internally new data lists or editing an existing one. Internally, data lists are created in the dedicated "Data List" editor (see Section 4.5.3.7, "Data list editor", on page 118). A separate file is created for each list and saved on the instrument's hard disk. The filename is user-defined; the file extension is `*.dm_iqd`.
  The maximum length of a data list is determined by the size of the data list memory. There is no restriction on the number of lists that can be saved.
  Settings for file handling, like transferring external data lists to the instrument, or renaming of folders and files, are accessed via the standard "File Manger" function. (See also Section 11, "File and data management", on page 418).
- **Data patterns**
  Simple data patterns such as binary 0 ("All 0") strings or 1 ("All 1") strings or variable bit strings with a maximum length of 64 bits can be used as internal modulation data.
- **PRBS data**
  The PRBS generators deliver pseudo random binary sequences of differing length and duration. They are known as maximum length sequences. PRBS sequences are generated with the aid of ring shift registers with feedback points determined by the polynomial.
  The pseudo-random sequence from a PRBS generator is uniquely defined by the register number and the feedback. The Table 4-1 describes the available PRBS generators.
  For PRBS15 and PRBS23, a CCITT V.52-compliant data inversion is performed in the feedback path automatically.

For more information, refer to the specifications document.

Table 4-1: Overview of PRBS generators

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

Example:

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

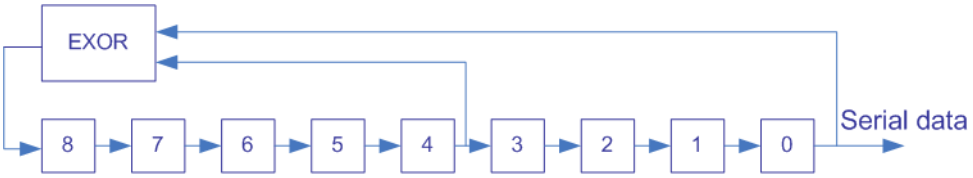


Figure 4-1: A 9-bit PRBS generator

Related settings:

- Section 4.5.3.3, "Data source settings", on page 109
- Section 4.5.3.7, "Data list editor", on page 118
- Section 4.5.3.8, "Control and marker lists editor", on page 120
- "Data Source" selection in the dialogs of the firmware options

4.4.1.2 Clock signals

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

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

Synchronizing data signals and clock signals

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

Related settings:

- Section 4.4.2.3, "Clock settings", on page 104
- Section 12.2, "Configuring global connectors", on page 456

4.4.1.3 About control signals

The following control signals are processed in the R&S SMCV100B:

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

A dedicated internal "Control Data Editor" is provided for defining the control signals. Refer to Section 4.5.3.8, "Control and marker lists editor", on page 120 for a description on the provided settings.

Continuous wave mode

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

Power ramping and level attenuation

The R&S SMCV100B uses the two control signals "Burst Gate" and "Lev_Att" to trigger the power ramping and level attenuation functions.

The instrument internally generates control signals as configured in Section 4.5.3.8, "Control and marker lists editor", on page 120; the signals can be output on the User x connectors.

- *Burst gate control signal*
  The "Burst Gate" signal is a rectangular pulse signal with variable low and high periods. Signal generation is restricted to the gate high periods. If the power ramping function is enabled, each transition between two gate periods of the "Burst Gate" signal triggers the generation of a ramp. Further settings define the form and the steepness of this ramp, see "Impact of the power ramping settings on the generated signal" on page 81.
- *Level attenuation control signal*
  The "Lev_Att" signal is a rectangular pulse signal with variable low and high periods. Level attenuation is applied, if the "Lev_Att" signal is high. If level attenuation is enabled, the modulation signal level is attenuated by a defined value.

Related settings:

- Section 4.5.3.6, "Power ramp control settings", on page 116

Possible applications

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

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

Impact of the power ramping settings on the generated signal

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

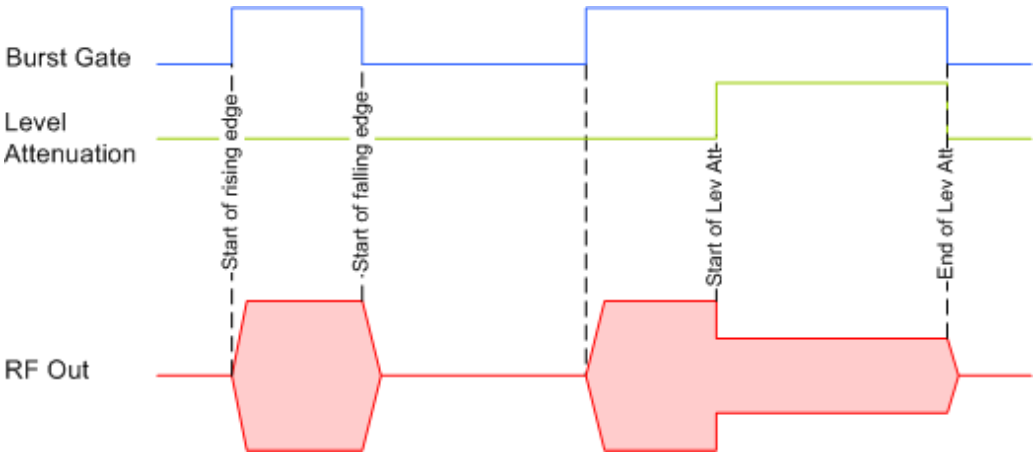


Figure 4-2: Signal behavior when power ramping and level attenuation are enabled

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

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

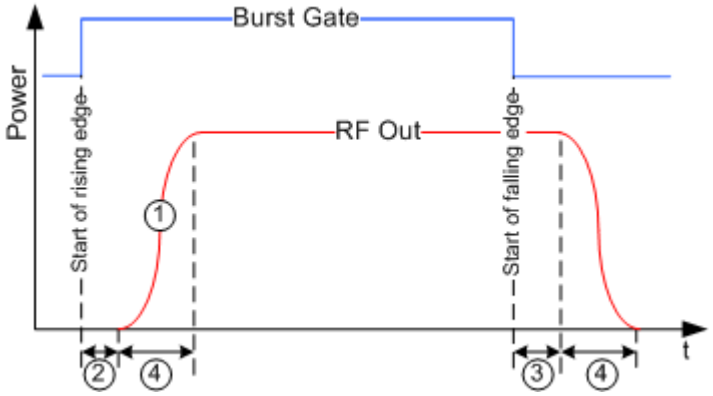


Figure 4-3: Impact of the ramp settings

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

4.4.1.4 About marker signals

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

One marker output signal is available. You can output this signal at both of the User x connectors.

Related settings:

- Section 4.4.2.2, "Marker settings", on page 103
- Section 12.2, "Configuring global connectors", on page 456
- Marker settings in the dialogs of the firmware options

Marker modes

Marker mode restart

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

Marker mode pulse

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

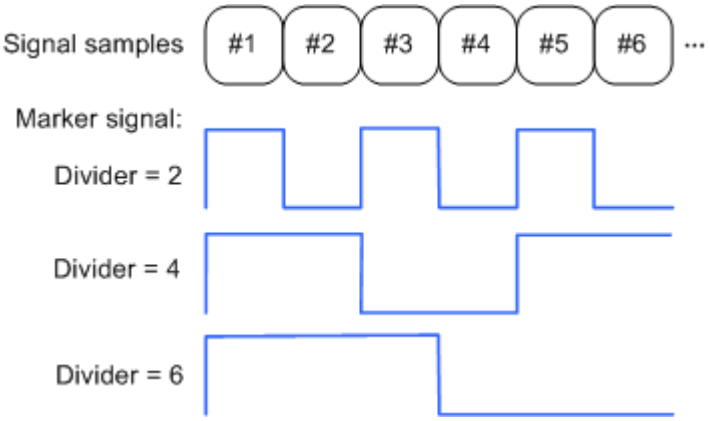
<Frequency> = "Symbol Rate"/"Sample Rate" / "Divider", respectively.

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

Example:

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

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

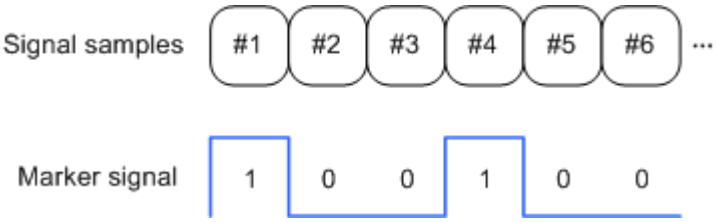


Marker mode pattern

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

Example:

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

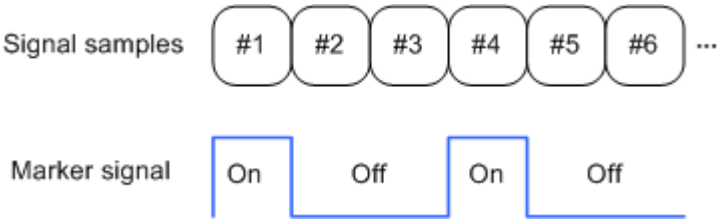


Marker mode On/Off Ratio

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

Example:

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



Marker mode CList

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

Delaying marker signals

In all the examples listed in "Marker modes" on page 83, the marker starts at the beginning of the first generated sample/symbol (sample/symbol no. 1). It is possible though to delay the start of the marker by an integer number of symbol periods or sample periods.

4.4.1.5 About trigger signals

The R&S SMCV100B provides several trigger modes, different trigger sources, and some additional trigger settings to suppress or delay the trigger events. This section provides an overview of the provided baseband trigger settings and the impact of the trigger settings on the signal generation.

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

For information on the trigger signals used in the RF domain, see Section 8.9.1, "Signal generation and triggering in the sweep and list modes", on page 324.

Trigger

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

Trigger event

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

- Trigger sources 85
- About trigger modes 85
- Impact of additional trigger settings 89
- Receiving and providing trigger signals 92

Trigger sources

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

- Internal ("Internal")
  Internal trigger signals are generated by the instrument itself.
- External ("External Global Trigger")
  External trigger signal is generated by an external trigger source.
  The instrument expects the trigger signal at one of the User x connectors. Refer to Configuring global connectors for information on how to configure the required settings.

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

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

A signal which marks the trigger event can be output at the User x connectors.

Related settings:

- Section 4.4.2.1, "Trigger settings", on page 99
- Section 12.2.5, "Global connectors settings", on page 462

About trigger modes

A trigger event defines the signal generation and depends on the trigger mode. The Table 4-2 provides an overview of the trigger modes and their impact on the signal generation start.

Table 4-2: Impact of the trigger events on the generated signal

"Trigger Mode"	Signal generation mode[1)]	1st Trigger event "Exec. Trigger" or "External" trigger signal	Subsequent trigger event "Exec. Trigger" or "External" trigger signal	Trigger event "Arm"
"Auto" See Figure 4-5	Continuous	-	-	-
"Retrigger" See Figure 4-6	Continuous	Initial start	Restart	-
"Armed_auto" See Figure 4-7	Continuous	Initial start	Restart (only after previous "Arm")	Stop
"Armed_retrigger" See Figure 4-8	Continuous	Initial start	Restart	Stop
"Single" See Figure 4-4	Single length determined by "Trigger Signal Duration"	Initial start	Restart	-

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

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

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

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

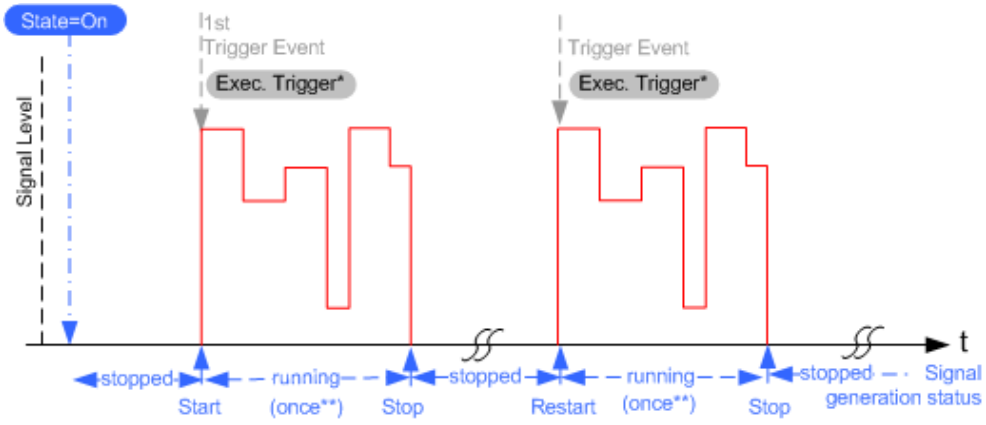


Figure 4-4: Trigger mode single

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

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

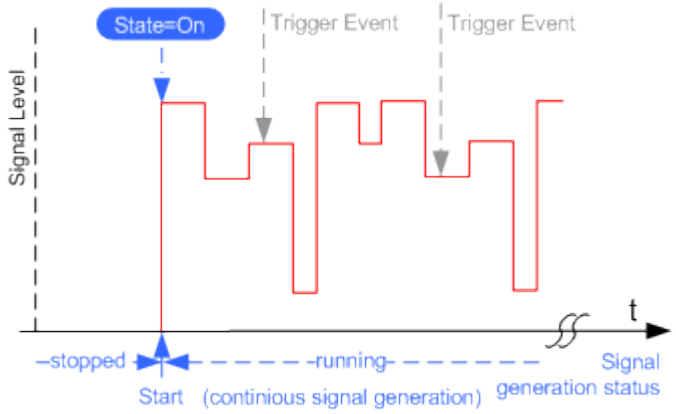


Figure 4-5: Trigger mode auto

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

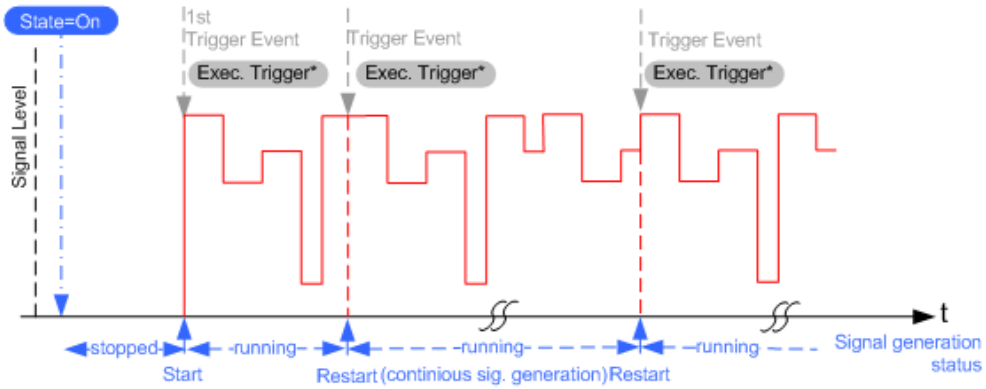


Figure 4-6: Trigger mode retrigger

* = Internal trigger event (to simplify the description)

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

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

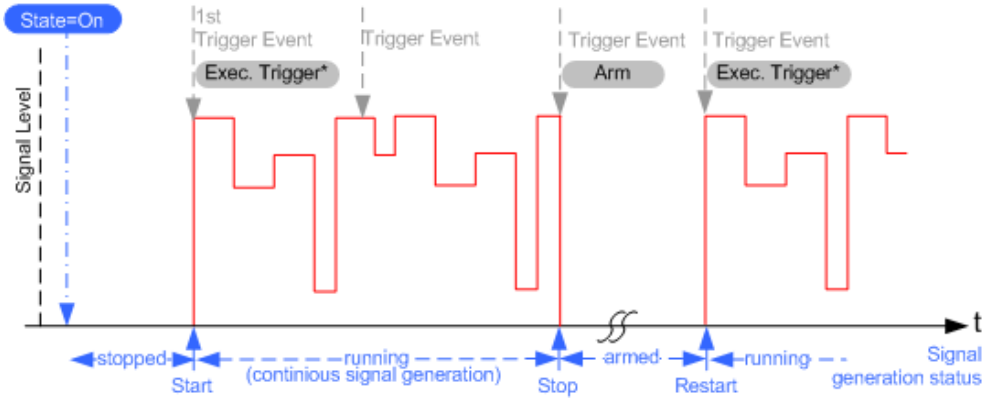


Figure 4-7: Trigger mode armed auto

* = Internal trigger event (to simplify the description)

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

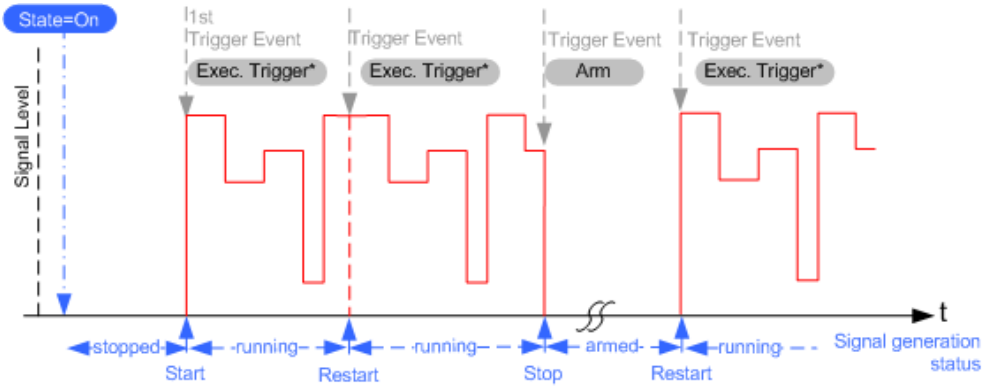


Figure 4-8: Trigger mode armed retrigger

* = Internal trigger event (to simplify the description)

Impact of additional trigger settings

The R&S SMCV100B provides a set of settings to configure the behavior upon receiving of a trigger signal. For example:

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

Avoiding accidental trigger events

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

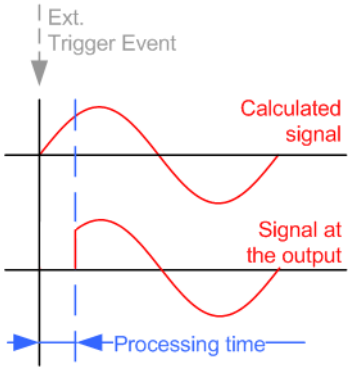
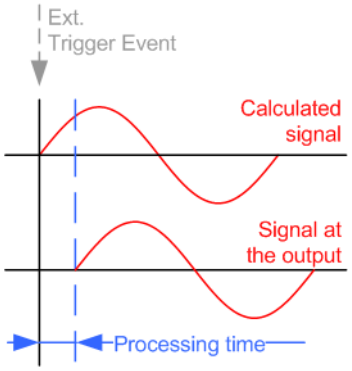
- "Threshold Trigger Input"
  Defines the voltage level of the trigger signal where the R&S SMCV100B generates a trigger event. Trigger signals below the trigger threshold are ignored.
- "Trigger Input Slope"
  Specifies the edge (rising or falling edge) of the trigger signal that is to provide the trigger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

Starting the signal generation with the first sample

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

This default behavior, however, can cause problems if short signal sequences are generated. To overcome this problem, the instrument provides the special parameter "Sync. Output to (External) Trigger". If this parameter is disabled, the signal output begins after elapsing of the processing time and starts with sample 0. That is, the complete signal is output (compare both figures in Table 4-3).

Table 4-3: Impact of the parameter Sync. Output to (External) Trigger

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

Suppressing and delaying trigger events

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

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

  This feature is useful to:

  – Simulate the time delay between a base station signal and a user equipment signal, for example during base station tests

  – Compensate for known propagation delays or a timing offset in the test setups
- "(External) Trigger Inhibit"
  You can suppress the effect of a restarted trigger signal in the "Retrigger" trigger mode for a definable number of symbols.
  During base station tests, for example, this feature enables the trigger suppression for a definable number of frames and yet the signal can still be generated synchronously. In each frame, the base station generates a trigger event that restarts the signal generation every time but for the suppression.

Example:

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

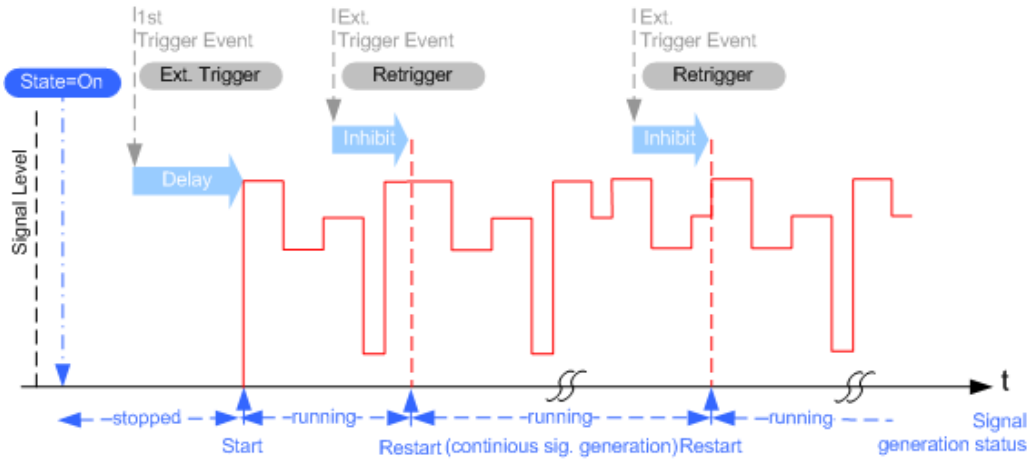


Figure 4-9: Trigger delay and trigger inhibit in trigger mode retrigger

To set delay and inhibit values

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

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

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

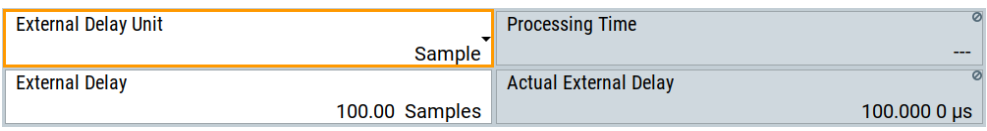
For more information, refer to the specifications document.

Example: ARB clock frequency and trigger delay

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

1. Select "Baseband" > "ARB" > "Clock Frequency" = "1 MHz".
2. Configure an external, for example, for an armed auto trigger mode.
   a) Select "ARB" > "Trigger In" > "Mode" > "Armed Auto"
   b) Select "Source" > "External Global Trigger 1".
   c) Select "External Delay Unit" > "Samples".
   d) Set "External Delay" = "100 Samples".

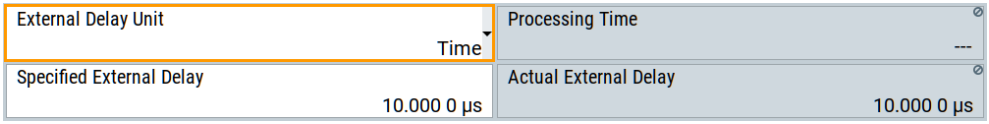
   The parameter "Actual External Delay" = "100 us" displays the actual delay in time units.



3. Set the delay in time units.

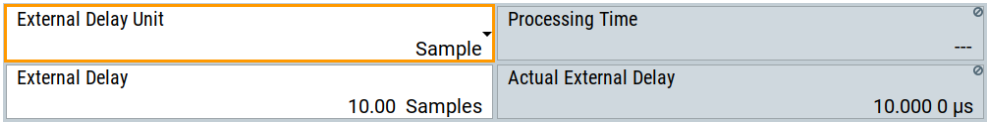
   a) Select "External Delay Unit" > "Time".
   b) Select "Specified External Delay" > "10 µs".

   The "Actual External Delay" changes to 10 us.



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

   The external dealy and actual delay is 10 samples.



Receiving and providing trigger signals

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

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

For information on triggering the R&S SMCV100B externally, see Section 3.3.3, "Triggering the instrument with an external signal", on page 46.

4.4.1.6 Supported modulation signals

The R&S SMCV100B supports a range of predefined digital and analog modulation signals. All related signals are baseband signals and digitally modulated onto the analog RF carrier.

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

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

Most of the provided modulation schemes are implemented according to a communication standard. The QAM procedures 16QAM, 32QAM, 64QAM, for instance, have been produced in accordance with ETSI standard ETS 300429 for digital video broadcasting

(DVB). The QAM procedures 256QAM and 1024QAM are not specified in this standard, but have been produced according to the same basic principles.

For all FSK procedures, you can set the symbol rate f_{SYMB} up to a maximum value. The frequency deviation (FSK deviation) of the MSK modulation is permanently set to ¼ of the symbol rate. Also a variable FSK modulation with definable deviation per symbol is available and for even greater flexibility. A user-defined modulation mapping can be applied, see "User mapping" on page 93.

For more information, refer to the specifications document.

User mapping

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

The main purpose of "mapwiz" is the assignment of logical symbol numbers to constellation points and the selection of modulation-specific parameters. Also, the tool supports the creation of nearly any arbitrarily chosen constellation diagram. The output of "mapwiz" is a mapping file (`*.vam`) that can be imported into a R&S SMCV100B. The program was developed on a 32-bit Microsoft Windows platform under MATLAB.

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

The remote commands required to define the modulation settings are described in Section 14.16.4.2, "SOURce:BB:DM subsystem", on page 683.

Related settings:

- Section 4.5.3.4, "Modulation settings", on page 111

4.4.1.7 Supported coding schemes

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

See section Section 4.5.5.1, "Default settings and predefined configurations", on page 127 for an overview on the available coding combinations. This section also defines the modulation formats for which the various coding procedures can be used.

Related settings:

- "Coding" on page 109

4.4.1.8 Supported baseband filters

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

To fulfill wide range of requirements, the R&S SMCV100B offers a wide selection of predefined baseband filters. The predefined filters are designed for the special spectrum characteristics of the different communication standards. However, depending on the selected filter form one or more filter parameters are provided for even more precise adjustment of the filter characteristic. You can select, for example, steeper edges or change the transition bandwidth. For more information on the provided settings, see "Impact of the filter parameters" on page 94.

The selection of user-defined filters offers even more flexibility. Use these filters if you need to filter with filters of complex or proprietary form are required. For more information, refer to "User filter" on page 94.

Predefined baseband filters

See Section 4.5.5.3, "Predefined baseband filters", on page 132 for an overview of available baseband filters.

User filter

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

The filter wizard (filtwiz) is a tool from Rohde & Schwarz designed for creating filter files that can be imported on a R&S SMCV100B. Its main purpose is the conversion of user-defined finite impulse response (FIR) filters into the filter format (`*.vaf`). Beyond this filtwiz provides designs for standard filters, e.g. root raised cosine (RRC), Gaussian.

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

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

The remote commands required to define the filter settings are described in Section 14.16.4.2, "SOURce:BB:DM subsystem", on page 683 and the corresponding section in the user manual of each firmware option.

Related settings:

- Section 4.5.3.5, "Filter settings", on page 114
- Filter settings in the dialogs of the firmware options

Impact of the filter parameters

The following is a simple description of the filter parameters and the way they affect the main filter characteristics. Changing filter parameters is an effective way to ensure that

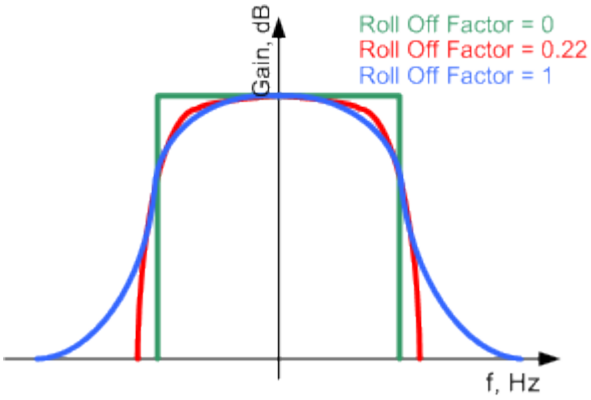
the entire bandwidth of the desired signal is allowed to pass and adjust the filter form to reach the spectrum mask requirements.

Cut Off Frequency

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

Rolloff Factor

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



Passband

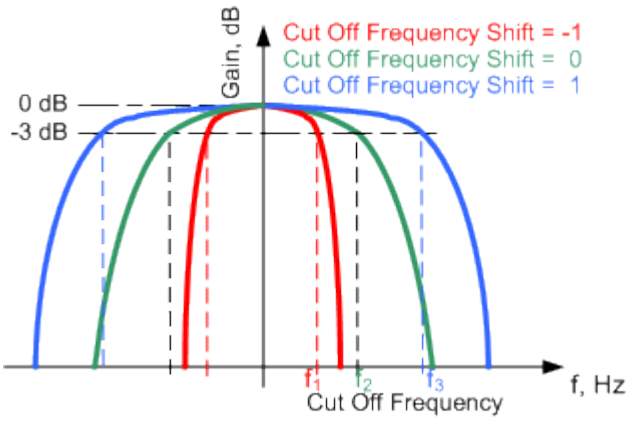
The passband describes the frequency span that the filter passes unchanged. The total passband of a filter is given as follows:

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

Cut Off Frequency Shift

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

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



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

4.4.1.9 Methods for optimizing the crest factor

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

About the crest factor

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

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

High crest factors entail two basic problems:

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

Both effects increase the adjacent-channel power.

Direct crest factor reduction

At the individual signal generation stages, the R&S SMCV100B offers different direct approaches to reduce the crest factor. While the corresponding parameters are enabled, the implemented algorithms ensure minimizing the crest factor or achieving of predefined target crest factor by applying of automatic settings. Methods of reducing

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

The provided crest factor reduction methods include:

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

Applying clipping and filtering

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

- Clipping is a method that applies a wanted distortion to the signal, see Example "Vector clipping and crest factor" on page 97.
  This method includes specifying a level limit, finding out the signal peaks and clipping off the peaks that exceed the limit. The level limit is a percentage of the highest peak value. Clipping does not influence the spectrum but the error vector magnitude (EVM) increases.

  The instrument offers two clipping modes:

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

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

Example: Vector clipping and crest factor

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

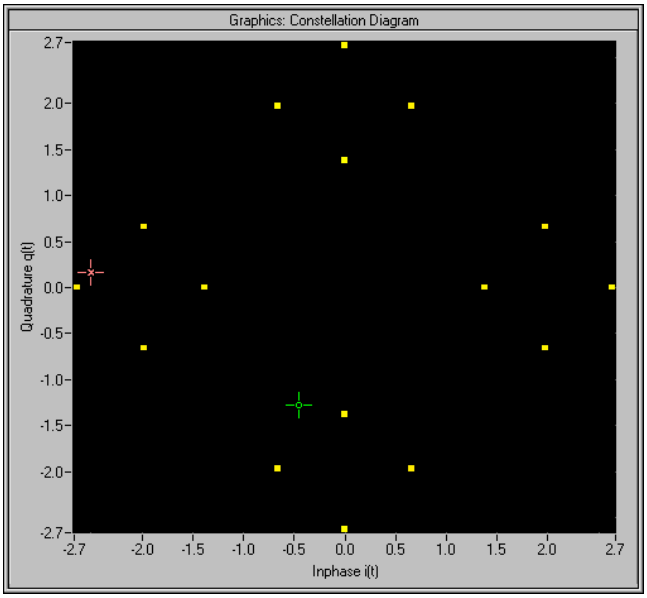


Figure 4-10: I/Q constellation without clipping

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

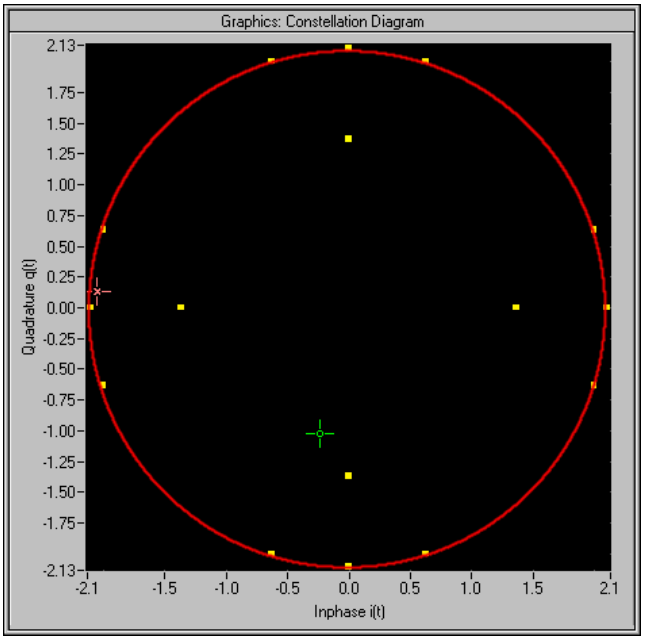


Figure 4-11: I/Q constellation with vector clipping and clipping level 80 %

4.4.2 Common baseband settings

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

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

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

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

About trigger marker clock signals

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

- Section 4.4.1.5, "About trigger signals", on page 84
- Section 4.4.1.4, "About marker signals", on page 82
- Section 4.4.1.2, "Clock signals", on page 80

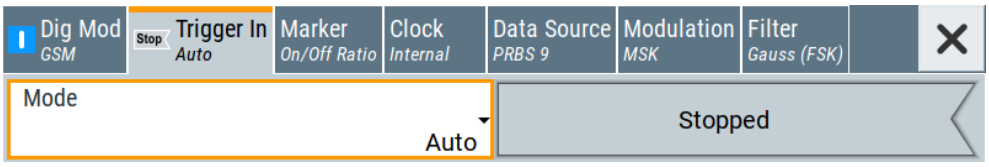
Settings:

- Trigger settings..... 99
- Marker settings.....103
- Clock settings.....104
- Global connector settings.....105

4.4.2.1 Trigger settings

Access:

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



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

Routing and activating a trigger signal

1. Define the effect of a trigger event and the trigger signal source.
   a) Select "Trigger In" > "Mode".
   b) Select "Trigger In" > "Source".
2. For external trigger signals, define the connector for signal input. See Section 4.4.2.4, "Global connector settings", on page 105.

You can map trigger signals to one or more User x connectors.

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

3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMCV100B starts baseband signal generation after the configured trigger event.

About baseband trigger signals

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 78.

Settings:

Mode 100
Running/Stopped 100
Arm 101
Execute Trigger 101
Source 101
Sync. Output to Ext. Trigger/Sync. Output to Trigger 101
External Inhibit/Trigger Inhibit 101
(External) Delay Unit 102
(Specified) External Delay/(Specified) Trigger Delay 102
Actual Trigger Delay/Actual External Delay 102
Signal Duration 102

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

See also "About trigger modes" on page 85.

Remote command:
`[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence` on page 697
`[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence` on page 748

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

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

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:RMODe?` on page 698
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?` on page 749

Arm
Stops the signal generation until subsequent trigger event occurs.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute on page 698
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute on page 749

Execute Trigger
Requires trigger "Source" > "Internal"

Executes the trigger manually.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXECute on page 699
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute on page 750

Source
The following sources of the trigger signal are available:

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

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

See "Trigger sources" on page 85

See also Section 12.2, "Configuring global connectors", on page 456.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:SOURce on page 697
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce on page 748

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

See also "Impact of additional trigger settings" on page 89.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut
on page 698
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut
on page 750

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

Applies for:
- External trigger signal

See also "Impact of additional trigger settings" on page 89.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit on page 700
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit on page 752

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

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

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

See also "To set delay and inhibit values" on page 91.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT on page 699
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT on page 750

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

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

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

See also the following sections:
- "Impact of additional trigger settings" on page 89
- "To set delay and inhibit values" on page 91

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay on page 699
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay on page 699
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay on page 751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay on page 751

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

See also "To set delay and inhibit values" on page 91.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay? on page 700
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay? on page 751

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

Enters the length of the trigger signal sequence.

Use this parameter, for example, for the following applications:

- To output the trigger signal partly.
- To output a predefined sequence of the trigger signal.

Remote command:

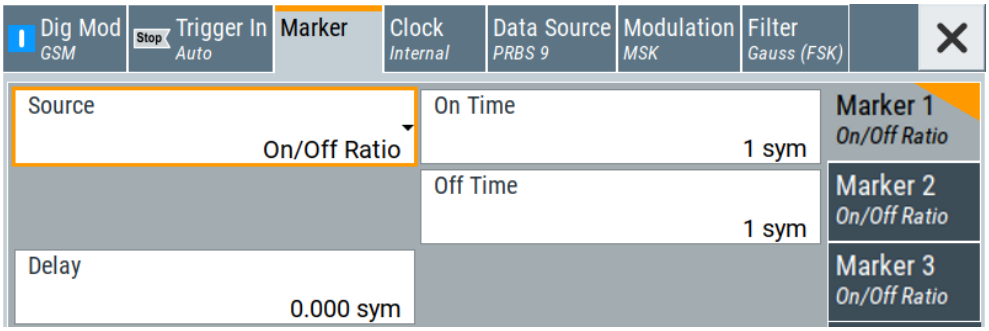
`[:SOURce<hw>]:BB:DM:TRIGger:SLENgth` on page 697

`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit` on page 749

4.4.2.2 Marker settings

Access:

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



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

Routing and activating a marker signal

1. To define the signal shape of an individual marker signal "x", select "Marker" > "Marker x" > "Mode".
2. Optionally, define the connector for signal output. See Section 4.4.2.4, "Global connector settings", on page 105.
   You can map marker signals to one or more User x connectors.
3. Enable baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMCV100B adds the marker signal to the baseband signal. Also, R&S SMCV100B outputs this signal at the configured User x connector.

About marker output signals

Settings:

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 78.

Mode..... 104
Delay..... 104

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

You can configure individual marker modes for each marker signal. The number of available markers is 1. The marker configuration changes with the selected marker mode.

How to: "Routing and activating a marker signal" on page 103

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

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE` on page 701
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 702
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 702
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern` on page 701
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime` on page 701
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime` on page 701
ARB: see "Mode" on page 153

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

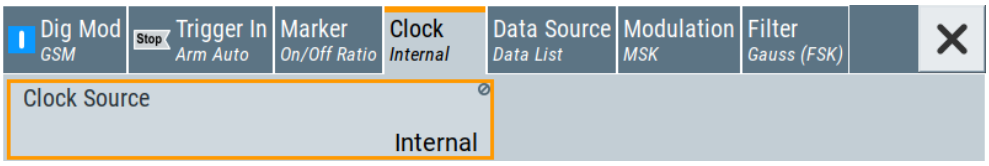
Variation of the parameter "Marker x" > "Delay" causes signal recalculation.

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay` on page 702
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay` on page 754

4.4.2.3 Clock settings

Access:

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



This tab provides clock source settings.

Defining the clock

1. Select "Clock" > "Source" to define the source of the clock signal.

2. For external clock signals, define the connector for the signal input. See Section 4.4.2.4, "Global connector settings", on page 105.
   You can map clock signals to one or more User x connectors.

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

3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMCV100B starts baseband signal generation with a symbol rate that equals the clock rate.

About clock signals

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 78.

Settings:

Clock Source 105

Clock Source
Selects the clock source.

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

How to: "Defining the clock" on page 104

See also Section 4.4.1.2, "Clock signals", on page 80.

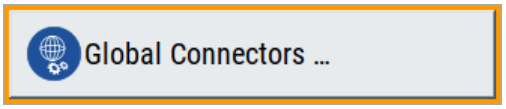
Remote command:
`[:SOURce<hw>]:BB:DM:CLOCk:SOURce` on page 703
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce` on page 754

4.4.2.4 Global connector settings

Opens a dialog to configure global connectors.

The button is available in the following dialogs or tabs:

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



See also Section 12.2, "Configuring global connectors", on page 456.

4.5 Generating custom digital modulation signals

The R&S SMCV100B can generate digital modulation signals with user-definable characteristics. The baseband filtering and the symbol rate can be set within wide limits.

4.5.1 Required options

The equipment layout for generating the digital modulation signals includes:

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

4.5.2 About custom digital modulation

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

- Section 4.4.1.8, "Supported baseband filters", on page 94
- Section 4.4.1.6, "Supported modulation signals", on page 92
- Section 4.4.1.7, "Supported coding schemes", on page 93.

About modulation types and coding schemes

Modulation types and coding schemes directly relate to each other. You cannot use all coding schemes for each modulation type. For available coding schemes, see Section 4.5.5.1, "Default settings and predefined configurations", on page 127.

An inappropriate change of a parameter triggers a settings conflict. The "Info" line displays this conflict with an info message. Although the R&S SMCV100B displays the selected settings, the generated modulation signal does not correspond to this display. The conflict message disappears if you configure a conflict-free setting.

4.5.3 Custom digital modulation settings

Access:

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

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

The remote commands required to define these settings are described in Section 14.16.4.2, "SOURce:BB:DM subsystem", on page 683.

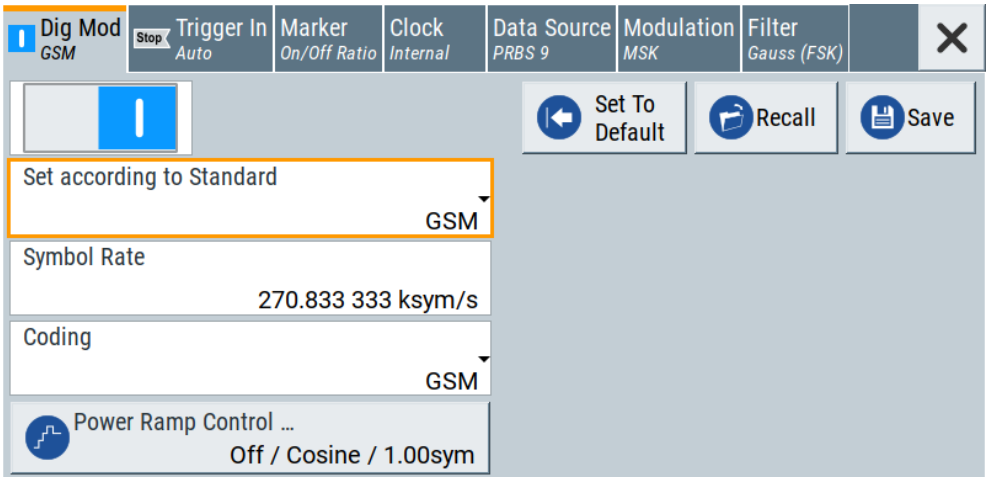
Settings:

- General settings 107
- Trigger, marker and clock settings 109
- Data source settings 109
- Modulation settings 111
- Filter settings 114
- Power ramp control settings 116
- Data list editor 118
- Control and marker lists editor 120

4.5.3.1 General settings

Access:

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



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

Settings:

State 107
Set To Default 108
Save/Recall 108
Set according to Standard 108
Symbol Rate 109
Coding 109
Power Ramp Control 109

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

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

Remote command:
`[:SOURce<hw>]:BB:DM:STATe` on page 686

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

Remote command:
`[:SOURce<hw>]:BB:DM:PRESet` on page 686

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.

See also Section 11, "File and data management", on page 418.

Remote command:
`[:SOURce<hw>]:BB:DM:SETTing:CATalog?` on page 688
`[:SOURce<hw>]:BB:DM:SETTing:DELete` on page 689
`[:SOURce<hw>]:BB:DM:SETTing:LOAD` on page 689
`[:SOURce<hw>]:BB:DM:SETTing:STORe` on page 688

Set according to Standard
Selects a predefined communication standard.

Communication standard
Selects a predefined communication standard. If selected, the firmware automatically sets standard-compliant values for the following parameters: "Modulation Type", "Symbol Rate", "Filter" and "Coding". For "Set according to Standard" > "Telemetry - SOQPSK-TG", the "Data Source" is "Data List" only. See Section 4.5.3.3, "Data source settings", on page 109. See Table 4-5 for an overview of the available standards and standard-compliant settings of the modulation parameters.

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

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

Remote command:
[:SOURce<hw>]:BB:DM:STANdard on page 687

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

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

Remote command:
[:SOURce<hw>]:BB:DM:SRATe on page 686

Coding
Sets the coding scheme, see Section 4.4.1.7, "Supported coding schemes", on page 93.

The dialog shows only the coding settings that are permissible for the selected modulation type and installed options, see Table 4-7. All other coding methods are grayed out.

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

Remote command:
[:SOURce<hw>]:BB:DM:CODing on page 691

Power Ramp Control
Accesses the power ramp control dialog, see Section 4.5.3.6, "Power ramp control settings", on page 116.

4.5.3.2 Trigger, marker and clock settings

These tabs provide standard settings.

For detailed description, see:

- Section 4.4.2.1, "Trigger settings", on page 99
- Section 4.4.2.2, "Marker settings", on page 103
- Section 4.4.2.3, "Clock settings", on page 104
- Section 4.4.2.4, "Global connector settings", on page 105

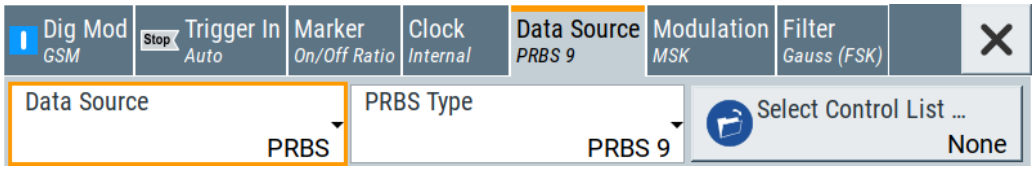
4.5.3.3 Data source settings

Access:

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

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

For an overview of the supported data sources, refer to Section 4.4.1.1, "About data signals", on page 78.



Settings:

Data Source....110
Select Data List....110
Select Control List....111
Connector Settings....111

Data Source
Selects the data source (see Section 4.4.1.1, "About data signals", on page 78).

The following data sources are available:

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

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

Remote command:
`[:SOURce<hw>]:BB:DM:PRBS[:LENGth]` on page 688

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

Remote command:
`[:SOURce<hw>]:BB:DM:PATTern` on page 687

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

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 703
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 704

Remote command:
`[:SOURce<hw>]:BB:DM:SOURce` on page 687

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

Generate data lists externally or internally in the data editor.

- Select "Select Data List", navigate to the list file `*.dm_iqd` and tap "Select".
- Use the standard "File Manager" function to transfer external data lists to the instrument.
- Use the functions "New" or"Edit" to create a data list or to edit an existing data list, see Section 4.5.3.7, "Data list editor", on page 118.

See also Section 4.5.4.2, "How to create and assign a data list", on page 126.

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 703
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 704

[:SOURce<hw>]:BB:DM:DLISt:COPY on page 706
[:SOURce<hw>]:BB:DM:DLISt:DELete on page 704

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

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

- Select "Select Control List", navigate to the list file *.dm_iqc and tap "Select".
- Use the standard "File Manager" function to transfer external lists to the instrument.
- Use the functions "New" or"Edit" to create a data list or to edit an existing data list, see Section 4.5.3.8, "Control and marker lists editor", on page 120.

Irrespectively on the way they are created, control lists are not automatically used (see "To assign and activate control signals from a control list" on page 125).

Remote command:
[:SOURce<hw>]:BB:DM:CLISt:CATalog? on page 703
[:SOURce<hw>]:BB:DM:CLISt:SELect on page 703
[:SOURce<hw>]:BB:DM:CLISt:COPY on page 706
[:SOURce<hw>]:BB:DM:CLISt:DELete on page 704

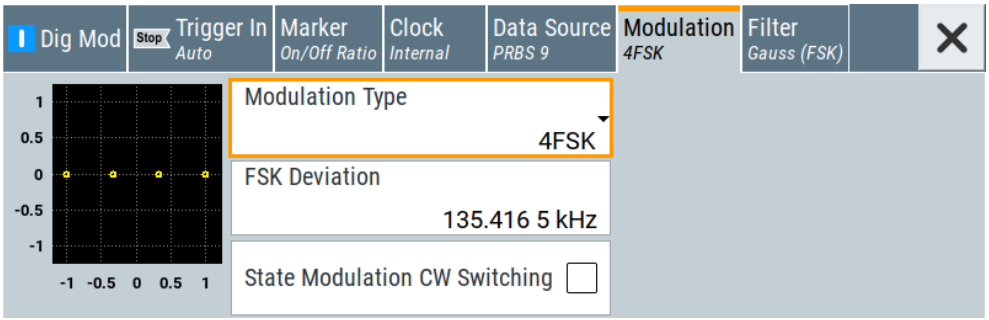
Connector Settings
Opens a dialog to configure connector settings.

See also Section 12.2, "Configuring global connectors", on page 456.

4.5.3.4 Modulation settings

Access:

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



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

This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to Section 4.4.1.6, "Supported modulation signals", on page 92.

Settings:

Modulation Type 112
Load User Mapping 112
ASK Depth 112
FSK Deviation 112
Angle Alpha 112
FSK Type 113
Deviation xxxx 113
Gamma/Gamma 1 113
State Modulation CW Switching 113

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

If the configured modulation type does not allow a specific coding scheme, the "Coding" is "Off".

See also Table 4-6.

Remote command:
`[:SOURce<hw>]:BB:DM:FORMat` on page 692

Load User Mapping
Opens the "Select List File User Mapping" dialog to select the mapping table (see "User mapping" on page 93). The dialog provides all standard file management functions.

Remote command:
`[:SOURce<hw>]:BB:DM:MLISt:SELect` on page 704
`[:SOURce<hw>]:BB:DM:MLISt:CATalog?` on page 703
`[:SOURce<hw>]:BB:DM:MLISt:DELete` on page 704

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

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

Remote command:
`[:SOURce<hw>]:BB:DM:ASK:DEPTh` on page 692

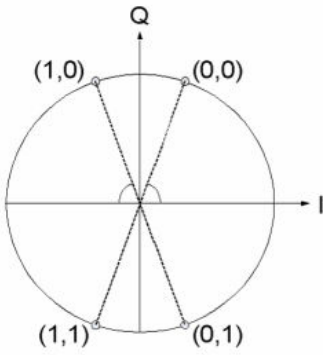
FSK Deviation
Sets the frequency deviation for FSK modulation. The range of values depends on the symbol rate, see "Symbol Rate" on page 109.

For more information, refer to the specifications document.

If you select "Modulation Type" > "FSK" > "MSK", the FSK deviation has a fixed value of 1/4 of the symbol rate.

Remote command:
`[:SOURce<hw>]:BB:DM:FSK:DEViation` on page 693

Angle Alpha
For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.



Remote command:
[:SOURce<hw>]:BB:DM:AQPSk:ANGLe on page 692

FSK Type
For "Variable FSK", selects the FSK modulation type.

Available are 4FSK, 8FSK and 16FSK.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE on page 693

Deviation xxxx
For "Variable FSK", sets the deviation of the associated symbol. The number of symbols depends on the selected modulation type. The value of each symbol is indicated in binary format, i.e. x can be 1 or 0.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation on page 693

Gamma/Gamma 1
Selects the gamma function γ for the 16APSK and 32APSK modulations.

The values in brackets indicate the used code rate according to the DVB-S2 specification.

Remote command:
[:SOURce<hw>]:BB:DM:APSK16:GAMMa on page 693
[:SOURce<hw>]:BB:DM:APSK32:GAMMa on page 694

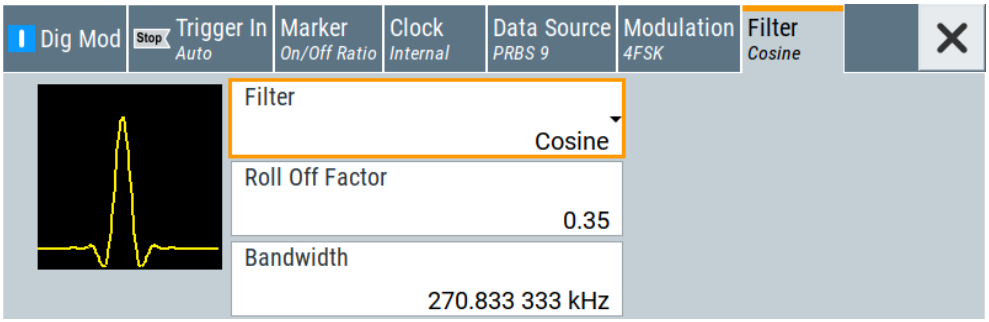
State Modulation CW Switching
Enables switching between the digitally modulated and an unmodulated (CW) signal.

Remote command:
[:SOURce<hw>]:BB:DM:SWITching:STATe on page 694

4.5.3.5 Filter settings

Access:

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



This tab provides filter settings, like filter type and if available further filter settings. A simplified diagram shows the filter characteristics of the selected filter.

This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to Section 4.4.1.8, "Supported baseband filters", on page 94.

Settings:

Filter....114
Roll Off Factor/B*T....114
Cut Off Frequency Factor....115
Gauss Cut Off FrequencyLowpass Cut Off Frequency....115
Bandwidth....115
Load User Filter....115

Filter
Selects the baseband filter.

See Section 4.5.5.3, "Predefined baseband filters", on page 132 for an overview of the available filter types, their filter shapes and filter parameters.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:TYPE` on page 689

Roll Off Factor/B*T
Sets the rolloff factor or bandwidth time product of the corresponding filter type.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff]` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 690

Cut Off Frequency Factor
Requires the filter parameter "Lowpass (ACP optim.)" and "Lowpass (EVM optim.)".

Sets the cutoff frequency factor. Adjust the cutoff frequency of the filter to meet your spectrum mask requirements.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM` on page 690

Gauss Cut Off FrequencyLowpass Cut Off Frequency
Requires the filter parameter "APCO25 (LSM)".

Sets the cutoff frequency of the filter. Adjust the cutoff frequency of the filter to meet your spectrum mask requirements.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs` on page 690
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass` on page 690

Bandwidth
Requires "Filter" > "Raised Cosine (RC)".

Sets the filter bandwidth, so that the equation H(f) = 0 holds for *f >= (1 + rolloff)* bandwidth /2*.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth` on page 690

Load User Filter
Opens the dialog "Select User Filter" to load a user-defined filter file with file extension `*.vaf`. This dialog provides the standard file management functions, like save, load, delete.

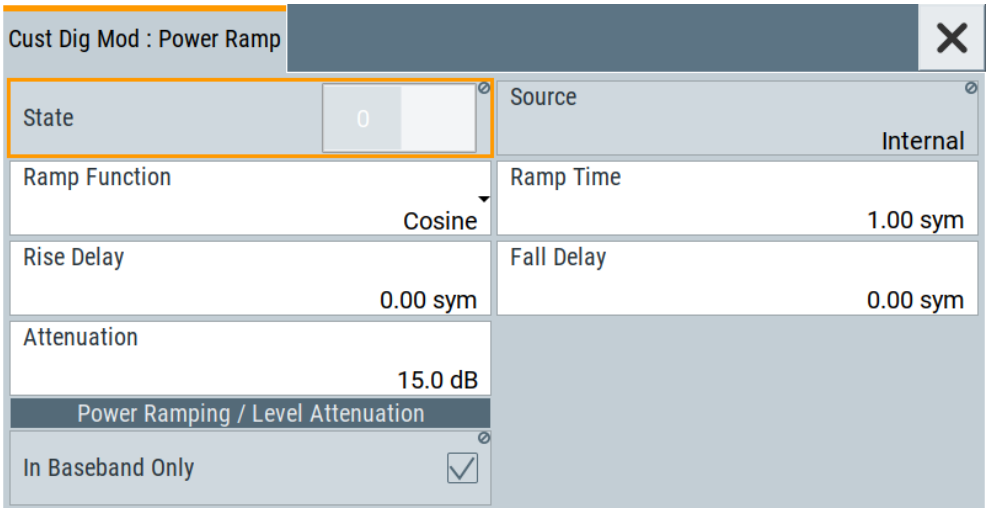
See also "User filter" on page 94.

Remote command:
`[:SOURce<hw>]:BB:DM:FLISt:SELect` on page 703
`[:SOURce<hw>]:BB:DM:FLISt:CATalog?` on page 703
`[:SOURce<hw>]:BB:DM:FLISt:DELete` on page 704

4.5.3.6 Power ramp control settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "General" > "Power Ramp Control".



The dialog comprises the settings used to configure the power ramping, like the source of the control signals, the form of the ramp function and the applied attenuation.

See also "Power ramping and level attenuation" on page 81.

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

Settings:

State 116
Source 116
Ramp Function 117
Ramp Time 117
Rise Delay 117
Fall Delay 117
Attenuation 117
In Baseband Only 117

State
Enables/disables power ramping.

Remote command:
`[:SOURce<hw>]:BB:DM:PRAMp[:STATe]` on page 696

Source
Defines the source for the power ramp control signals.

"Internal" The control signals as defined in the internal control list are used for control purposes.
See also Section 4.5.4.1, "How to create and assign a control list", on page 124.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:SOURce on page 694

Ramp Function
Selects the ramp function that describes the shape of the rising and falling edges during power ramp control, see Figure 4-3.

"Linear" The transmit power rises and falls in linear fashion.

"Cosine" The transmit power rises and falls with a cosine-shaped edge, resulting in a more favorable spectrum than the "Linear" setting.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe on page 695

Ramp Time
Enters the power ramping rise time and the fall time for a burst. The setting is expressed in symbols. See also Figure 4-3.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:TIME on page 695

Rise Delay
Sets the offset in the rising edge of the envelope at the start of a burst, see Figure 4-3.

A positive value delays (the envelope length decreases) and a negative value causes an advance (the envelope length increases). The setting is expressed in symbols.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:RDELay on page 695

Fall Delay
Sets the offset in the falling edge of the envelope at the end of a burst, see Figure 4-3.

A positive value delays (the envelope length increases) and a negative value causes an advance (the envelope length decreases). The setting is expressed in symbols.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:FDELay on page 695

Attenuation
Determines the level by that the average signal level is attenuated during the signal attenuation period, while the "Lev_Att" signal is high. See also Figure 4-2.

For information about the required control signal, refer to "Power ramping and level attenuation" on page 81.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation on page 696

In Baseband Only
Restricts power ramping to the baseband signal.

"Off" Level attenuation is affected via the attenuator stages in the RF section; only the remaining part is attenuated in the baseband. The signal is issued at the RF output with the defined level values.

"On" Level attenuation is affected in the baseband only.

Note:
This setting is mandatory in the following cases:
- When only the baseband signal is issued at the I/Q outputs
  It is thus ensured that, with power ramping active, this signal is output with the defined level values.
- For two-path instruments, when one baseband signal is applied to two RF paths.

Remote command:
`[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe]` on page 696

4.5.3.7 Data list editor

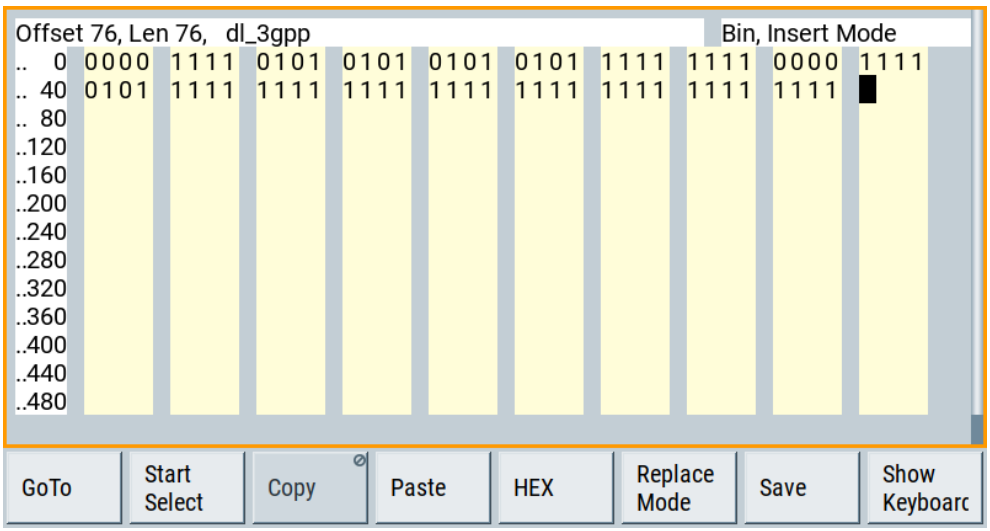
The R&S SMCV100B provides the following ways to create a data list file:

- To use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 126
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 167.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 168.

Access:

1. Select "Baseband > Custom Digital Mod > Data Source > Data List".
2. Select "Select Data List".
3. Navigate to the required directory.
4. Select "New".
5. Enter a filename.

For example, in the directory `/var/user/`, enter "Filename" = `dl_3gpp`



The "Data List Editor" is a list of binary values with a maximum length of 2^{31} bits. This value corresponds to a file size of approx. 268 Mbyte.
To increase readability, the bits are displayed in groups of four (binary format) or two (hexadecimal format). Also, above the list are displayed: The current cursor position and the length of the list and the list filename are displayed above the list.
The offset starts with the value 0 which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.
An existing list can be edited in the insert or replace mode. The upper right corner shows the current mode.
SCPI command:
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 704
`[:SOURce<hw>]:BB:DM:DLISt:DATA` on page 707
`[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend` on page 708
The buttons below the binary list simplify the editing.

Settings:

GoTo 119
Start Select/Undo Select 119
Copy, Cut, Paste 120
BIN/HEX 120
Replace Mode/Insert Mode 120
Save 120

GoTo
Opens the entry window for the bit position. The cursor marks the bit at the selected position.

Start Select/Undo Select
Defines the current cursor position as the start position for the range to be selected. To define the stop position, select "GoTo > Go To Offset" and define the offset.

Selecting "Undo Select" deactivates the selected range.

Copy, Cut, Paste
Standard copy, cut, and paste functions.

BIN/HEX
Switches between hexadecimal and binary display.

Every 4-bit group is displayed as a hexadecimal value. To increase readability, the hexadecimal values in turn are displayed in pairs of two.

The hex functions are automatically assigned to the numeric keys at the front panel.

Replace Mode/Insert Mode
Switches between replace and insert mode to enter new or replace old values.

Save
Saves the changes into the selected data list file.

4.5.3.8 Control and marker lists editor

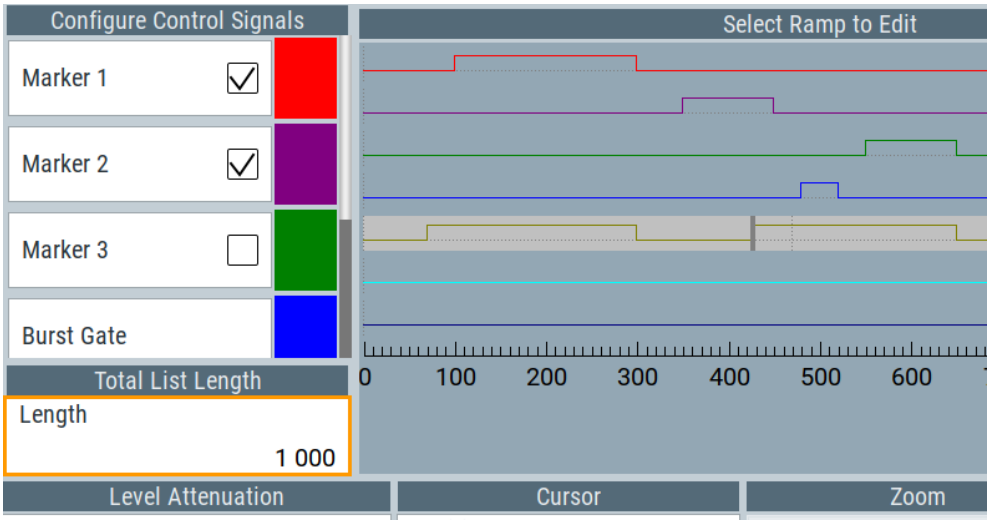
The R&S SMCV100B provides the following ways to create a file containing control signals:

- To use the tag-oriented format and create a control list file, see "To create a control list with tag file format" on page 166.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 167.
- To use the dedicated "Control Data Editor" and create a file in ASCII format and with an extension `*.dm_iqc`.
  The "Control Data Editor" is described in this section. Refer to "To create a control list in ASCII format manually" on page 124 for step-by-step instructions.

To access the "Control Data Editor"

1. Select "Baseband" > "Custom Digital Mod" > "Data Source".
2. Select "Select Control List".
3. Navigate to the required directory, for example `/var/user/`.
4. Select "New".
5. In the "Filename" field, enter the name of the new control list, for example `dl_3gpp`.

6. Select "Edit".



The dedicated internal "Control Data Editor" is an intuitive graphical interface provided for defining and managing of:

- Marker signals
- Control signals, like the CW, "Hop", "Burst Gate", and "Lev_Att" control signals
  See also Section 4.4.1.3, "About control signals", on page 80.

A separate file with the file extension `*.dm_iqc` is created for each defined control signal and held on the instrument's hard disk. Control lists created with the editor are files in an ASCII file format.

In the "Control Data Editor" dialog, the available marker and control signals are displayed color-coded. The "Select Ramp to Edit" is a graphical display of the signal characteristics. To define the ramp for the individual markers or control signals, tap on the desired position or use the provided support functions "<Signal> Table" and "Cursor Position". To simplify the settings, use the predefined preset ramp characteristics in the "<Signal> Preset Type" section. The scaling of the x-axis is always adapted to the overall length of the control list to provide a constant overview of all defined ramps. For detailed representation, zoom the displayed area around the current cursor position.

In the "Configure Control Signal" section, a status checkbox indicates whether the individual marker or control signal is assigned or enabled (see Section 4.5.4.1, "How to create and assign a control list", on page 124).

SCPI command:

`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 703

`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 703

Settings:

Configure Control Signal..... 122
Select Ramp to Edit..... 122
Total List Length..... 122
Preset Type..... 122
Cursor Position..... 123

Positions Control Signal....123
Zoom/Visible....123
Save/Save As....123

Configure Control Signal
Displays the color the marker/control signal has been assigned.

The status checkbox indicates whether the individual marker or control signal is assigned or enabled (see Section 4.5.4.1, "How to create and assign a control list", on page 124).

Remote command:
n.a.

Select Ramp to Edit
Graphical representation for editing of the marker/control signals.

Refer to Section 4.5.4.1, "How to create and assign a control list", on page 124 for an overview of the editing capabilities of the display.

Remote command:
`{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}` on page 182
`[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 707

Total List Length
Enters the length of the definition range of the control list in bits. The starting value is always bit 0. The entire definition range is displayed, i.e. the bit scale is adapted to the entry. If the definition range is decreased, the ramps outside the range are lost.

When used, the control list is always repeated over the length of the definition range if the length of the data list exceeds the length of the control list.

Tip: With long control lists, it is useful to zoom the displayed area around the current cursor position ("Zoom in").

Remote command:
`{CONTROL LENGTH: ControlLength}` on page 179

Preset Type
Triggered with "Preset", presets for the ramp characteristic of the selected control signal as defined with the "Preset Type".

"All Up, All Down"
Continuously high/low marker/control signal.

"Ramp Up, Ramp Down"
A ramp from low to high or from high to low is configured in the center of the displayed signal area; the ramp position can be later shifted as required.

"Ramp Up/Down, Ramp Down/Up"
Created is a ramp sequence of low to high and high to low transitions, respectively high to low, and low to high transitions. The ramps are symmetrically distributed around the center of the displayed signal area but can be later shifted as required.

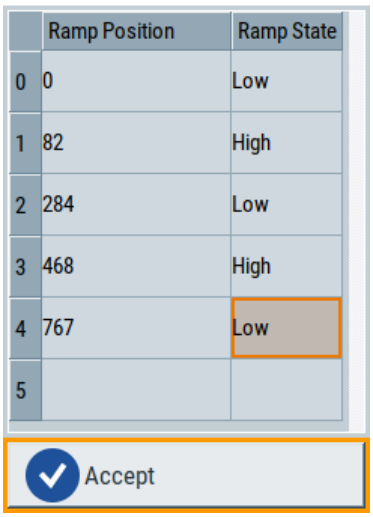
Remote command:
n.a.

Cursor Position
Displays/enters the cursor position in the graphical display

If the entered value exceeds the selected length of the definition range, the length is adjusted automatically.

Remote command:
n.a.

Positions Control Signal
Select "Edit ..." to access a dialog with a representation of the ramps of the selected signal in table form.



The bit position is specified in the "Ramp Position" column, the high or low signal status in the "Ramp State" column. Use the last blank row to enter the new ramps.

To apply the changes, press "Accept".

Remote command:
n.a.

Zoom/Visible
Zooms the displayed area of the control list. The designation of the button changes from "Zoom in" to "Zoom out".

With long control lists, it is helpful to display only a part of the control list. In such cases, set the "Visible/Bits Visible" to determine the number of symbols/bits to be displayed and select "Zoom" to focus the displayed area around the current "Cursor Position".

Ramps outside the displayed area are not lost by zooming.

Remote command:
n.a.

Save/Save As
Saves the changes in the selected control list file or in a new file.

Remote command:
n.a.

4.5.4 How to create data and control lists

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings, see Section 4.5.3, "Custom digital modulation settings", on page 106.

For more information, refer to the specifications document.

4.5.4.1 How to create and assign a control list

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

- To use the dedicated Control and marker lists editor and create a file in ASCII format and with an extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 124
- To use the tag-oriented format and create a control list file, see "To create a control list with tag file format" on page 166.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 167.

To create a control list in ASCII format manually

Use the intuitive build in Control and marker lists editor dialog:

1. To open the "Control Data Editor":
   a) Select "Baseband" > "Custom Digital Mod" > "Data Source" > "Select Control List".
   b) Select a file.
   You can select an existing file or a "New".

   If the selected file is an existing one, the dialog shows the used settings. If you create a file, the control list is empty.
2. Adjust the control signals as required.
   a) In the graphic editor "Select Ramp to Edit", select the color-coded trace of the required signal.
   b) Tap at a position which requires a ramp. The number or ramps per marker is unlimited.
   c) To remove a ramp, place the cursor at the desired ramp position.
   On the connected keyboard, press "Del".
   d) For faster marker and control signal definition, use the predefined ramp functions ("Preset Type"). Apply them with "Preset".
   e) If necessary, readjust the ramps with the help of the "Edit" function.
   f) Define the "Total List Lenght".

g) To display only a part of the control list, set the "Visible/Bits Visible" to determine the number of displayed symbols/bits.
Select "Zoom" to focus the displayed area around the current "Cursor Position".

Ramps outside the displayed area are not lost.

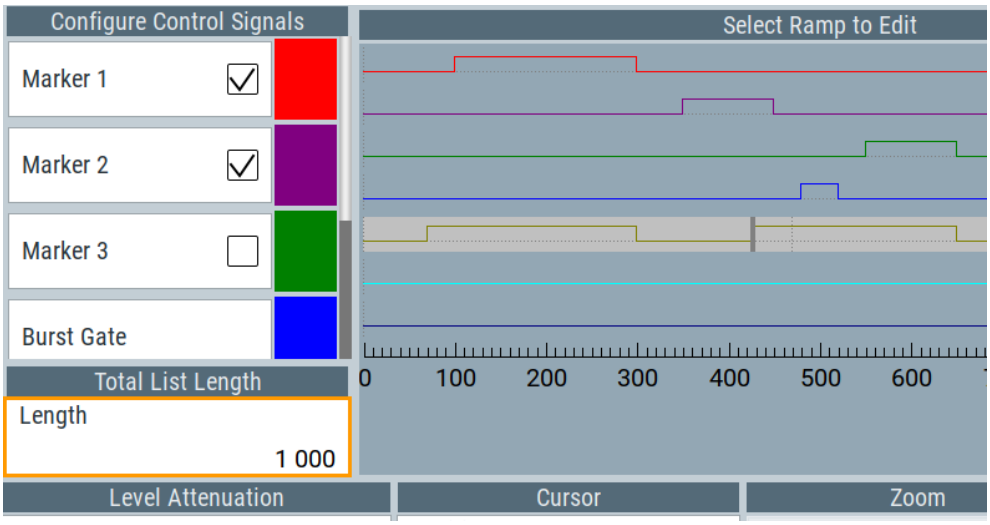


Figure 4-12: Example of control list settings

3. Select "Save" or "Save As" to save the used settings as a control list file.

   The created file is an ASCII file with the extension `*.dm_iqc`.

   Enable the instrument to use the control list, e.g. for the marker and/or other control signals.
   Enabled control signals are indicated as active in the "Configure Control Signal" section.

To assign and activate control signals from a control list

Irrespectively on the way they are created, generated control lists are not automatically used. To use a marker signal or a control signal from a control list and to output this signal at the supported connector, proceed as follows:

► Enable the R&S SMCV100B to use the control list for marker output 2.
Output this signal at the User2 connector:

a) Select "Baseband" > "Custom Digital Mod" > "Marker".
b) Select "Marker 2" > "Mode" > "CList".
c) Select "Baseband" > "Custom Digital Mod" > "Marker" > "Global Connectors".
d) Select "Routing" > "User 2" > "Direction" > "Output".
The output signal is "Signal" > "Baseband Marker 2".

4.5.4.2 How to create and assign a data list

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

- To use the dedicated Data list editor and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 126
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 167.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 168.

To create data lists manually

Use the intuitive build in Data list editor dialog:

1. To access the "Data List Editor":
   a) Select "Baseband" > "Custom Digital Mod".
   b) Select "Data Source" > "Data List".
   c) Select "Select Data List"
   d) Navigate to the required directory, for example `/var/user/`.
   e) Select "New". Enter a filename, for example `dl`.

   The "Data List Editor" opens; the data list is empty.

2. Enter a sequence of 0 and 1, for example *01110101*.

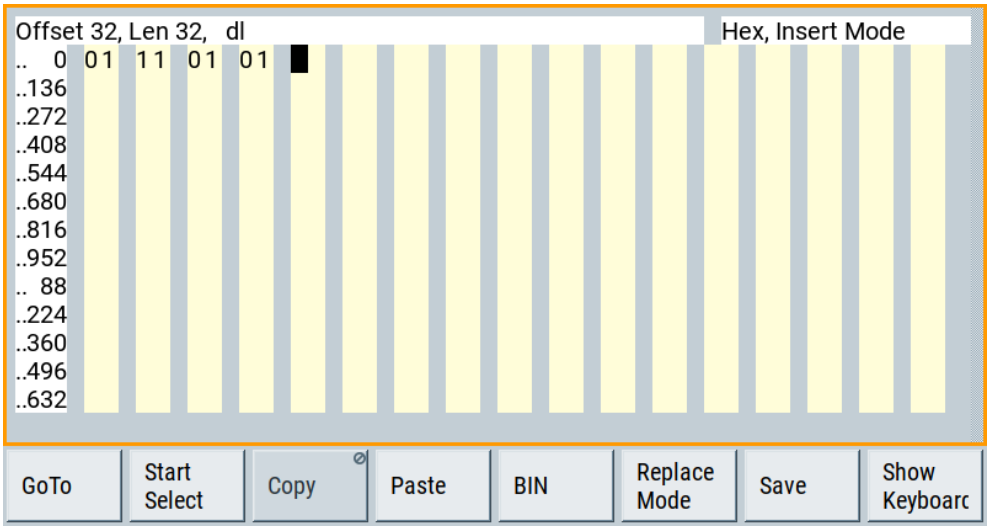


Figure 4-13: Example of data list

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

   The instrument saves the `dl.dm_iqd` file in the `/var/user/` directory.

How to assign and activate data lists

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

► To enable the R&S SMCV100B to use the data list as a data source for the custom digital modulation:

a) Select "Baseband" > "Custom Digital Mod".
b) Select "Data Source" > "Data List".
c) Select "Select Data List"
d) Navigate through the file system.
e) To select the file, confirm with "Select".

4.5.5 References

This section provides reference information on common custom digital modulation characteristics including default settings and predefined settings. It covers the following topics:

- Default settings and predefined configurations 127
- Common coding algorithms 130
- Predefined baseband filters 132

4.5.5.1 Default settings and predefined configurations

Table 4-4: Custom digital modulation default settings

Settings	Parameter	Value
"General"	"State" "Standard" "Symbol Rate" "Coding"	Not affected "GSM" "270.833333 ksym/s" "GSM"
"Data Source"	"Data Source" "PRBS Type"	"PRBS" "PRBS 9"
"Modulation"	"Modulation Type"	"MSK"
"Filter"	"Filter" "B*T"	"Gauss (FSK)" "0.30"
"Trigger In"	"Mode" "Source"	"Auto" "Internal"
"Marker"	"Mode"	"On/Off Ratio"

Settings	Parameter	Value
"Clock"	"Clock Source"	"Internal"
"Power Ramp Control"	"State" "Source" "Ramp Function" "Ramp Time" "Rise Delay" "Fall Delay" "Attenuation"	"Off" "Internal" "Cosine" "1.00 sym" "0.00 sym" "0.00 sym" "15.0 dB"

Table 4-5: Predefined settings for communication standards

Standard	Modulation	Symbol rate	Filter	Coding	SCPI filter type
APCO Phase1 C4FM	4FSK f_{dev} = 1.8 kHz	4.8 ksym/s	APCO25 Rolloff factor = 0.2	APCO25(FSK)	`APCOPH1C4fm`
APCO Phase1 CQPSK	pi/4-DQPSK	4.8 ksym/s	Raised Cosine Rolloff factor = 0.2 Bandwidth = 4.8 kHz	APCO25(PSK)	`APCOPH1CQpsk`
APCO Phase2 H-CPM	4FSK f_{dev} = 3 kHz	6 ksym/s	APCO25(H-CPM)	APCO25(FSK)	`APCOPH2HCpm`
APCO Phase2 H-DQPSK	pi/4-DQPSK	6 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(PSK)	`APCOPH2HDQpsk`
APCO Phase2 H-D8PSK Wide	pi/8-D8PSK	4 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(8PSK)	`APCOPH2HD8PSKW`
APCO Phase2 H-D8PSK Narrow	pi/8-D8PSK	4 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 5 kHz	APCO25(8PSK)	`APCOPH2HD8PSKN`
APCO Phase1 LSM	pi/4-DQPSK	4.8 ksym/s	APCO25(LSM) Gauss Cut Off Freq. = 2.04 kHz Lowpass Cut Off Freq. = 6.2 kHz	APCO25(PSK)	`APCOPH1Lsm`
APCO Phase1 WCQPSK	pi/4-DQPSK	4.8 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(PSK)	`APCOPH1Wcqpsk`
Bluetooth	2FSK f_{dev} = 160 kHz	1 Msym/s	Gauss (FSK) B*T = 0.5	Off	`BLUetooth`
CDMA2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	`CFORward`
CDMA2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	`CREVerse`

Standard	Modulation	Symbol rate	Filter	Coding	SCPI filter type
CW in Baseband	BPSK	1 Msym/s	Gauss (FSK) B*T = 0.5	Off	CWBPsk
DECT	2FSK f_{dev} = 288 kHz	1.152 Msym/s	Gauss (FSK) B*T = 0.5	Off	DECT
ETC	ASK m = 100 %	1.024 Msym/s	Split Phase B*T = 2.0	Off	ETC
GSM	MSK	270.833333 ksym/s	Gauss (FSK) B*T = 0.3	GSM	GSM
GSM EDGE	8PSK EDGE (3pi/8 8PSK)	270.833333 ksym/s	Gauss Linearized	Off	GSMEdge
NADC	pi/4 DQPSK	24.3 ksym/s	Root Raised Cosine Rolloff factor = 0.35	NADC	NADC
PDC	pi/4 DQPSK	21 ksym/s	Root Raised Cosine Rolloff factor = 0.5	PDC	PDC
PHS	pi/4 DQPSK	192 ksym/s	Root Raised Cosine Rolloff factor = 0.5	PHS	PHS
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	Root Raised Cosine Rolloff factor = 0.22	Off	TCSCdma
Telemetry SOQPSK-TG	2FSK f_{dev} = 1.25 MHz	5 Msym/s	SOQPSK	Off	SOQPSKTG
TETRA	pi/4 DQPSK	18 ksym/s	Root Raised Cosine Rolloff factor = 0.35	TETRA	TETRa
TFTS	pi/4 DQPSK	22.1 ksym/s	Root Raised Cosine Rolloff factor = 0.4	TFTS/TETRA	TFTS
WCDMA-3GPP	QPSK 45° Offset	3.84 Msym/s	Root Raised Cosine Rolloff factor = 0.22	WCDMA 3GPP	W3GPp
Worldspace	QPSK	1.84 Msym/s	Root Raised Cosine Rolloff factor = 0.4	Off	WORLdspace

Table 4-6: Modulation type and coding combinations

Modulation	Coding	Modulation	Coding
ASK	Off Differential, Differential + Gray, Gray	pi/8 D8PSK	Off Gray APCO25(8PSK)
BPSK, AQPSK, OQPSK	Off Differential, Differential + Gray, Gray	8PSK	Off Differential, Differential + Gray, Gray VDL

Modulation	Coding	Modulation	Coding
QPSK	Off Differential, Differential + Gray, Gray INMARSAT, ICO, CDMA2000, WCDMA	16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM	Off Differential, Phase Differential, Differential + Gray, Gray
QPSK 45° Offset	Off Differential, Differential + Gray, Gray ICO, CDMA2000, WCDMA	MSK, 2 FSK	Off Differential, Differential + Gray, Gray GSM
QPSK EDGE, 8PSK EDGE, 16QAM EDGE, 32QAM EDGE	Off	4FSK, Variable FSK > 4FSK	Off Differential, Differential + Gray, Gray APCO25(FSK)
OQPSK	Off Differential, Differential + Gray, Gray INMARSAT, ICO, CDMA2000, WCDMA	8FSK, 16FSK, 32FSK, 64FSK	Off
pi/4 QPSK	Off Differential, Gray	Variable FSK > 8FSK, Variable FSK > 16FSK	Off Differential, Differential + Gray, Gray
pi/2 DBPSK	Off Gray	16APSK, 32APSK	Off
pi/4 DQPSK	Off Gray NADC, PDC, PHS, TETRA APCO25(PSK), PWT, TFTS/ TETRA	User	Off

4.5.5.2 Common coding algorithms

Coding notation

In the notation used below, a_n denotes the n^{th} input symbol and b_n denotes the correspondingly coded output symbol. Individual bits in the symbols from the LSB (least significant bit) to the MSB (most significant bit) are denoted by a_{0n}, a_{1n}, etc. The same applies to the output symbols.

The table Table 4-7 lists common coding types and coding algorithms.

Table 4-7: Coding types and coding algorithms

Coding	Coding algorithm	Bit per symbol
"None"	$b_n = a_n$	k = 1 to 8
"Differential"	$b_n = (a_n + b_{-1})$ modulo 2^k	k = 1 to 7

Coding	Coding algorithm	Bit per symbol
"Differential + Gray"	Gray coding with additional differential coding	k = 1 to 7
"Phase Differential"	b_{1n} = [NOT (a_{1n} EXOR a_{0n}) AND (a_{1n} EXOR $b_{1(n-1)}$)] OR [(a_{1n} EXOR a_{0n}) AND (a_{1n} EXOR $b_{0(n-1)}$)] b_{0n} = [NOT (a_{1n} EXOR a_{0n}) AND (a_{0n} EXOR $b_{0(n-1)}$)] OR [(a_{1n} EXOR $a_{0(n-1)}$) AND (a_{0n} EXOR $b_{1(n-1)}$)]	-

"Coding" > "INMARSAT" or "Phase Differential" corresponds to system standards Inmarsat-M and DVB according to ETS 300 429. You can use INMARSAT coding for modulation types with 2 bit/symbol coding, such as QPSK.

Examples

The following examples illustrate how some of the coding schemes and modulation type influence the signal.

Example: Differential coding for QPSK modulation with k = 2 bits per symbol

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

According to Table 4-7 and for $k = 2$, the recursive coding is as follows:

$b_n = (a_n + b_{-1})$ *modulo 4*.

Depending on the state of a preceding modulation symbol b_{-1}, the coded modulation symbol b_n is obtained, for example, from modulation symbol, $a_n = 2$ as follows:

b_{-1}	0	1	2	3
b_n	2	3	0	1

With differential coding, the assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

Table 4-8: Phase difference for QPSK

Modulation symbol a_n	00	01	10	11
Phase difference	0°	90°	180°	270°

Example: Differential coding for modulation type pi/4 DQPSK

With differential coding switched on at the same time, the obtained constellation diagram for pi/4DQPSK is similar to that of 8PSK. Phase shifts are however assigned to the individual modulation symbols. The Table 4-9 shows the assignment of modulation symbols a_n (binary indication: MSB, LSB) to phase shifts of the I/Q vector in relation to the selected coding.

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

Modulation symbol a_n	00	01	10	11
"Coding" > "Off"	+ 45°	+ 135°	- 135°	- 45°
"Coding" > "NADC"/"PDC"/"PHS"/"TETRA"/"APCO25(PSK)"	+ 45°	+ 135°	- 45°	- 135°
"Coding" > "TFTS"	- 135°	+ 135°	- 45°	+ 45°

Example: Gray and differential coding for 8PSK modulation

When this coding scheme is used, the gray coding according to the gray code is performed before the differential coding. The later uses the recursive coding algorithm quoted above, see Table 4-7. The assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

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

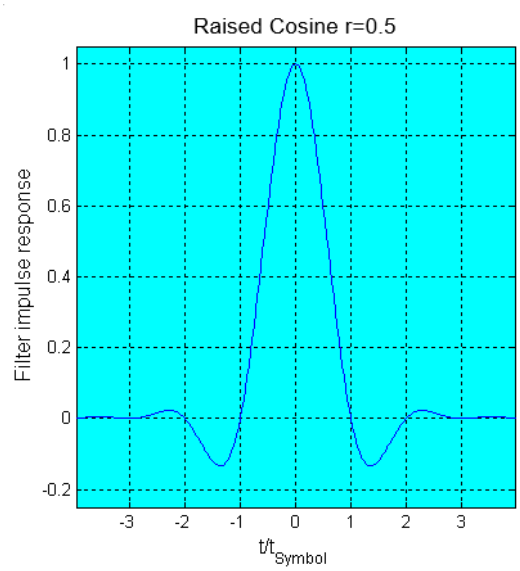
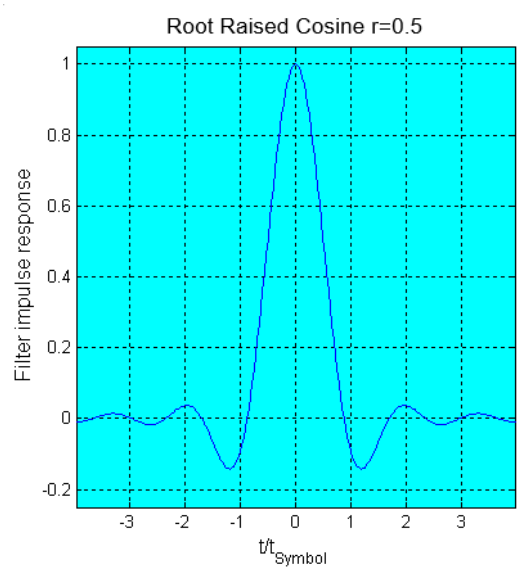
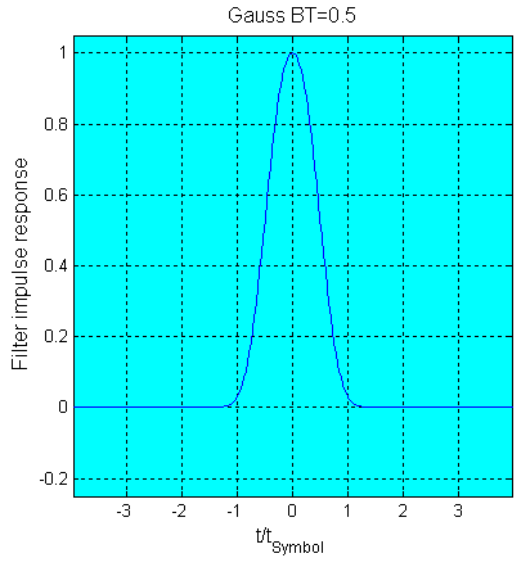
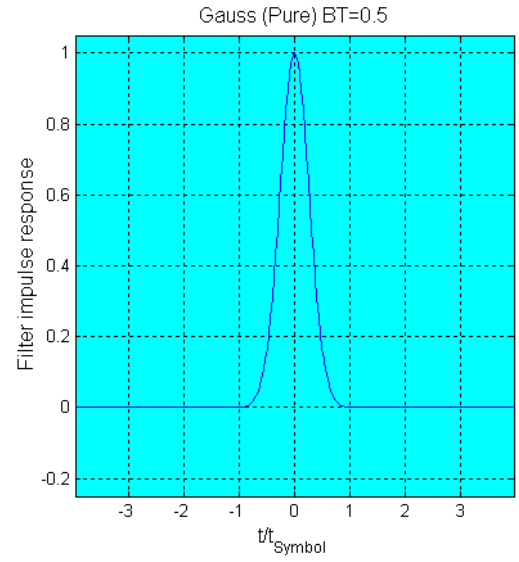
Symbol d_n	Phase difference		Symbol d_n	Phase difference
000	0°		100	270°
001	45°		101	315°
010	135°		110	225°
011	90°		111	180°

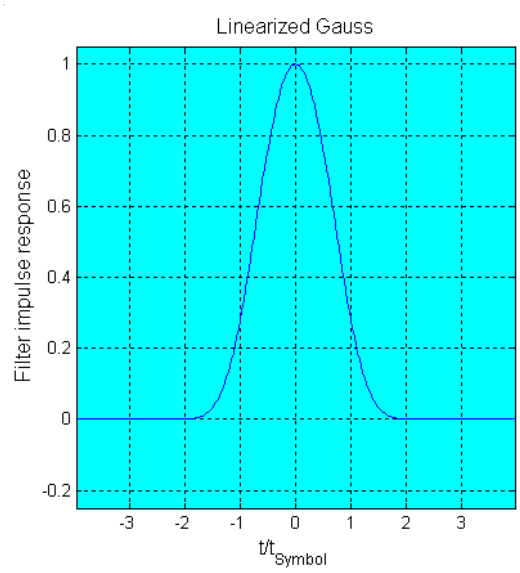
[1)] VHF data link (VDL) coding for modulation types with 3 bits/symbol, for example 8PSK.

4.5.5.3 Predefined baseband filters

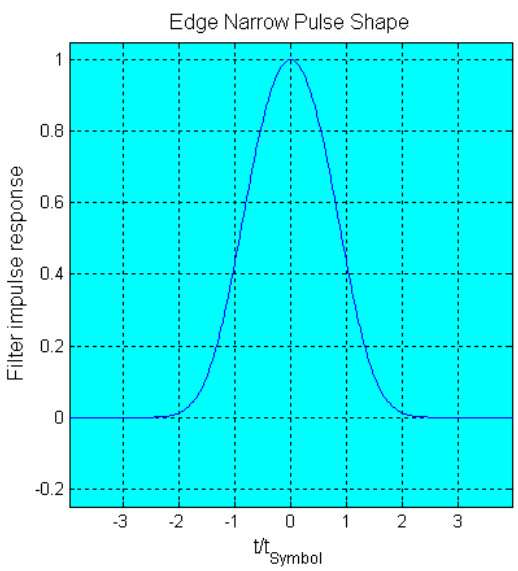
The Table 4-11 shows the filters that are available, together with their associated parameters. The filter characteristic is displayed in graphical form.

Table 4-11: Overview of the baseband filters

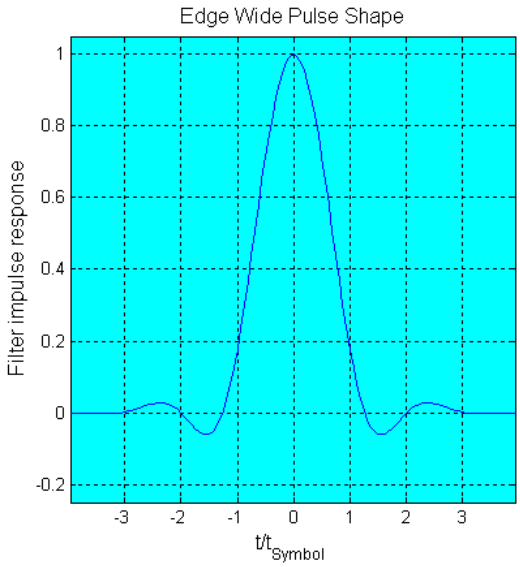
"Raised Cosine (RC)" "Roll Off Factor"	"Root Raised Cosine (RRC)" "Roll Off Factor"
	
"Gauss (FSK)" "B*T"	"Gauss (Pure)" "B*T"
	
"Gauss Linearized"	"Edge Narrow Pulse Shape"



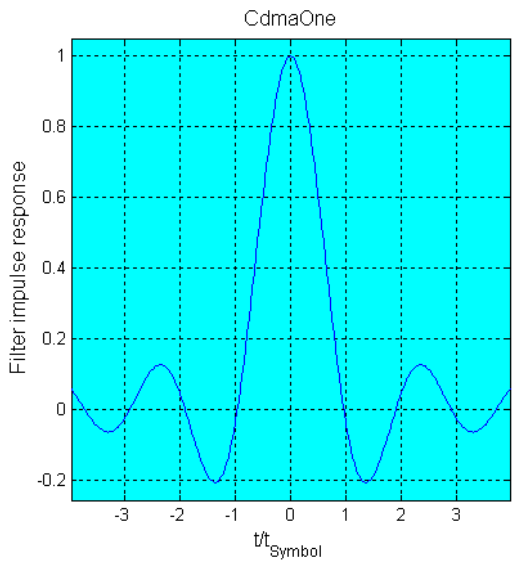
"Edge Wide Pulse Shape"



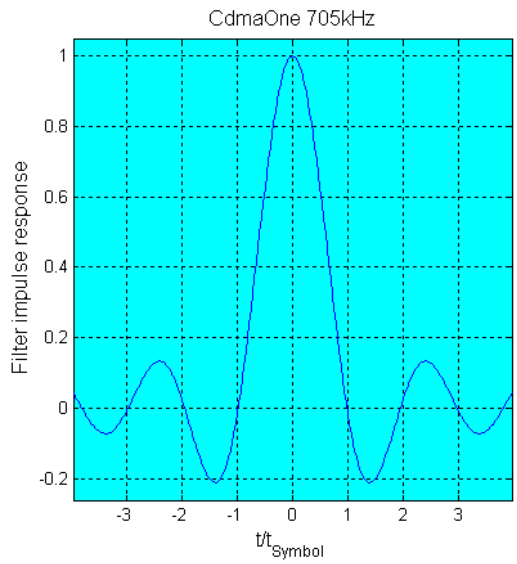
"cdmaOne"



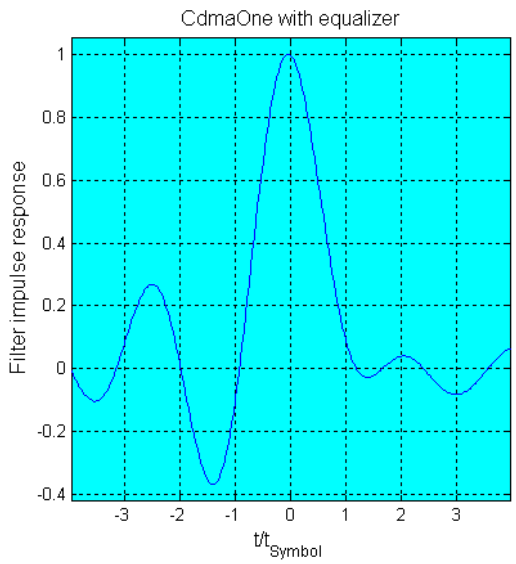
"cdmaOne 705kHz"



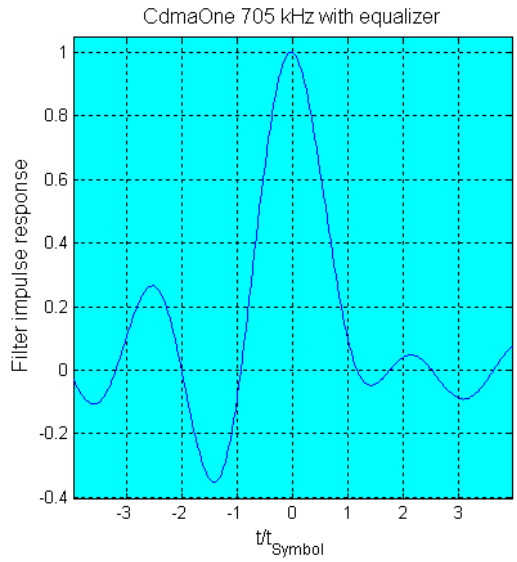
"cdmaOne + Equalizer"



"cdmaOne 705kHz + Equalizer"

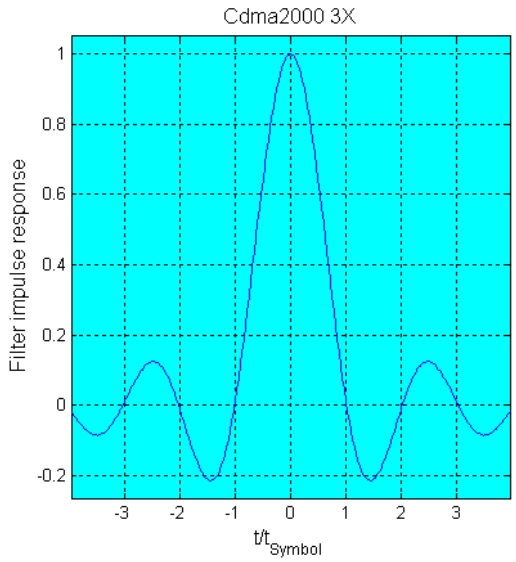


"cdma2000 3X"

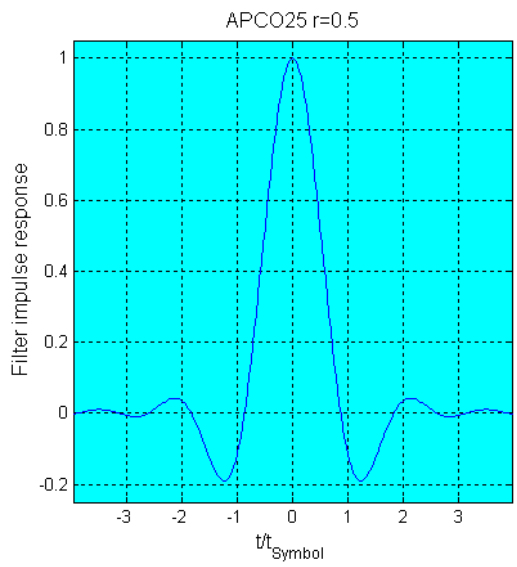


"APCO25"

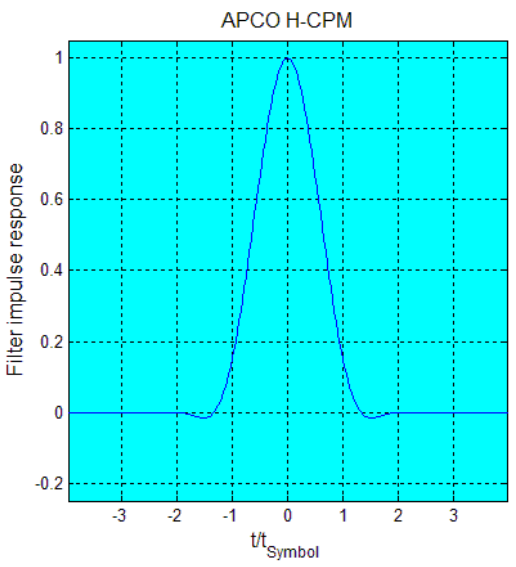
"Roll Off Factor"



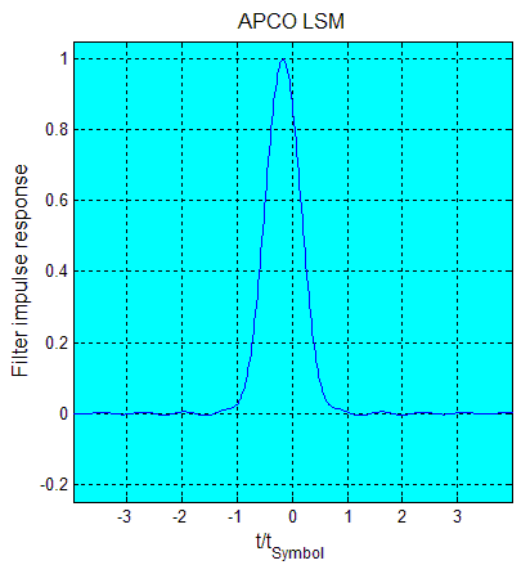
"APCO25 (H-CPM)"



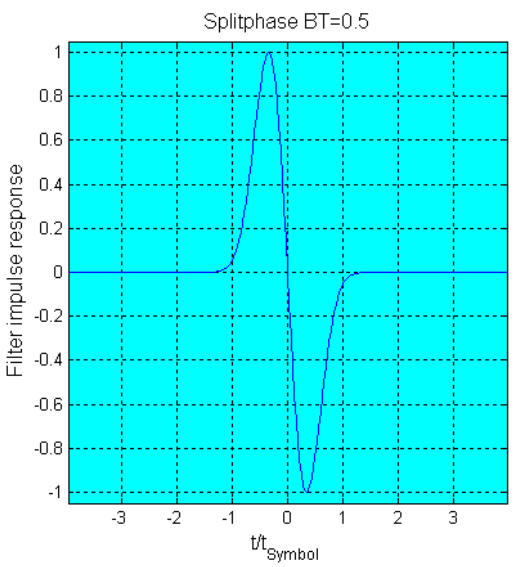
"APCO25 (LSM)"
"Gauss Cut Off Frequency"
"Lowpass Cut Off Frequency"



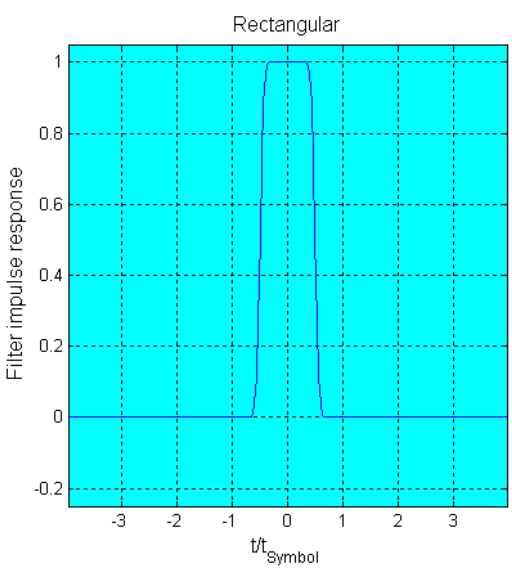
"Split Phase"
"B*T"

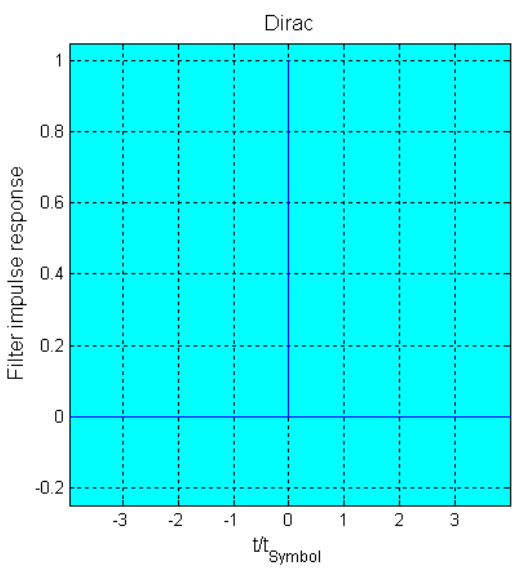


"Rectangular"

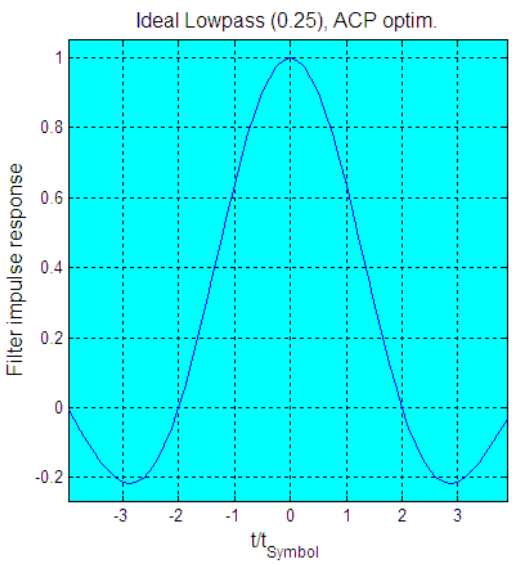


"Dirac"

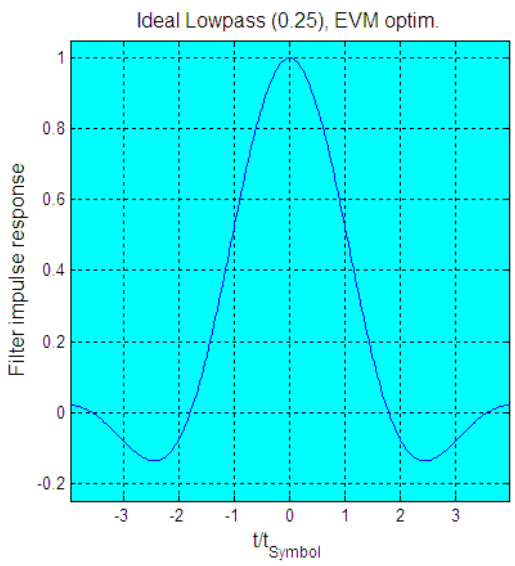


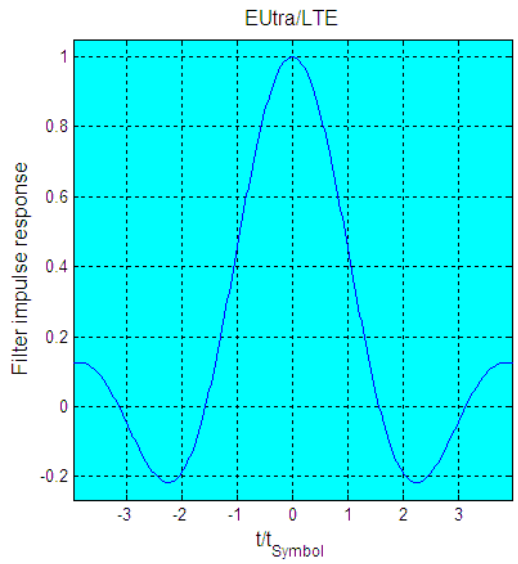


"Lowpass (ACP optim.)"



"Lowpass (EVM optim.)"



"EUTRA/LTE"	
	

4.6 Using the arbitrary waveform generator (ARB)

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

- Required options 138
- About ARB 139
- ARB settings 144
- Playing waveform files 154
- Working with waveform libraries 169
- Streaming waveforms from an external storage device 173
- Tags for waveforms, data and control lists 175

4.6.1 Required options

The equipment layout for processing of waveform files includes:

- Base unit, including arbitrary waveform generator (64 MSample ARB memory, 60 MHz RF bandwidth)
- Digital standard waveform option (R&S SMCVB-K2xx/K4xx) to play a waveform file generated by the signal generation software R&S WinIQSIM2.
  For example, if you purchase option Digital Standard EUTRA/LTE R&S SMCVB-K255, you can process EUTRA/LTE waveform file generated by R&S WinIQSIM2.
- Optional ARB memory extension (R&S SMCVB-K511/-K512)
- Optional ARB waveform streaming (R&S SMCVB-K505)

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

- Optional waveform libraries (R&S SMCVB-KVxx)
  Required for playing waveforms of a waveform library. The libraries contain waveform files for various broadcast signals.

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

- Output at the RF connector requires an RF frequency option, for example, option R&S SMCVB-B103.
- Output at the Dig. IQ HS x connectors requires option R&S SMCVB-K19 digital baseband interface.

For more information, refer to the specifications document.

4.6.2 About ARB

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

For more complex waveform signals, see the following sections:

- Section 4.9, "Generating multicarrier waveform signals", on page 223
- Section 4.8, "Generating multi-segment waveform files", on page 192

Related settings

See Section 4.6.3, "ARB settings", on page 144.

Related step-by-step descriptions

See the following sections:

- Section 4.6.4, "Playing waveform files", on page 154
- Section 4.6.4.5, "Defining periodically repeating traces", on page 164
- Section 4.6.4.4, "Creating waveforms with tag file format", on page 160
- Section 4.6.4.6, "Creating control lists with tag file format", on page 166
- Section 4.6.4.7, "Creating data lists with tag file format", on page 167
- Section 4.6.4.8, "Editing waveform files, data and control lists", on page 168
- Section 4.6.5, "Working with waveform libraries", on page 169

4.6.2.1 About ARB file formats

In ARB mode, the R&S SMCV100B can load and play back various file formats.

ARB file formats

You can load the following file formats using the "Load Waveform" function.

File format	I/Q format	Description	Max. file size
`*.wv`	Real and complex	Standard waveform file format, see Section 4.6.2.2, "About waveform files", on page 140.	Limited by internal memory
`*.iqtar`	Complex	Standard Rohde & Schwarz I/Q data format, see R&S iq-tar.	13 MB to 30 MB
`*.csv`	Complex	Predefined `*.csv` file format, see Section B, "ARB *.csv file format", on page 900.	13 MB to 30 MB
`*.mat`	Complex	MATLAB® file format.	13 MB to 30 MB

For files with extension `*.iqtar`, `*.csv` and `*.mat`, also the following applies:

- You can load one I/Q stream per file, the file formats state `NumberOfChannels = 1`.
- The files do not provide power values for the PEP and RMS power.

4.6.2.2 About waveform files

The R&S SMCV100B uses waveform files to obtain the digital I/Q data of the baseband signal. The R&S SMCV100B can play back a waveform file from the internal storage medium but it can also generate and play back simple waveforms for test purposes.

What is a waveform?

A waveform is a file with a specified file format containing raw I/Q samples. Waveform files have the file extension `*.wv` and contain calculated I/Q values.

When creating waveforms, the instrument inserts a waveform header at the beginning of each created ARB file. The header of the generated I/Q data files consists of tags in braces "{ }". For a detailed description, see Section 4.6.7, "Tags for waveforms, data and control lists", on page 175.

Waveform file sources

The following waveform file sources are available:

- **Internally generated waveforms**
  The ARB enables the calculation and the generation of waveform files. The ARB also provides a built-in function to create a test waveform and keep it as a file or in the RAM.
- **Externally generated or created waveforms**
  The ARB processes externally created waveform files, for example:
  - The waveform files generated by software R&S WinIQSIM2, the R&S ARB Toolbox or the R&S Pulse Sequencer
  - Streaming of large waveform files from an internal solid-state drive (SSD) or an externally connected mass memory (HDD, USB flash drive).

– A mathematical program, for example, MATLAB calculates the waveform signals. See Section 4.6.7, "Tags for waveforms, data and control lists", on page 175.

You can load the externally generated waveform files into the instrument via one of the available interfaces, for example, USB or LAN. Usually, the waveform file is saved on one of the network drives which are accessible for the operating system.

- **Waveform libraries**
  The R&S SMCV100B provides waveform libraries (R&S SMCVB-KVxx) containing a wide range of ready-made signals for testing systems with different transmission parameters. The libraries contain waveforms for numerous broadcast transmission standards.
  For more information, see the user manual of the waveform library at:
  www.rohde-schwarz.com/manual/smcv100b/ksxx-kvxx-stream-and-waveform-libraries-user-manuals-manuals-gb1_78701-972224.html

4.6.2.3 Playing and streaming waveform files

You can process waveforms with the ARB as follows:

- Play back from the internal memory
  In the most common case, the ARB plays back a waveform file with a selectable clock frequency. The R&S SMCV100B loads the entire file into the ARB memory from where the I/Q samples are played repeatedly.
  Playing back files is limited by the ARB memory size, for example 64 MSample, for a R&S SMCV100B base unit.
- Streaming
  Perform direct streaming from a mass memory at 75 MHz maximum clock frequency with no restrictions to the waveform file length. If HDD streaming is active, the instrument streams the modulation data directly from an internal solid-state drive (SSD) or an external storage device connected to the instrument via USB. We recommend that you use HDD streaming for processing of large files that require more memory than the internal SSD offers. Also, you can stream encrypted waveform files, if you installed the corresponding waveform option or waveform library option.

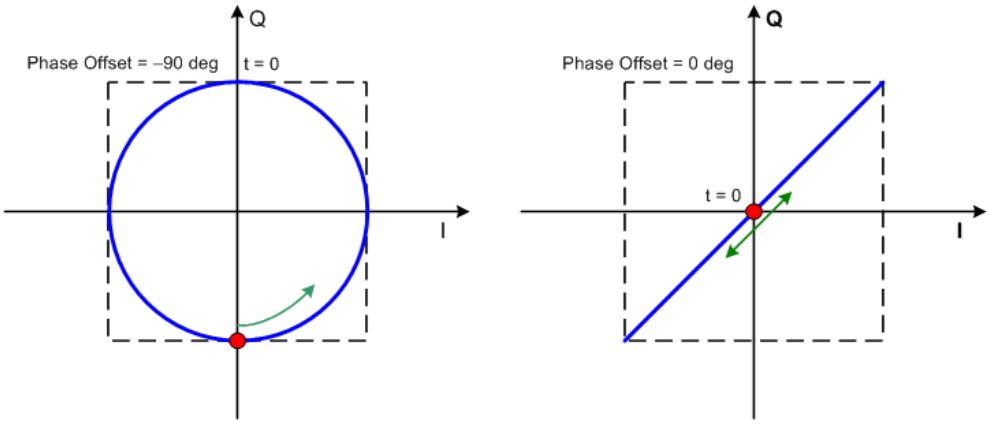
For more information, refer to the specifications document.

4.6.2.4 ARB test signals

The following test signals are available:

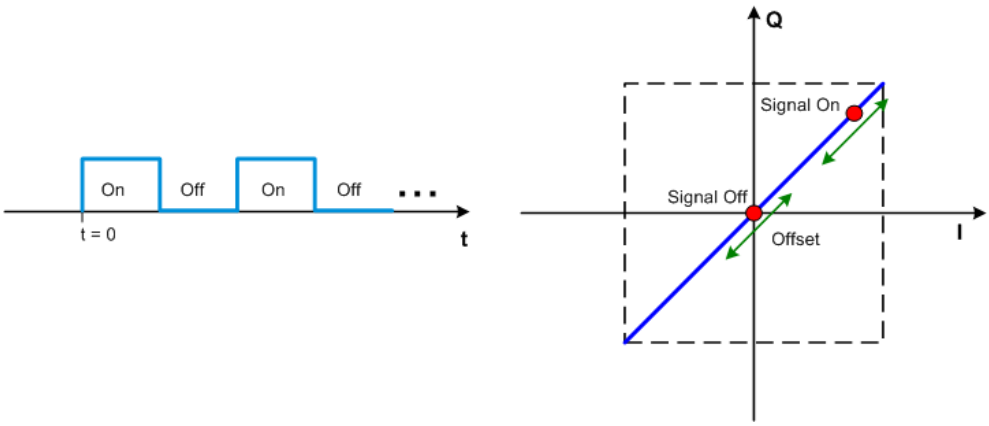
- **"Sine" test signal**: Two sine-wave signals with a selectable (but equal) number of samples per period and equal frequencies. When the generation is triggered, the number of samples per period, together with the frequency of the test signal, determine the ARB clock frequency: "Clock Frequency" = "Frequency" * "Samples per Period".
  Note: Because the resulting clock rate must not exceed the maximum ARB clock rate, the number of sample values is automatically restricted depending on the selected frequency.

The first sine signal is mapped on the I samples, the second on the Q samples. The two signals differ by a selectable phase offset. For a –90 deg offset, the result is a unit vector in the I/Q plane, rotating counterclockwise and starting at I = 0, Q = –1. For a 0 deg offset, the I and Q samples are on the diagonal of a unit square (I(t) = Q(t)).



In general, the I/Q samples are located on a deformed circle which is confined to the dashed square in the upper diagrams.

- **"Rect" test signal**: Rectangle signal with selectable but equal on and off periods and amplitude. The period is defined by the selected frequency: <Period> = 1 / "Frequency".
  The signal is mapped on both the I and Q samples. The mapping results in two distinct points in the I/Q plane. The "Offset DC" shifts both points along the diagonal I(t) = Q(t).



- **"Const I/Q" test signal:** Continuous test signal with constant I/Q and constant clock frequency of 10 kHz. The values for each I and Q components are selectable but constant. They are defined as a decimal number, which is decimal-to-binary converted internally. The signal is provided as a 16-bit wide digital signal for both I and Q channels.
  You can output the signal directly at the BNC connectors I and Q outputs of the instrument.

For more information, refer to the specifications document.

4.6.2.5 Waveform sample rate

The Arbitrary Waveform Generator includes a resampling unit that interpolates the input samples to target a certain digital output I/Q sample rate. The input sample rate f_{input} is retrieved from the waveform (the default sample rate tag) or is defined by the corresponding parameter in the ARB user interface.

The Figure 4-14 depicts the stages involved in the processing and resampling of a waveform in the ARB.

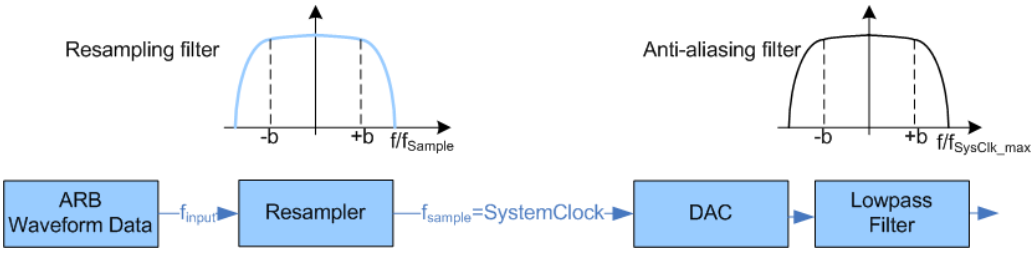


Figure 4-14: Processing of the waveform files in the ARB

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

Where:

- f_{SysClk_max} = $SystemClock_{max}$ = $SampleRate_{max}$ = 300 MHz
- b = 0.4165

Impact of the resampling filter

As illustrated in Figure 4-14, the filter in the resampling stage is distortion-free for signals with the following maximum baseband bandwidth:

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

The usable bandwidth factor b equals b = 0.4165.

An externally created waveform file has to provide a sample rate f_{input} that is high enough for perfect signal reconstruction. For distortion-free resampling the lower bound of the required sample rate f_{input} is then calculated as follows:

$f_{input} \geq Usable_Bandwidth / b$

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

Impact of the oversampling factor

Waveforms generated by the R&S WinIQSIM2 software can be optimized by choosing a suitable integer oversampling factor.

Conventional ARB often assumes an oversampling factor of 4. The ARB of the R&S SMCV100B requires low oversampling factors and still provides excellent signal quality in terms of EVM and ACP.

A reduced sample rate saves significantly the amount of memory or allows an increased signal cycle time, and vice versa.

4.6.2.6 Marker signals and waveform length

The R&S SMCV100B provides the possibility to define marker signals that are sent to the marker outputs in synchronicity with the I/Q output signals. Marker signals can be either predefined or later defined.

The I/Q data and marker data are located in separate memory areas of the SDRAM and can be independently configured. Each marker signal requires 1 bit of the available memory size. Sometimes, it is useful to generate a modulation signal without extra marker signals to increase the maximum waveform length.

The following example explains the dependency between the number of enabled marker signals, the available memory size, and the resulting waveform length.

Example: Calculating the maximum waveform length

The calculation assumes a R&S SMCV100B with an ARB memory of 512 Msample, see Section 4.6.1, "Required options", on page 138.

- Total memory size = 512 Mbyte
- Required memory size (per complex sample) = 32 bit + 1 bit = 33 bit = 4.125 byte, where:
  - The raw I/Q samples are saved as 16-bit values. For the length of the I/Q data that is:
    2 x 16 bit = 32 bit (16 bit per I/Q channel)
  - The marker requires one bit.
- Maximum waveform length with 1 marker = 512 Mbyte / 4.125 byte = 124 Msample
- Theoretical maximum waveform length (no markers) = 512 Mbyte / 4 byte = 128 Msample

A memory size of 512 Mbyte yields a maximum waveform length of 124 Msample, if one marker is enabled. The maximum waveform length increases to 128 Msample, if the internal hardware markers are used, and the complete memory is available for I/Q data.

4.6.3 ARB settings

Access:

► Select "Baseband" > "ARB".

The "ARB" dialog enables direct selection of the waveform file to be processed, the selection of a test signal or access to the multi-segment and multicarrier settings.

The remote commands required to define these settings are described in Section 14.16.4.3, "SOURce:BB:ARBitrary subsystem", on page 709.

Settings:

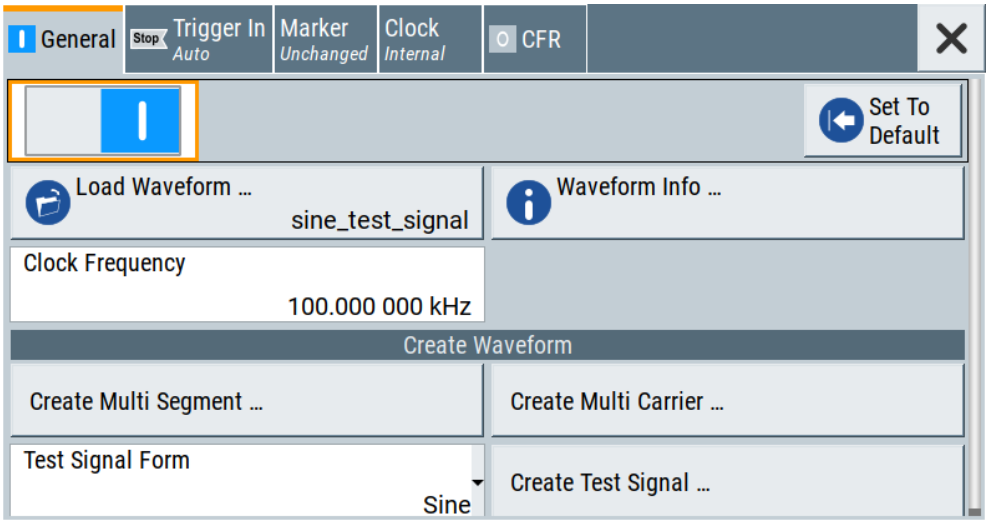
- ARB general settings 145
- Sine test signal settings 148
- Rectangular test signal settings 150
- Constant IQ test signal settings 152
- Trigger, marker and clock settings 153

4.6.3.1 ARB general settings

Access:

► Select "Baseband" > "ARB".

This tab provides general settings to select and create a waveform file and enable the ARB.



Further settings depend on the system configuration and the waveform type:

- If you use a single-segment waveform, the tab also provides settings for configuring the test signal and access to the settings for calculating a multi-segment or a multicarrier waveform.
- If you load a multi-segment waveform, the tab expands and displays the dedicated section "Multi Segment Waveform Options".
  This section provides settings to configure the segment to be output and adjust the trigger for the switch between the segments of the multi-segment waveform.
  The displayed parameters depend on the trigger source. The provided parameters are identical with the parameters in the section "Next Segment Trigger In" in the "Trigger" tab. See Section 4.8.3.5, "Multi-segment waveform trigger settings", on page 211.

Settings:

State....146
Set To Default....146
Load Waveform....147
Waveform Info....147
Clock Frequency....147
HDD Streaming....147
Create Multi Segment....148
Create Multi Carrier....148
Test Signal Form....148
Create Test Signal....148

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

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

Note: ARB stays disabled.
You cannot enable the ARB in the following cases:

- **No or empty waveform file**
  By default, no waveform file is loaded. The "Load Waveform" button displays "None".
  Remedy: Select a waveform file, before activating the ARB.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:STATe` on page 717

Set To Default
Calls default settings, see Table 4-12.

Table 4-12: ARB 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 717

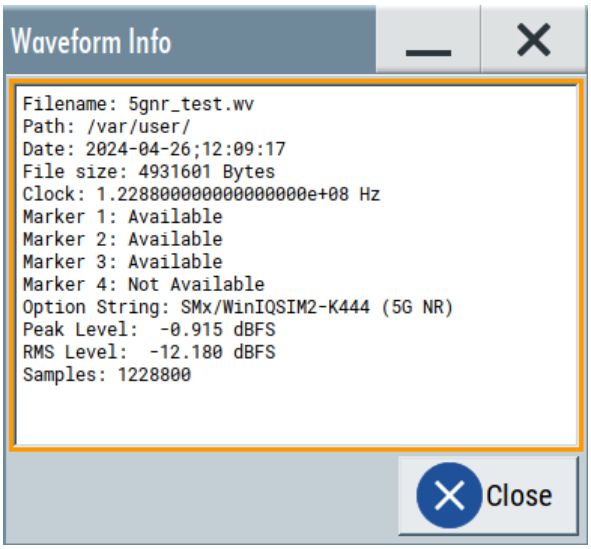
Load Waveform
Opens the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

The waveform files have a predefined file extension `*.wv`. If you select a file, the dialog displays short information about the selected waveform.

Enable the ARB to trigger the instrument to load and process the selected waveform file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect` on page 722

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



Remote command:
n.a.
For non-multi-segment waveform files, use the `Tag` commands. See Section 4.6.7, "Tags for waveforms, data and control lists", on page 175.

Clock Frequency
Displays or sets the ARB output clock rate.

The value of this parameter is set to the clock rate defined in the loaded waveform file (`{CLOCK}` tag). The value can be changed afterwards.

Note: The clock frequency must match the value of the externally applied clock source.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:CLOCk` on page 724

HDD Streaming
Option: R&S SMCVB-K505

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

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

How to: "To activate waveform streaming" on page 174

If streaming is activated, you can only use trigger modes "Auto" and "Armed Auto" and marker modes "Restart". See also "Mode" on page 100 and "Mode" on page 104.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe` on page 725

Create Multi Segment
Opens the dialog for creating multi-segment waveforms, see Section 4.8, "Generating multi-segment waveform files", on page 192.

Create Multi Carrier
Opens the dialog for creating multicarrier waveforms, see Section 4.9, "Generating multicarrier waveform signals", on page 223.

Test Signal Form
Selects the form of the test signal. A choice between a sinusoidal, rectangular, AWGN or test signal with constant I/Q is provided.

To access further settings, select Create Test Signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE` on page 718

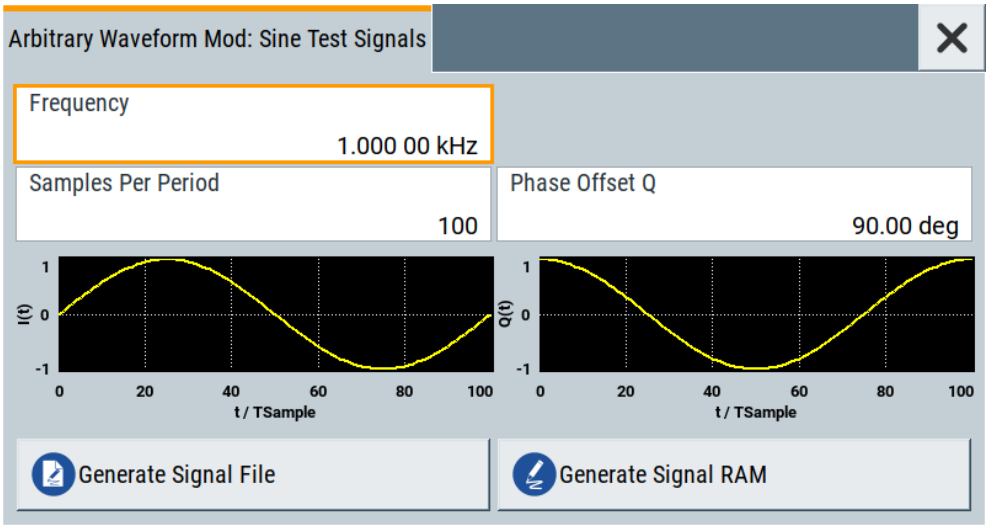
Create Test Signal
Opens a dialog with further test signal settings. Provided are the following test signals:
- Section 4.6.3.2, "Sine test signal settings", on page 148
- Section 4.6.3.3, "Rectangular test signal settings", on page 150
- Section 4.6.3.4, "Constant IQ test signal settings", on page 152

4.6.3.2 Sine test signal settings

Access:

1. Select "Baseband" > "ARB" > "General".
2. Select "Test Signal Form" > "Sine".

3. Select "Create Test Signal".



This dialog provides settings to configure a sinusoidal test signal. A sine wave is generated on the I path, and a sine wave of the same frequency but phase-shifted is generated on the Q path. For more information, refer to Section 4.6.2.4, "ARB test signals", on page 141.
The dialog displays the characteristic of the currently selected signal.

Settings:

Frequency 149
Samples per Period 149
Phase Offset Q 149
Generate Signal File 150
Generate Signal RAM 150

Frequency
Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency` on page 719

Samples per Period
Enters the number of sample values required from the sine wave per period.

The maximum allowed value is determined by the maximum ARB clock rate and the selected frequency.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles` on page 720

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 720

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

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 720

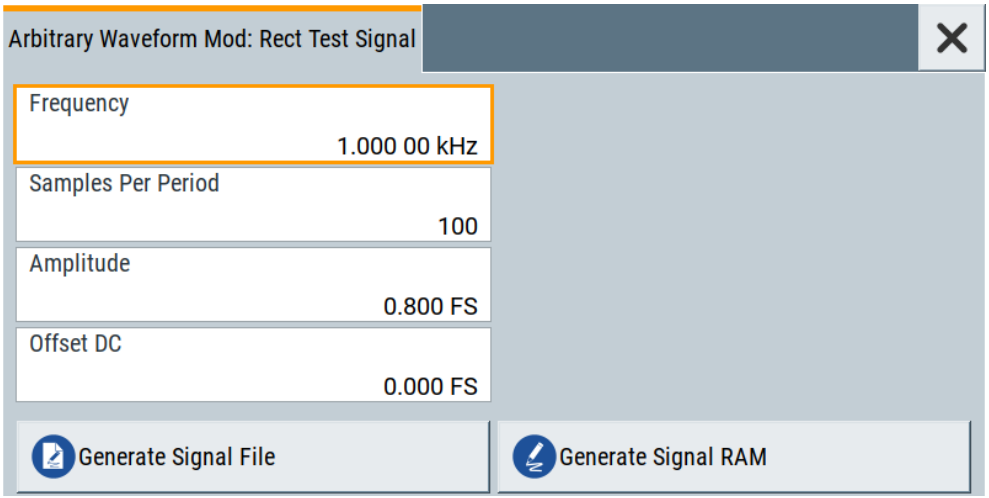
Generate Signal RAM
Generates a signal and uses this signal as output straight away. The instrument saves the file using a predefined filename.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 721

4.6.3.3 Rectangular test signal settings

Access:

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



This dialog provides settings to configure a rectangular test signal. A rectangular test signal with a duty factor of 0.5 is created. Amplitude and offset are adjustable. Both paths, I and Q, use the same signal.
For more information, refer to Section 4.6.2.4, "ARB test signals", on page 141.

Settings:

Frequency 151
Samples per Period 151
Amplitude 151
Offset DC 151
Generate Signal File 151
Generate Signal RAM 151

Frequency
Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency` on page 718

Samples per Period
Enters the number of sample values required for the rectangular signal per period.

The maximum allowed value is determined by the maximum ARB clock rate and the selected frequency.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles` on page 719

Amplitude
Enters the digital amplitude of the rectangular wave. The abbreviation FS means full-scale.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude` on page 718

Offset DC
Enters a DC component.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet` on page 719

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

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed` on page 720

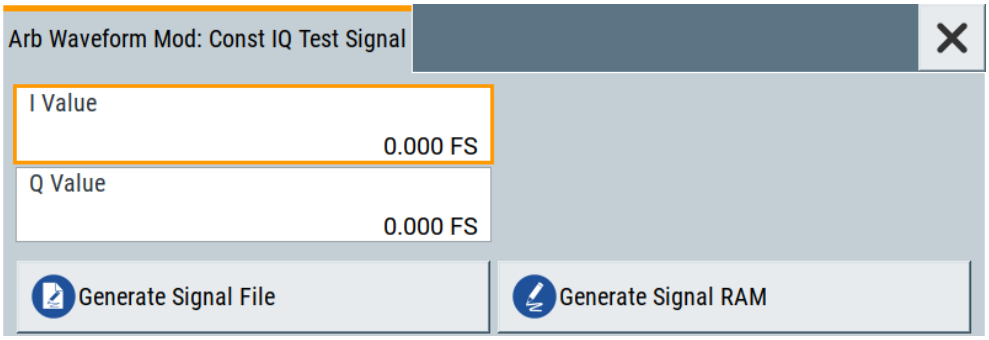
Generate Signal RAM
Generates a signal and outputs it straight away. The instrument saves the file using a predefined filename.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate` on page 721

4.6.3.4 Constant IQ test signal settings

Access:

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



This dialog provides settings to configure a continuous test signal with constant IQ. The I and Q values for each path are adjustable but constant. For more information, refer to Section 4.6.2.4, "ARB test signals", on page 141.

Settings:

I ValueIQ Value....152
Generate Signal File....152
Generate Signal RAM....152

I ValueIQ Value
Sets the value for the I component and Q component of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I` on page 718
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q` on page 718

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

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed` on page 720

Generate Signal RAM
Generates a signal and uses this signal as output straight away. The instrument saves the file using a predefined filename.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate` on page 721

4.6.3.5 Trigger, marker and clock settings

These tabs provide standard settings.

For a detailed description, see the following sections:

- Section 4.4.2.1, "Trigger settings", on page 99
- Section 4.4.2.2, "Marker settings", on page 103
- Section 4.4.2.3, "Clock settings", on page 104
- Section 4.4.2.4, "Global connector settings", on page 105

The following settings are specific to the ARB dialog.

Processing Time....153
Mode....153
Delay (Time)....154

Processing Time
Displays the internal processing time.

The processing time is the elapsed time between the input of the external trigger event and the output of the baseband signal. An additional delay applies to the RF signal with respect to the baseband signal depending on the RF frequency.

For more information, see "Starting the signal generation with the first sample" on page 89.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe?` on page 750

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

You can configure individual marker modes for each marker signal. The number of available markers is 1. The marker configuration changes with the selected marker mode.

For more information on marker modes, see Section 4.4.1.4, "About marker signals", on page 82.

Note: Setting an ARB marker mode that is different than "Unchanged" does not change the marker trace in the loaded waveform file. But, when playing the waveform file the instrument uses the configured ARB marker mode.

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

See also Section 12.2, "Configuring global connectors", on page 456.

"Unchanged" The waveform file with its configured marker traces defines the marker signal of the ARB baseband signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE` on page 752
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 753
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 753
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern` on page 753

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime on page 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime on page 753

Delay (Time)
Shows the marker delay time in microseconds, milliseconds or seconds depending on the marker delay.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec? on page 754

4.6.4 Playing waveform files

This section provides step-by-step instructions to create, generate and play waveform files on the R&S SMCV100B. Provided the R&S SMCV100B is equipped with the required option, you can load this waveform file and process it with the instrument.

For details on individual functions and settings, see Section 4.6.3, "ARB settings", on page 144.

Some test cases do not require a real-time signal generation according to a digital standard. For these test cases, the replay of a previously generated waveform is sufficient. Generate these waveform files as follows:

- Internal generation with the "Create Test Signal" function, see Section 4.6.4.1, "Generating ARB test signals", on page 154.
- External waveform generation with Rohde & Schwarz software products:
  - For R&S WinIQSIM2, see Section 4.6.4.3, "Working with R&S WinIQSIM2", on page 155
  - For R&S ARB Toolbox, see 1GP88.
- External waveform generation with MATLAB, see Section 4.6.4.4, "Creating waveforms with tag file format", on page 160 and 1GP60.

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

- Generating ARB test signals 154
- Loading and playing waveform files 155
- Working with R&S WinIQSIM2 155
- Creating waveforms with tag file format 160
- Defining periodically repeating traces 164
- Creating control lists with tag file format 166
- Creating data lists with tag file format 167
- Editing waveform files, data and control lists 168

4.6.4.1 Generating ARB test signals

If your test case requires a simple sine signal or square signal, use the ARB test signals.

To generate a sine test signal

1. Select "Baseband" > "ARB"
2. Select "Create Test Signal" > "Sine".
3. Adjust the "Sine Test Signal" settings as required.
4. Select "Generate Signal File".
   A standard file select dialog opens.
   a) Navigate to the directory in that you want to save the file, for example /var/user/.
   b) Enter a filename, for example `sine_waveform`.
   c) Click "Save".

   The R&S SMCV100B saves the generated waveform file and automatically loads it in the ARB.
5. Select "ARB" > "State" > "On".

   The R&S SMCV100B processes the waveform file.

4.6.4.2 Loading and playing waveform files

Irrespectively on how you generate a waveform, you can transfer it to the instrument, load it in the ARB and play it.

To load and play a waveform file

1. Transfer an externally created waveform file to the instrument.
   See Section 11.10, "Transferring files from and to the instrument", on page 440.
2. Select "Baseband" > "ARB".
3. Select "Load Waveform".
   A standard file select dialog opens.
   a) Navigate to the directory that the waveform file contains.
   b) Select the waveform file, for example `/var/user/lte_waveform`.
   c) Click "Select".

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

   The R&S SMCV100B processes the waveform file.

4.6.4.3 Working with R&S WinIQSIM2

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

The workflow consists of three main steps, each described in a separate step-by-step instruction:

- Configuring the connection between the R&S WinIQSIM2 and the R&S SMCV100B
- Generating of a waveform file with the required settings
- Transferring the waveform file to and playing it with the R&S SMCV100B.

This section does not describe the R&S WinIQSIM2 simulation software but focuses on the task-related settings. For a description of the simulation software, see the R&S WinIQSIM2 user manual.

To define the R&S SMCV100B as destination instrument

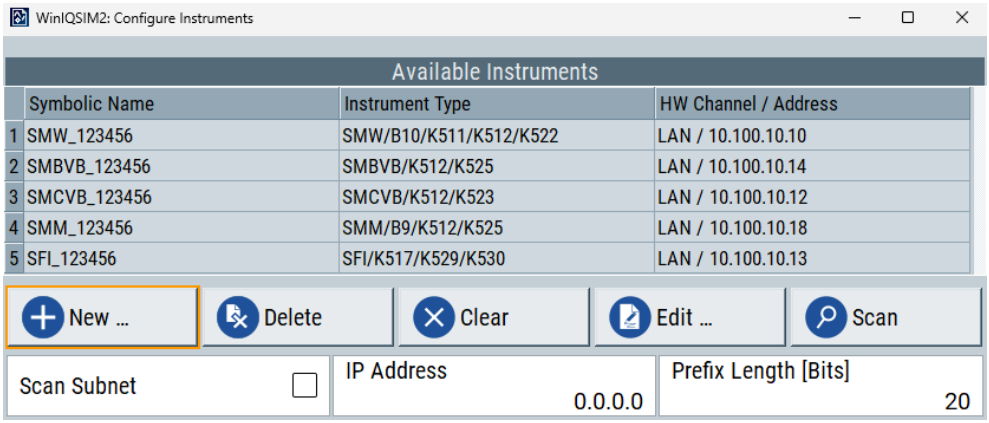
In this example, we assume that the R&S WinIQSIM2 is installed on a remote controller. This remote controller is connected over LAN to the R&S SMCV100B.

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

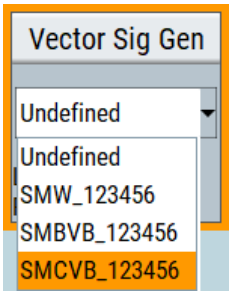
1. In the R&S WinIQSIM2, select "File" > "New" to preset the software.
2. In the block diagram, select "Vector Sig Gen" > "Instruments".

   The "Configure Instruments" dialog opens. The list of configured instruments is empty.
3. Select "Configure Instruments" > "Scan".

   The software scans the network for connected and active instruments.

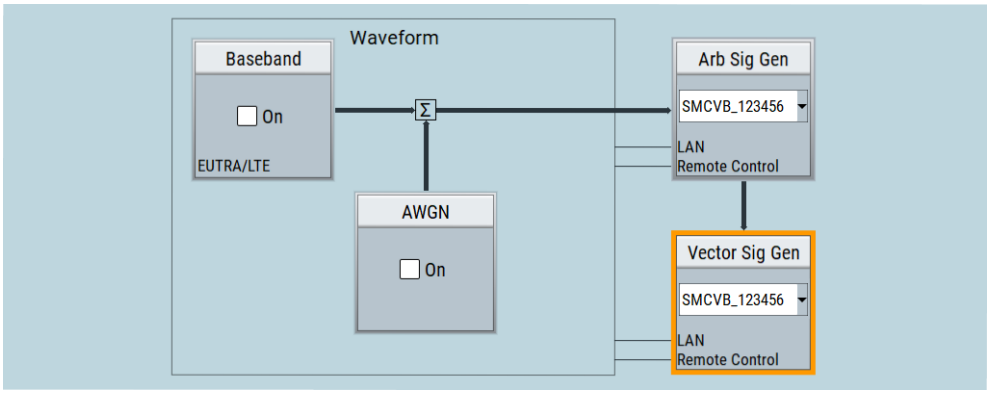


   Alternatively, use the "New" function to add the R&S SMCV100B manually to the list of instruments.
4. Close the dialog.
5. In the block diagram, select "Vector Sig Gen" block and select the R&S SMCV100B form the list.



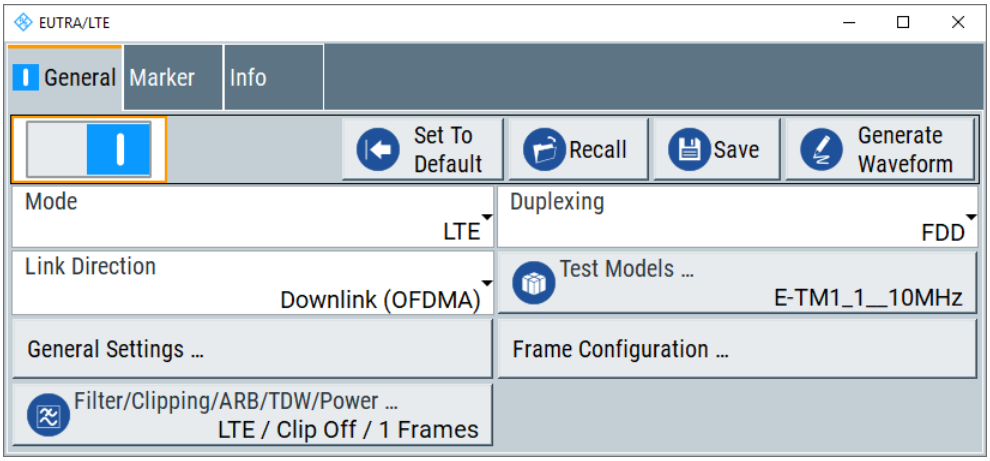
6. In the block diagram, select "ARB Sig Gen" block and select the R&S SMCV100B form the list.

   The two lines to the "Vector Sig Gen" and "ARB Sig Gen" blocks on the block diagram confirm that a remote connection to the R&S SMCV100B is established.

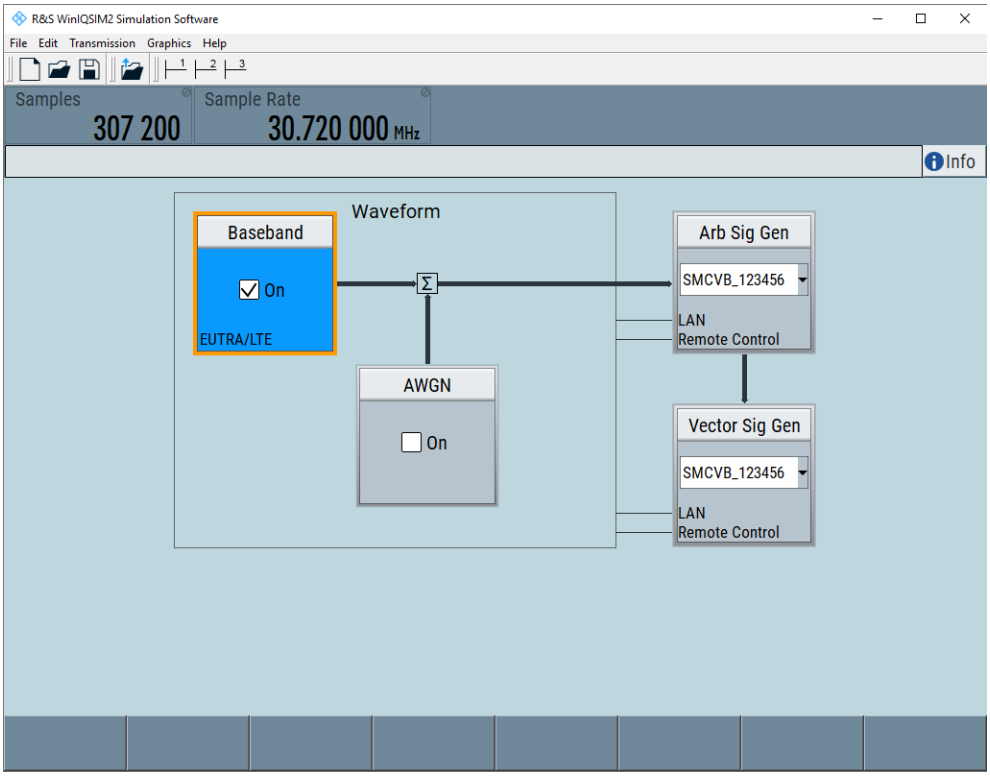


To generate a waveform file with R&S WinIQSIM2

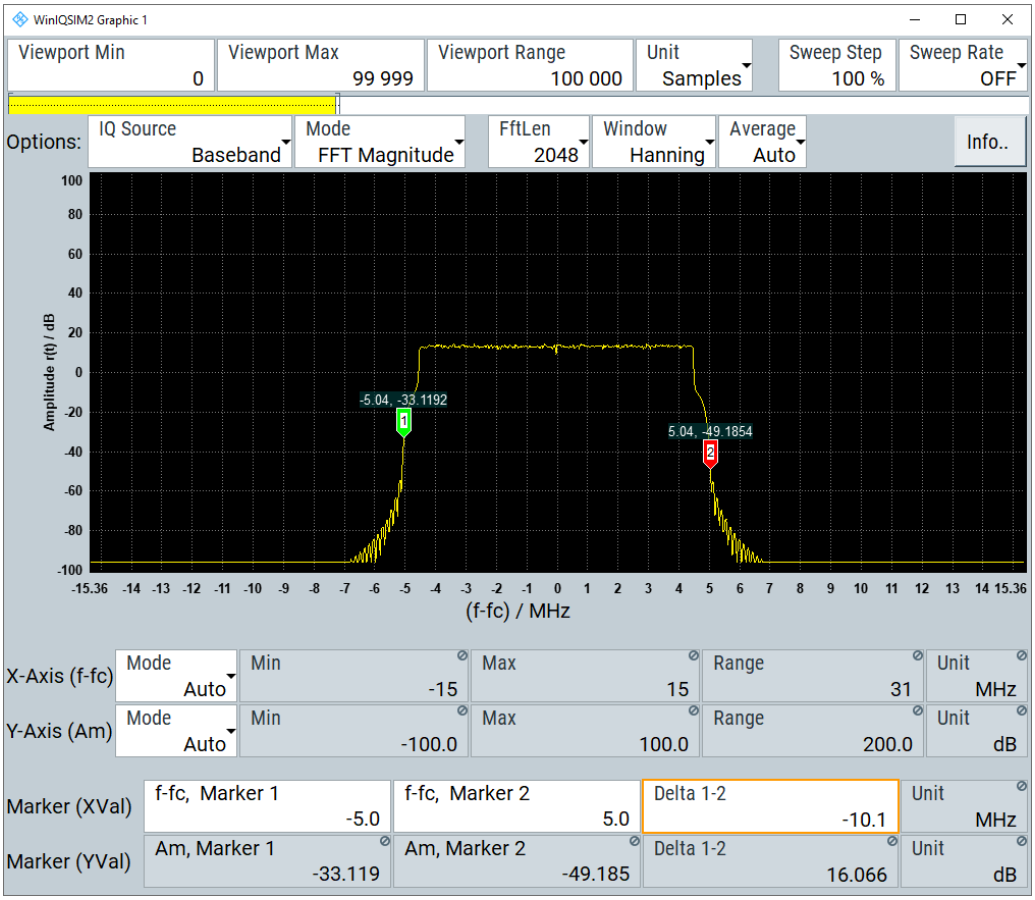
1. In the block diagram of R&S WinIQSIM2, select "Baseband" > "EUTRA/LTE/IoT".
2. Adjust the settings as required, for example:
   a) Select "Link Direction" > "Downlink (OFDMA)"
   b) Select a predefined test model, for example, "Test Models" > "E-TM1_1__10MHz".
3. Select "EUTRA/LTE/IoT" > "State" >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



R&S WinIQSIM2 calculates the signal and displays important signal parameters, for example, number of samples "Samples" and "Sample Rate".



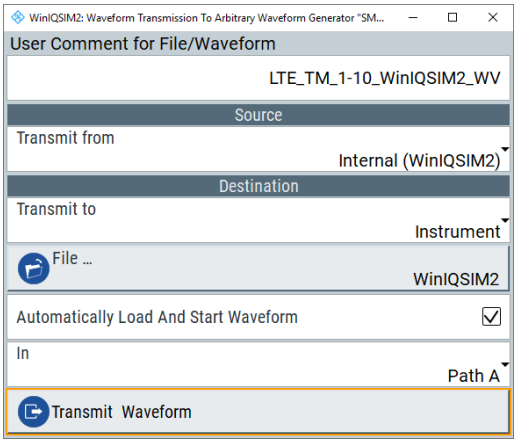
Select "Graphics" > "Graphic 1 (Complete)" to check for more information on the generated signal.



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

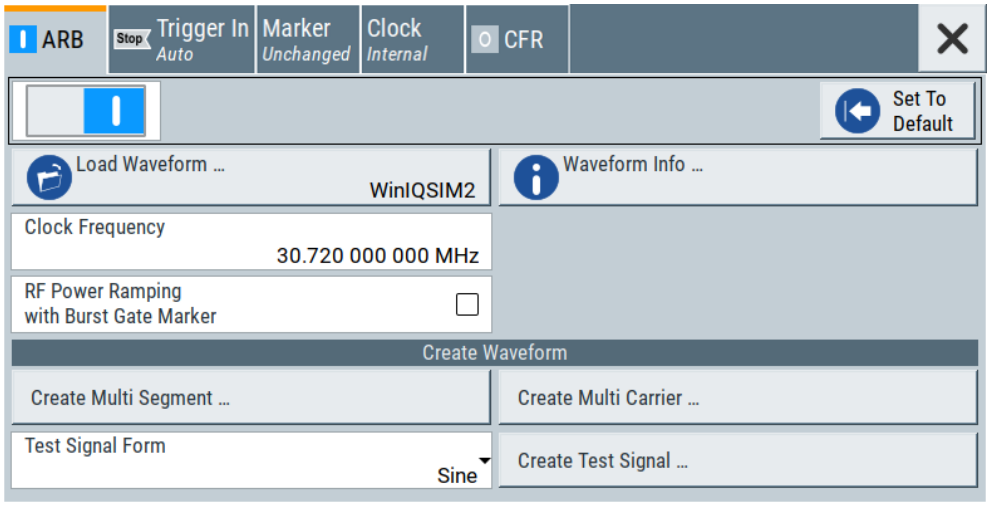
To transfer the waveform file to the R&S SMCV100B

1. At R&S WinIQSIM2, select "Transmission" > "Transmit".
2. In the "Waveform Transmission to Arbitrary Waveform Generator" dialog, proceed as follows:
   a) "Transmit from" > "Internal (WinIQSIM2)".
   b) "Transmit to" > "Instrument".
   c) Select "File".
   d) Define the filename of the transmitted file.
   e) Activate "Automatically Load and Start Waveform".
   f) Select the required baseband, for example "Path A".
   g) Add a comment to the waveform, for example as follows:
   "User Comment for File/Waveform" > "LTE_TM_1-10_WinIQSIM2_WV"
   h) Select "Transmit".



R&S WinIQSIM2 transmits the waveform to the default directory of the R&S SMCV100B.

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



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

4.6.4.4 Creating waveforms with tag file format

The provided example uses a sine function in the I channel and a cosine function in the Q channel, each with 20 points. The example uses a short program written in the programming language C to calculate the sine and cosine values (see Example "C-program for creating a waveform file" on page 163). They are saved in the file `SICO.txt`. The decimal values in `SICO.txt` are normalized such that they are between –1.0 and +1.0. The data is converted into binary format. The appropriate mandatory tags are added and the data is packed into the `WAVEFORM` tag. As result, the waveform file `SICO.wv` is generated.

This example follows the general principle of creating of a waveform manually, using the tag file format. The Figure 4-15 illustrates this general workflow.

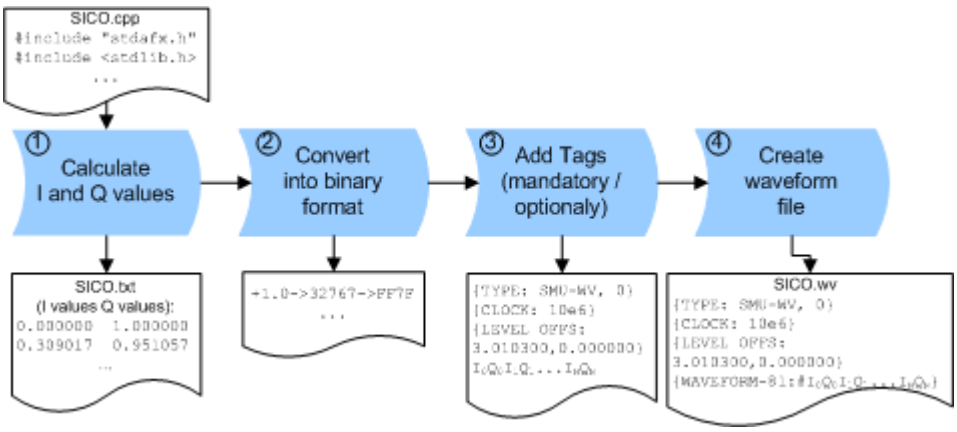


Figure 4-15: Principle of creating a waveform manually

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

1. Calculate the sine and cosine values. For example, use the `SICO.cpp` program.

   The result is saved in the file `SICO.txt`.

```
 0.000000  1.000000
 0.309017  0.951057
 0.587785  0.809017
 0.809017  0.587785
 0.951057  0.309017
 1.000000 -0.000000
 0.951057 -0.309017
 0.809017 -0.587785
 0.587785 -0.809017
 0.309017 -0.951057
-0.000000 -1.000000
-0.309017 -0.951056
-0.587785 -0.809017
-0.809017 -0.587785
-0.951056 -0.309017
-1.000000  0.000000
-0.951056  0.309017
-0.809017  0.587785
-0.587785  0.809017
-0.309017  0.951057
```

   Figure 4-16: Contents of SICO.txt: first column Sine (I), second column Cosine (Q)

2. Convert the values from the file `SICO.txt` into binary format consisting of 16-bit signed integer numbers. The numeric range between –1.0 and +1.0 corresponds to the modulation range of the waveform 16-bit D/A converter of -32767 to +32767.

   +1.0 -> 32767 -> = 0x7FFF

   0.0 -> 0 -> = 0x0000

   -1.0 -> -32767 -> = 0x8001

The Figure 4-17 shows the calculation and conversion steps. The highlighted columns contain the resulting I and Q values represented in Little endian format.

Sample n	deg = 360°/20 * n	I = sin(deg)	$I_{quant,dec}$ = I * FS = I * (2^{15}-1)	$I_{quant,hex}$	$I_{quant,hex}$ (little-endian waveform file representation)	Q = cos(deg)	$Q_{quant,dec}$ = I * FS = I * (2^{15}-1)	$Q_{quant,hex}$	$Q_{quant,hex}$ (little-endian waveform file representation)
0	0	0.000000	0	0000	0000 I_0	1.000000	32767	7FFF	FF7F Q_0
1	18	0.309017	10126	278E	8E27	0.951057	31163	79BB	BB79
2	36	0.587785	19260	4B3C	3C4B	0.809017	26509	678D	8D67
3	54	0.809017	26509	678D	8D67	0.587785	19260	4B3C	3C4B
4	72	0.951057	31163	79BB	BB79	0.309017	10126	278E	8E27
5	90	1.000000	32767	7FFF	FF7F	0.000000	0	0000	0000
6	108	0.951057	31163	79BB	BB79	-0.309017	-10126	D872	72D8
7	126	0.809017	26509	678D	8D67	-0.587785	-19260	B4C4	C4B4
8	144	0.587785	19260	4B3C	3C4B	-0.809017	-26509	9873	7398
9	162	0.309017	10126	278E	8E27	-0.951057	-31163	8645	4586
10	180	0.000000	0	0000	0000	-1.000000	-32767	8001	0180
11	198	-0.309017	-10126	D872	72D8	-0.951057	-31163	8645	4586
12	216	-0.587785	-19260	B4C4	C4B4	-0.809017	-26509	9873	7398
13	234	-0.809017	-26509	9873	7398	-0.587785	-19260	B4C4	C4B4
14	252	-0.951057	-31163	8645	4586	-0.309017	-10126	D872	72D8
15	270	-1.000000	-32767	8001	0180	0.000000	0	0000	0000
16	288	-0.951057	-31163	8645	4586	0.309017	10126	278E	8E27
17	306	-0.809017	-26509	9873	7398	0.587785	19260	4B3C	3C4B
18	324	-0.587785	-19260	B4C4	C4B4	0.809017	26509	678D	8D67
19	342	-0.309017	-10126	D872	72D8	0.951057	31163	79BB	BB79

Figure 4-17: I and Q values calculation and conversion

3. Use an ASCII editor which is able to handle binary data. Create and add the following mandatory tags before this binary data set can be further processed:
   - `CLOCK`
   - `LEVEL OFFS`

   An example of the `SICO.wv` file contents could be:

   ```
   {TYPE: SMU-WV, 0}{CLOCK: 10e6}{LEVEL OFFS: 3.010300,0.000000}
   0000FF7F8E27BB79 ... 72D8BB79
   ```

   To simplify the example, the checksum is set to 0, i.e. the instrument does not evaluate a checksum.

   Tip: The tags `TYPE`, `CLOCK`, `LEVEL OFFS` and `WAVEFORM` are mandatory for each waveform. All other tags are optional and can be inserted after the `TYPE` tag in arbitrary order.

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

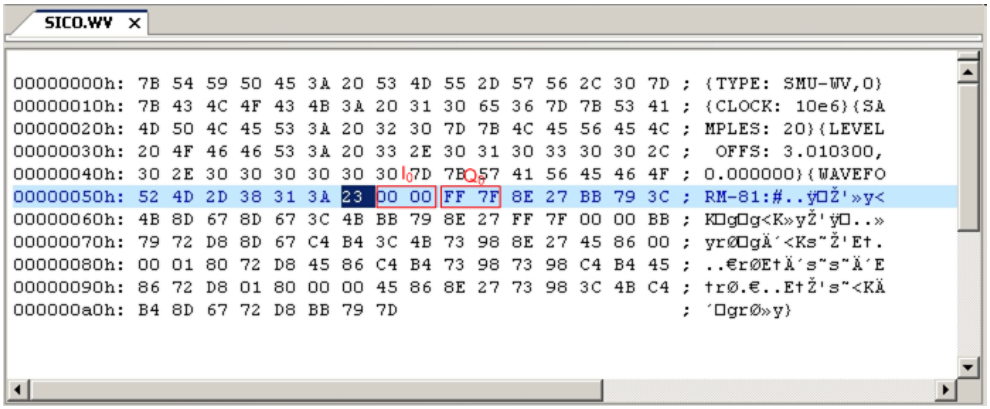
   ```
   {WAVEFORM-Length: #I0Q0I1Q1I2Q2 ... InQn}
   ```

   - Calculate the `Length`
     Length = Number of I/Q pairs * 4 + 1 = 20*4 + 1 = 81 bytes
   - Place the string `{WAVEFORM-81:#` at the beginning of the data set
   - Place the symbol `}` at the end of the data set

   The contents of the waveform file `SICO.wv` for 20 I/Q pairs is now ready for operation and reads:

   ```
   {TYPE: SMU-WV,0}
   {CLOCK: 10e6}
   {LEVEL OFFS: 3.010300,0.000000}
   {WAVEFORM-81:#I0Q0I1Q1...InQn}
   ```

There is no readable representation for binary values in this document. This example uses the sequence `I0Q0I1Q1...InQn` to characterize the binary code. The following figure shows this waveform in a data editor.



Example: C-program for creating a waveform file

C-program `SICO.cpp` for creating the file `SICO.txt` containing 20 sine and cosine pairs, converting them into binary data and creating the waveform file `SICO.wv`.

```
// SICO.cpp
// Defines the entry point for the console application

#include "stdafx.h"
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int _tmain(int argc, _TCHAR* argv[])
{
    const unsigned int samples = 20;
    const float pi = 3.141592654f;
    int i;

// SICO.txt
// Creating the file SICO.txt containing 20 sine and cosine pairs
    float grad, rad;
    FILE *fp;
    fp = fopen("SICO.txt", "w");
    if (fp == 0)
        return;
    for (i=0; i<samples; i++)
    {
        grad = (360.0f / (float)samples) * (float)i;
        rad = grad * (pi / 180.0f);
        fprintf(fp, "%f %f\n", sin(rad), cos(rad));
    }
    fclose(fp);
```

```
// SICO.wv
// Generating a binary data set from the I/Q pairs in the file SICO.txt
// and storing the result to file SICO.wv
    FILE *fp_sour, *fp_dest;
    float i_float, q_float;
    unsigned short i_usint, q_usint;
    fp_sour = fopen("SICO.TXT", "rt");
    if (fp_sour == 0)
        return -1;
    fp_dest = fopen("SICO.WV", "wb");
    if (fp_dest == 0)
    {
        fclose(fp_sour);
        return -1;
    }
    // Write required tags to waveform file
    fprintf(fp_dest, "{TYPE: SMU-WV,0}");
    fprintf(fp_dest, "{CLOCK: 10e6}");
    fprintf(fp_dest, "{SAMPLES: %d}", samples);
    // RMS, Peak
    fprintf(fp_dest, "{LEVEL OFFS: %f,%f}", -1.0f * 20.0f * log10(1.0f/sqrt(2.0f)), 0.0f);
    fprintf(fp_dest, "{WAVEFORM-%d:#", (samples * 4) + 1);
    for (i=0; i<samples; i++)
    {
      // Read I/Q pair from ASCII file
         if (fscanf(fp_sour, "%f %f", &i_float, &q_float) == EOF)
            break;
        // Convert I/Q pair to unsigned short
        i_usint = (unsigned short)floor((i_float * 32767.0) + 0.5);
        q_usint = (unsigned short)floor((q_float * 32767.0) + 0.5);
        // Write converted I/Q pair to waveform file
        fwrite(&i_usint, 2, 1, fp_dest);
        fwrite(&q_usint, 2, 1, fp_dest);
    }
    fprintf(fp_dest, "}");
    fclose(fp_dest);
    fclose(fp_sour);
return 0;
}
```

4.6.4.5 Defining periodically repeating traces

If you test setup requires marking an event, for example, each frame start, it is sufficient to define the trace ones and repeat it over the length of a waveform. Repeating is useful for long waveforms with periodical marker signals.

The following examples use marker traces. You can use control lists analogously.

To define periodical marker trace

The waveform in the example below consists of three frames, each frame has a length of 100 samples. Waveform processing is continuous via "Trigger Mode" > "Auto".

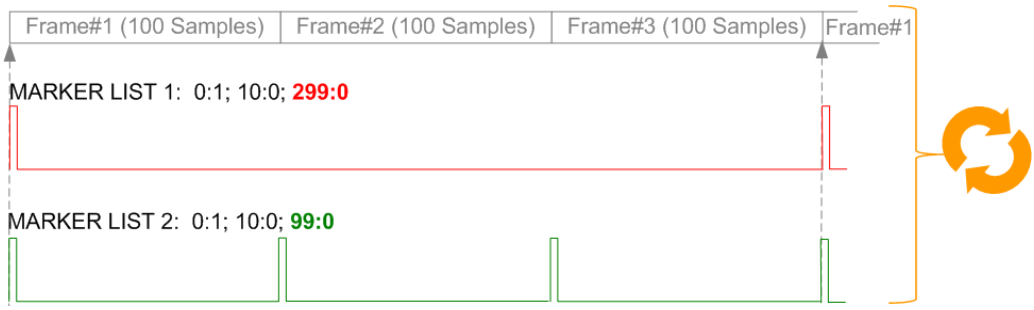


Figure 4-18: Example: Defining marker traces without CONTROL LENGTH tag

To define a restart marker and a frame start marker, use the following tags:

1. The waveform is 300 samples long, i.e. set `{SAMPLES: 300}`.
2. Set two `[TRACE] LIST` tags:
   - For Marker 1 that acts as a restart marker:
     `{MARKER LIST 1: 0:1; 10:0; 299:0}`
   - For Marker 2 that marks each frame start:
     `{MARKER LIST 2: 0:1; 10:0; 99:0}`
3. Do not use the `CONTROL LENGTH` tag.

   The length of the repeated patterns is determined by the last sample number in the `[TRACE] LIST` that is the last {**Pos:**State}.

Example: CONTROL LENGTH tag and trace processing

In the example below, use the same marker traces and set the `CONTROL LENGTH` tag, for example `{CONTROL LENGTH: 150}`.

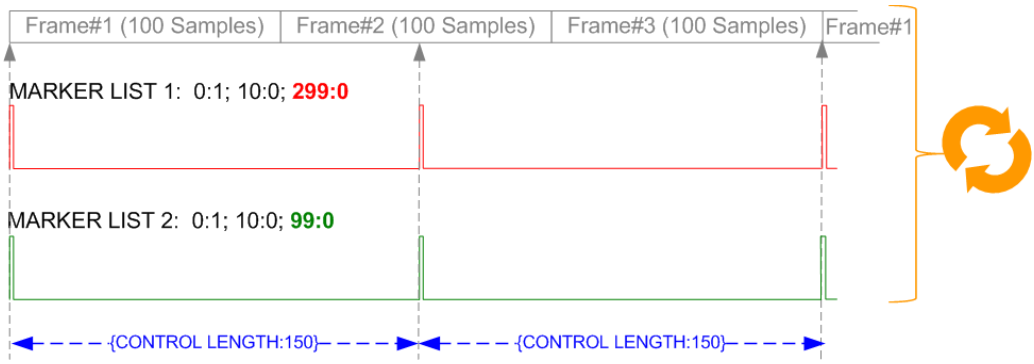


Figure 4-19: Example: Processing control signals with CONTROL LENGTH tag

The length of **all** control signals is determined by the `CONTROL LENGTH`. Observe how the marker traces are processed. In this example, both marker traces are repeated every 150 samples.

4.6.4.6 Creating control lists with tag file format

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

- To use the dedicated "Control Data Editor" and create a file in ASCII format and with an extension `*.dm_iqc`.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 167.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 168.

To create a control list with tag file format

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

1. Use a hex data editor.
2. Create the **mandatory** tags:
   - `TYPE`
   - `[TRACE] LIST`

   The `[TRACE] LIST` tag defines the individual markers or control traces in a combined `{Pos:State}` way within the control list period (`CONTROL LENGTH`).
3. Create the **recommended** tag `CONTROL LENGTH`.

   This tag defines the periodicity of the total control list.
4. Add required optional tags.
   Insert these tags after the `TYPE` tag in arbitrary order.

   For example, the control list file contains the following information:

```
{TYPE:SMU-CL}{COPYRIGHT:Rohde&Schwarz}
{DATE:2012-06-11;15:00:09}{HOP LIST:0:0;498:1;506:0}
{CW MODE LIST:0:0;380:1}{LEVATT LIST 3:0:0;464:1}
{BURST LIST:0:0;122:1;270:0;582:1;924:0}
{MARKER LIST 4:0:0;706:1;764:0}
{MARKER LIST 3:0:0;530:1;633:0}
{MARKER LIST 2:0:0;350:1;457:0}
{MARKER LIST 1:0:0;108:1;160:0}
{CONTROL LENGTH:1000}
```

   The Figure 4-12 shows the representation of the created control list in the "CList" data editor dialog.
   Compare the displayed ramp values of "Marker 1" and the "Total List Length" with the values in the corresponding tags.
   Note: In the provided example, the tags have been separated by line breaks for better reading.
   See also Example "To assign and activate control signals" on page 167.

To create a control list in binary format

Generation of a control list in binary format is not necessary but possible.

► Use the commands `BB:DM:CLISt:...` to generate a control list in binary format (see "Handling list files" on page 703 and the example in `[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 707).

See also Example "To assign and activate control signals" on page 167.

Example: To assign and activate control signals

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

We assume that a control list `clist.dm_iqc` containing information on marker 2, burst gate and level attenuation control signals is created and saved in the directory `/var/user/temp/`.

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

- Use the control list for a particular marker output, for example "Custom Digital Mod" > "Marker 1".
- Use the Burst Gate and Level Attenuation control signals as defined in a control list.

```
MMEM:CDIRectory "/var/user/temp"
SOURce1:BB:DM:CLISt:CATalog?
// Response: clist
SOURce1:BB:DM:CLISt:SELect "clist"
SOURce1:BB:DM:TRIGger:OUTPut1:MODE CLISt
SOURce1:BB:DM:PRAMp:SOURce INTernal
```

4.6.4.7 Creating data lists with tag file format

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

- To use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 126.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 167.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 168.

To create a data list with tag file format

1. Use a hex data editor.
2. Create the mandatory tags: `{TYPE}`, `{DATA BITLENGTH}` and `{DATA LIST}`
3. Consider the tag syntax and rules.

   The following is an example of the data list file content. The tags are separated by line breaks for better reading. The text in brackets is short explanation.

For details, see the tag description:

- TYPE
- {DATA BITLENGTH}
- {DATA LIST-Length}

```
{TYPE:SMU-DL}{COPYRIGHT:Rohde&Schwarz}
{DATE:201-06-11;15:00:09}
{DATA BITLENGTH: 8}
{DATA LIST-2: #d0d1...d7}
```

(1 byte containing 8 data bits d0 to d7 in binary format, where d0 is the MSB)

See also:

- Figure 4-13 for representation of the created data list in the "Data List Editor".
- Example "To assign and activate a data list" on page 168

To create a data list in binary format

► Use the commands BB:DM:DLISt:....
See "Handling list files" on page 703.

```
MMEM:CDIRectory "/var/user"
// Create a new data list file.
SOURce1:BB:DM:DLISt:SELect "dl_new"
// Append data to the data list and query the content.
FORMat ASCii
SOURce1:BB:DM:DLISt:DATA:APPend 0,1,1,1,0,1,0,1
SOURce1:BB:DM:DLISt:DATA?
// Response: 0,1,1,1,0,1,0,1
```

See also Example "To assign and activate a data list" on page 168.

Example: To assign and activate a data list

We assume, that a created data list file dl.dm_iqd in the directory /var/user/. The following example shows how to use this data list as data source for the custom digital modulation.

```
MMEM:CDIRectory "/var/user"
SOURce1:BB:DM:DLISt:CATalog?
// Response: dl
SOURce1:BB:DM:DLISt:SELect "dl"
```

4.6.4.8 Editing waveform files, data and control lists

You can edit the internally and externally crated waveform files, data and control lists. The waveform, data and control lists files contain binary and ASCII data.

Consider the following rules while editing files with binary data.

Rules for editing binary data

- **Use hex data editor**
  Always use a hex data editor to edit files containing binary data.

Editing of binary data file with a text editor, even if you only change the ASCII part of the file, corrupts the file.

- **Adapt the length information in the `{EMPTYTAG}`**
  If you change the content of a waveform file, change also the `{EMPTYTAG-Length}` value.
  For example, change this value, if you add a tag or add bytes to an existing tag. Reduce the value by the number of newly introduced bytes.

4.6.5 Working with waveform libraries

The R&S SMCV100B offers waveform libraries containing waveform files (`*.wv`) with a wide range of ready-made signals for testing systems with different transmission parameters.

Key features

- Support of numerous broadcast transmission standards
- Efficient use with dedicated streams and waveforms

For an overview of ARB options, see Section 4.6.1, "Required options", on page 138.

Required options

The equipment layout for processing files of waveform libraries includes:

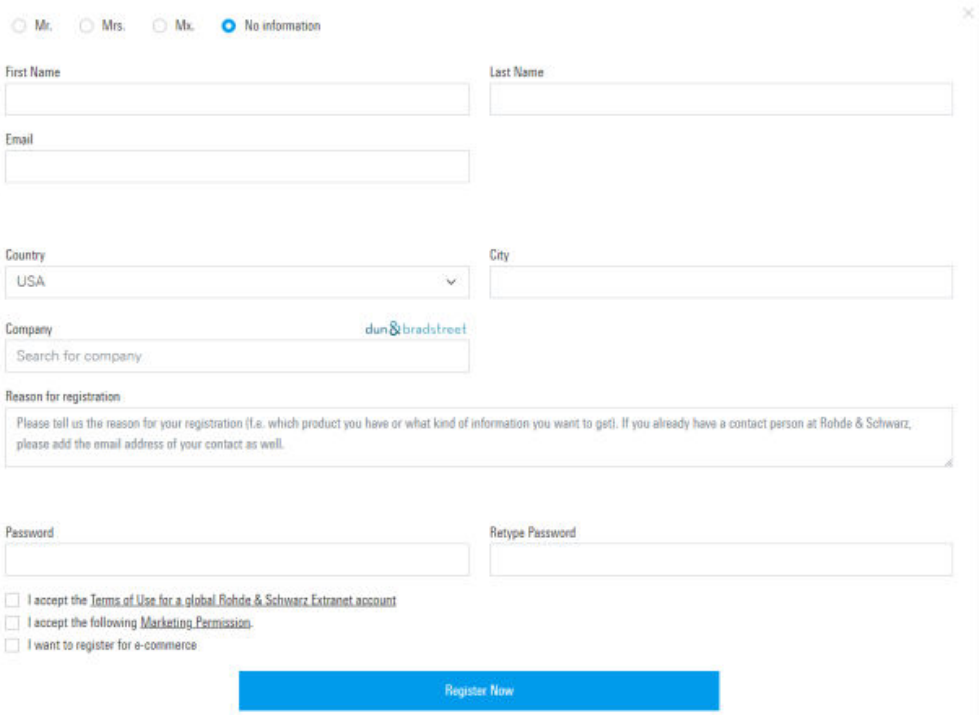
- R&S SMCV100B base unit, including arbitrary waveform generator (64 MSample ARB memory, 60 MHz RF bandwidth)
- Waveform library option (R&S SMCVB-KVxx)

For stream library key features and required options, see chapter "TS Player" in the digital broadcast standard user manual.

To register for access to the libraries

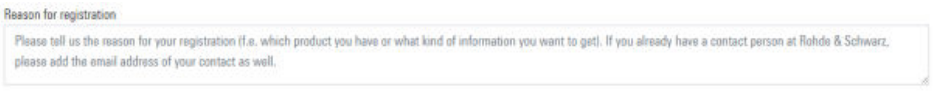
R&S SMCV100B stream and waveform libraries are available for download for registered users on the "Vector Signal Generator Customer Web" at the global Rohde & Schwarz information system (GLORIS).

1. For access, register at https://gloris.rohde-schwarz.com:
   In the section "How to register", follow the instructions provided in the introduction video "How to register for GLORIS".
2. Register to GLORIS with the creation of a personal account.

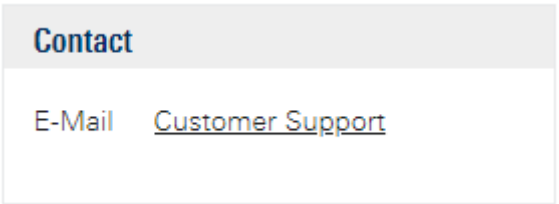


3. For access to the "Vector Signal Generator Customer Web", provide the following information:
   - Specify that you want access to the "Vector Signal Generator Customer Web".
   - Include the material number and serial number of your device.
     The label is located on the rear panel of the R&S SMCV100B.

   a) When using a new GLORIS account, fill the information in the "Reason for registration" field.

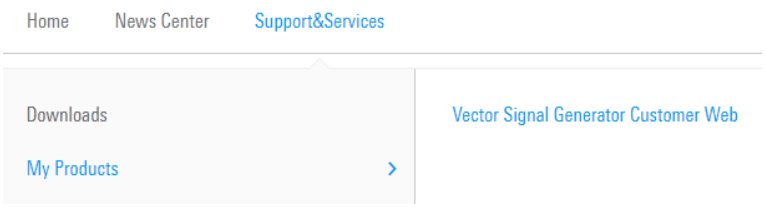


   b) When using an existing GLORIS account, click "Customer support" and fill in the information into an email.



To access "Product Related Documents"

1. Log in to GLORIS.
2. In the menu bar, select "Support&Services > My Products > Vector Signal Generator Customer Web".



The "R&S SMCV100B Customer Web" page opens.

3. In the selection field "Product Selection for VSG", select "R&S®SMCV100B".

   A webpage opens and displays search results for products related to the R&S SMCV100B.

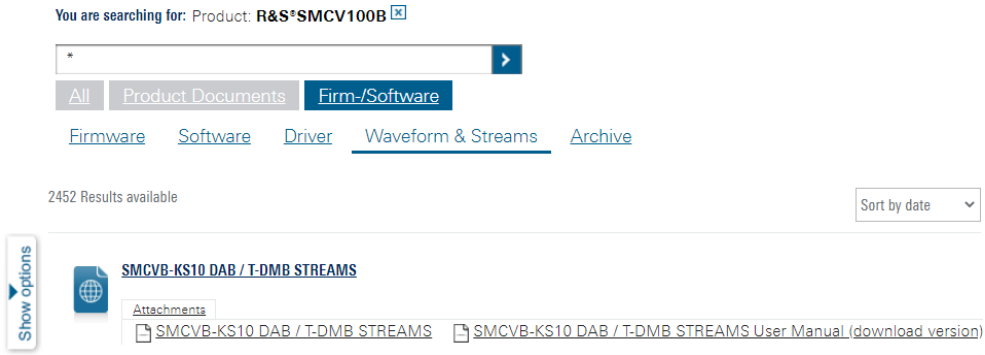


To download a library file

This procedure describes how to download library files. It provides a step-by-step description for download of a stream library file. The download of waveform library files is analogous.

1. Access the "Product Related Documents" webpage as described in "To access "Product Related Documents"" on page 170.
2. In the search navigation bar, select "Firm-/Software" > "Waveform & Streams".

   The search lists all information related to stream and waveform libraries of the R&S SMCV100B:
   - R&S SMCVB-KSxx results relate to stream libraries.
   - R&S SMCVB-KVxx results relate to waveform libraries.

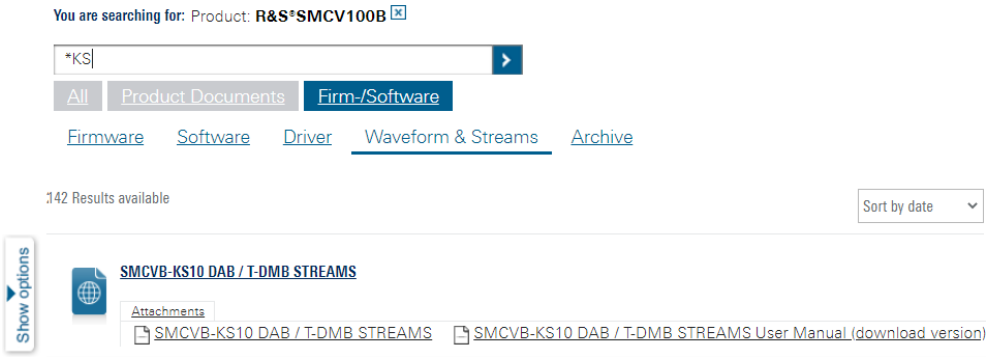


3. Optionally, deactivate the filtering to display all waveform and stream library content.

   a) On the left menu, select "Show options".
   b) Click "Filtering on. Reset all filters.".

4. Optionally, to filter for stream library content enter **KS* in the search input field.

5. In the search result list, navigate to the required library.
6. To download required library files, click the download link in the "Attachments" section of the library product page.
   For example, for DAB/T-DMB streams, click the download link "R&S SMCVB-KS10 DAB / T-DMB STREAMS".

   A download dialog opens to select and save files of the stream library.

To save a library file

► Save the library file to one of the following storage locations:
- External storage device (HDD, memory stick): Use an external USB storage device to save large files or complete libraries. Connect the storage device to one of the USB 3.0 connectors on the rear panel of the R&S SMCV100B. If detected correctly, you can access the files on the R&S SMCV100B in the `/usb/` directory in the file-select dialogs.

The R&S SMCV100B supports the following storage formats: ext2/ext3/ext4, FAT16/FAT32, NTFS (read-only), ISO9660, UDF

- Internal memory (SSD): Use the internal memory to save single files to the user directory `/var/user/` of the R&S SMCV100B, for example, using FTP via a LAN connection.

For more information on the content of the library, see the user manual of the library. For example, for DAB/T-DMB streams, see "R&S SMCVB-KS10 DAB / T-DMB Streams" user manual.

To load and play a waveform library file

1. Load the waveform file from its storage location:
   - External storage device (HDD, memory stick): Load the file from the `/usb/` directory.
   - Internal memory (SSD): Load the file from the user directory `/var/user/`

   Note: Library files are encrypted files. Loading the library file at the R&S SMCV100B requires installation of the corresponding library option. See "Required options" on page 169.
2. To load the file at the R&S SMCV100B, select the file in the dialog "Baseband" > "ARB" > "Load Waveform".
3. To select the file, navigate to the storage location (1).
4. Select "ARB" > "State" > "On".

   The R&S SMCV100B processes the waveform file.
5. In the block diagram, select "RF" > "On"

   The waveform file is modulated onto the RF carrier and output at the RF 50 Ω connector.

See also Section 4.6.4, "Playing waveform files", on page 154. For streaming library files, select the file in the "TS Player" application of the corresponding digital broadcast standard baseband configuration. See also chapter "Configuring the input signal" in the digital broadcast standard user manual.

4.6.6 Streaming waveforms from an external storage device

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

Required options

See Section 4.6.1, "Required options", on page 138.

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

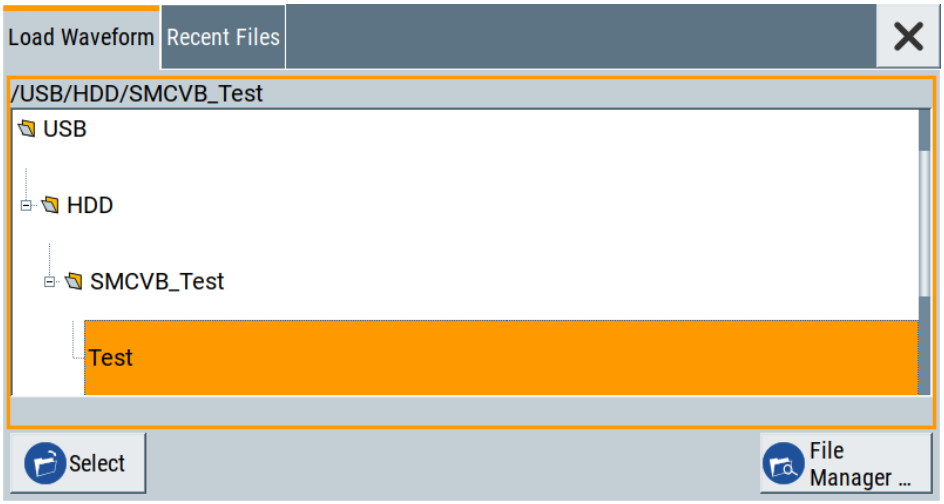
To set up and connect the external waveform source

1. Provide an HDD as a waveform streaming source.
   The R&S SMCV100B supports the following storage formats: ext2/ext3/ext4, FAT16/FAT32, NTFS (read-only), ISO9660, UDF
2. Save the waveform file on the HDD.
3. Connect the HDD to one of the USB 3.0 connectors on the rear panel of the instrument.
   See Section 3.1.9, "Connecting USB devices", on page 28.

See also Section 11.10.4, "Using a USB storage device for file transfer", on page 444.

To activate waveform streaming

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



3. Select "HDD Streaming" > "On".
4. Optionally, configure trigger and marker settings.
   a) In the "Trigger In" tab, select "Mode" > "Auto".
   b) In the "Marker" tab, select "Mode" > "Restart".
5. Select "ARB" > "State" > "On".

   The R&S SMCV100B processes the waveform stream signal.

To output the waveform stream signal

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

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

4.6.7 Tags for waveforms, data and control lists

The instrument uses a simple tag-oriented format for externally or internally generated waveforms, data and control lists. Files with this format can be transmitted from an external computer to the instrument and vice versa.

The instrument transmits these files as a binary data block, using the following SCPI command:

- `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`
- `[:SOURce<hw>]:BB:DM:DLISt:DATA`
- `[:SOURce<hw>]:BB:DM:CLISt:DATA`

Tag general format

Tags are self-contained information units, enclosed in braces { }. Their general format is `{Name: Data}` or `{Name-Length: Data}`. The colon separates the name part and the data part. The colon can be followed by a space for the sake of readability.

- The **`Name`** identifies the tag. It is always expressed in capital letters.
- The **`Data`** is tag-specific, and usually it is in ASCII plain text.
- The **`Length`** specifies the number of bytes in a `WAVEFORM` tag, `DATA LIST` tag, or `EMPTYTAG`
  Length is an ASCII integer value, defining the number of bytes from the colon `:` to the end brace `}`

Rules

Each waveform file must begin with the `TYPE` tag. The sequence of the remaining tags is arbitrary. For each tag, an indication shows whether it must be included in the file concerned (mandatory) or can be included (optional).

Unknown tags are not analyzed by the R&S SMCV100B; they are left unchanged and saved without an error message for a possible further read back.

R&S SMU waveforms can also be loaded on the instrument, where they are converted internally into an R&S SMCV100B waveform.



In all examples of file contents listed in this section, the tags have been separated by line breaks for better reading.

Tag description

This section describes the **mandatory `TYPE` tag** followed by a description of all other tags, grouped per file type and listed in an alphabetical order. Some tags are valid for all three file types. If a tag is valid only for a single file type, e.g. only for a waveform, this fact is indicated in the description.

Related step-by-step descriptions

See:

- Section 4.6.4.5, "Defining periodically repeating traces", on page 164
- Section 4.6.4.4, "Creating waveforms with tag file format", on page 160
- Section 4.6.4.6, "Creating control lists with tag file format", on page 166
- Section 4.6.4.7, "Creating data lists with tag file format", on page 167
- Section 4.6.4.8, "Editing waveform files, data and control lists", on page 168

Supported tags:

- Common tags....176
- Tags for waveforms....178
- Tags for multi-segment waveforms....184
- Tags for data lists....189
- Tags for control lists....190

4.6.7.1 Common tags

The following tags are common to all file types. For all tags, see "Supported tags:" on page 176.

Common tags

{TYPE: magic, xxxxxxxx}....176
{COMMENT: string}....177
{COPYRIGHT: string}....178
{DATE: yyyy-mm-dd;hh:mm:ss}....178

{TYPE: magic, xxxxxxxx}

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

Identifies the file as a valid R&S SMCV100B file. It must be present and must be the first in the waveform. If a file of the same name exists on the target medium, it is overwritten.

Setting parameters:

magic — Designates the file type and has the following values:

SMU-WV
A valid R&S SMCV100B waveform.

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

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

SMU-CL
A valid R&S SMCV100B control list.

xxxxxxxx Is an ASCII-coded checksum of the data part of the `WAVEFORM` tag in the file. This value is always 0 for data lists and control lists.
The checksum for waveforms is used for detecting transmission errors. If the `TYPE` tag contains 0 or a non-numeric value for the checksum, it is ignored.
It is calculated in accordance with the algorithm given bellow, where:
`start` is a pointer to the first byte after the `#` character in the `WAVEFORM` tag
`length` is the number of bytes between `start` and the closing curly bracket (excluding the latter; `length`'must be divisible by 4 without a remainder.

```
UINT32 checksum(void *start, UINT32 length)
{
UINT32 i, result = 0xA50F74FF;
for(i=0; i < length/4; i++)
result = result ^ ((UINT32 *)start)[i];
return(result);
}
```

The checksum is currently not verified when waveforms are loaded.

Example:
```
{TYPE: SMU-WV,106656}
BB:ARB:WAV:TAG? 'TYPE'
```
Queries the content of the `TYPE` tag.
```
Response: 'SMU-WV,106656'
```
This is a valid waveform.

{COMMENT: string}

The tag contains a plain text ASCII string of arbitrary length. The string is not analyzed in the R&S SMCV100B. It is used to describe the file. The string is allowed to contain all printable ASCII characters except the closing curly bracket.

Example:
```
{COMMENT: File with data for 3GPP enhanced
channels}
BB:ARB:WAV:TAG? 'COMMENT'
```
Queries the content of the `COMMENT` tag of the selected waveform file.
```
Response: 'File with data for 3GPP enhanced
channels'
```
The comment on the waveform reads "File with data for 3GPP enhanced channels".

Usage: Setting only

{COPYRIGHT: string}

The tag contains an ASCII string of arbitrary length. The string is not analyzed in the R&S SMCV100B. It is used to save copyright information about the file content.

Example: `{COPYRIGHT: Rohde&Schwarz}`
`BB:ARB:WAV:TAG? 'COPYRIGHT'`
Queries the content of the `COPYRIGHT` tag of the selected waveform file.
`Response: 'Rohde&Schwarz'`
Copyright resides with Rohde & Schwarz.

Usage: Setting only

{DATE: yyyy-mm-dd;hh:mm:ss}

(optional)

The tag contains the date and time at which the file was created. Enter the year as four digits. The instrument does not analyze this tag.

Example: `{DATE: 2009-04-02;14:32:12}`
`BB:ARB:WAV:TAG? 'DATE'`
Queries the content of the `DATE` tag of the selected waveform file.
`Response: '2009-04-02;14:32:12'`
The waveform was created on April 2, 2009 at 14 hrs 32 min.

Usage: Setting only

4.6.7.2 Tags for waveforms

The following tags apply to waveforms exclusively. For all tags, see "Supported tags:" on page 176.

Waveform tags

{CLOCK: frequency}....179
{CONTROL LENGTH: ControlLength}....179
{EMPTYTAG-Length: #EmptySequence}....180
{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}....181
{MARKER MODE [#]: GENERATOR}....181
{SAMPLES: Samples}....182
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....182
{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}....184

{CLOCK: frequency}

(mandatory for waveforms)

The tag specifies the clock frequency at which the waveform has to be output, in Hz (on multi-segment waveforms this tag contains the maximal clock of all segments).

A query of `ARB:CLOCk?` after loading the waveform returns the value set using the `CLOCK` tag. This value can later be altered with the command `ARB:CLOCk?`.

Example: `{CLOCK: 54000000}`
`BB:ARB:WAV:TAG? 'CLOCK'`
Queries the content of the `CLOCK` tag.
`Response: 54000000`
The clock frequency is set to 54 MHz.

Usage: Setting only

{CONTROL LENGTH: ControlLength}

(optional / recommended for marker and control lists)

The tag specifies the length of *all* control or marker list in ASCII format.

The control length influences the way the marker and control lists are processed, in particular the way traces are repeated; see Figure 4-20.

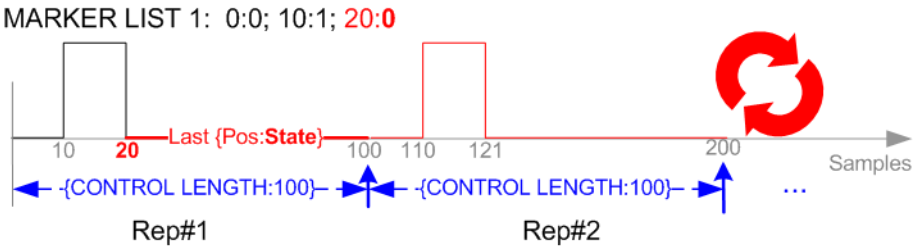


Figure 4-20: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

If the `CONTROL LENGTH` tag is not used, the marker and control list length are determined by the last position, that is the last {**Pos**:State} couple, defined in the particular `[TRACE] LIST` tag; see Figure 4-21.



Figure 4-21: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

To maintain marker signals and waveform data synchronized, set the `CONTROL LENGTH` to be equal to the number of samples specified with the tag `SAMPLES`.

See also Section 4.6.4.5, "Defining periodically repeating traces", on page 164.

Example:
```
{CONTROL LENGTH: 500}
SOURce:BB:ARBitary:CLISt:TAG? 'CONTROL LENGTH'
```
Queries the length of the control list.
```
Response: 500
```

Manual operation: See "Total List Length" on page 122

{EMPTYTAG-Length: #EmptySequence}

(mandatory in automatically generated one and multi-segment waveforms)

This tag is empty, i.e. contains no data, and is used as placeholder.

Setting parameters:

Length — An ASCII integer value that specifies the number of bytes in the `EMPTYTAG`, i.e. defines the number of bytes from the colon `:` to the end brace `}`
Note: If you change the content of a waveform file, change also the `{EMPTYTAG-Length}` value. For example, if you add a tag or add bytes to a tag, reduce the length by the number of newly introduced bytes.

EmptySequence — An empty sequence containing blanks only. The number of used blanks is calculated as the difference between the hex addresses of the `{WAVEFORM}` tag and the hash sign `#` in the `{EMPTYTAG}`.
The `{WAVEFORM}` tag always starts at hex address #4000.

Example:
```
{TYPE:SMU-WV, 837236424}
{COPYRIGHT:2003 Rohde&Schwarz SMU}
{DATE:2012-07-11;14:38:01}
{SAMPLES:80000}
{CLOCK:8666666.666666666}
{VECTOR MAX:1.000000038569158}
{LEVEL OFFS:3.333553817875577e-07,0}
{MARKER LIST 1:0:1;1:0;1249:0}
{MARKER LIST 2:0:1;1:0;1249:0}
{MARKER LIST 3:0:1;1:0;1249:0}
{MARKER LIST 4:0:1;1:0;1249:0}
{EMPTYTAG-15947:# ...}
{WAVEFORM-320017:#IQIQIQ...}
```

The example waveform file contains 436 (0x1b4) bytes before the `#` sign in the `EMPTYTAG`; the hex address of the `#` sign is *0x1b5*. The `{WAVEFORM}` starts at *0x4000*. The `EMPTYTAG` contains *15946* blanks and has a length of (15946+1) bytes.

Usage: Setting only

{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}

(recommended for waveforms)

The tag determines the level of the ARB signal in the waveform file. The offset levels define the offset of RMS and peak value relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.

Setting parameters:

RMSOffset_dB — Defines the RMS level offset of the signal relative to full scale ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format. The value is always positive.
A 3 dB value indicates that the RMS level of the signal is 3 dBs below the full scale.
full scale = max. amplitude of vector of I/Q samples = $|S_{IQ}|max$ = $sqrt(I^2+Q^2)max$ = 0 dB

PeakOffset_dB — Defines the peak level offset of the signal relative to full scale for the ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format.
The value usually equals 0 dB as usually the I/Q samples (signed 16-bit integer values) are modulated to full scale: Full scale = 0 dB = max. amplitude of vector of I/Q samples = $|S_{IQ}|$ max = $sqrt(I^2+Q^2)max$ = $(2^{15})-1$ = 32767.
A positive `PeakOffset_dB` value indicates that a headroom to full scale is provided when generating the waveform. A negative PeakOffset_dB value indicates that overrange is likely for some samples, i.e. clipping might occur.
The crest factor can be calculated from the two values as follows:
`Crest Factor = |PeakOffset_dB - RMSOffset_dB|`

Example:

```
{LEVEL OFFS: 3.45,2}
BB:ARB:WAV:TAG? 'LEVEL OFFS'
```

Queries the content of the `LEVEL OFFS` tag of the selected waveform file.

```
Response: 3.45,2
```

The level of the waveform is below full scale, clipping does not occur.

Usage: Setting only

{MARKER MODE [#]: GENERATOR}

(Optional for waveforms)

The tag defines how the marker signals are generated. The tag is included in the waveforms, created by the R&S WinIQSIM2 software.

- Tag not used

The marker signals defined with the tag MARKER LIST are converted into a separate binary control list. When the waveform is loaded into the ARB, this control list is also loaded automatically and processed synchronous with the waveform.
Note: This method reduces the maximum waveform length (given as number of samples). The number of available samples is limited, because each marker requires 4 bits per I/Q sample, additionally to the 32 bits required to describe an I/Q sample.

- Tag is used
  The marker signals defined with the tag MARKER LIST are processed internally; additional control list is not created. If the tag is used for **all 1 markers**, the whole ARB memory is available for the I/Q samples.
  Note: If this tag is used, the maximum number of marker states defined with the tag MARKER LIST is 64, i.e. Pos_{63}:$State_{63}$

Setting parameters:

[#] 1 to 1
Sets the marker number.

Example:
```
{MARKER MODE 1: GENERATOR}
{MARKER MODE 2: GENERATOR}
{MARKER MODE 3: GENERATOR}
```

Usage: Setting only

{SAMPLES: Samples}

(recommended for waveforms)

The tag contains the number of I/Q samples in the waveform in ASCII format.

On multi-segment waveforms, this tag contains the total I/Q samples of all segments.

Example:
```
{SAMPLES: 1000}
BB:ARB:WAV:TAG? 'SAMPLES'
```
Queries the content of the SAMPLES tag of the selected waveform file.
```
Response: 1000
```
The waveform contains 1000 I/Q samples.

Usage: Setting only

See also Section 4.6.4.5, "Defining periodically repeating traces", on page 164.

{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}

(mandatory for control lists / optional for waveforms)

The tag contains the data for the marker and control signals in the control list or the marker signals of ARB waveforms.

Depending on the control length, the instrument processes traces differently, see `{CONTROL LENGTH: ControlLength}` on page 179.

How to: Section 4.6.4.5, "Defining periodically repeating traces", on page 164

Also, the processing of the marker traces (`MARKER LIST`) depends on the presence of the marker mode tag. See `{MARKER MODE [#]: GENERATOR}` on page 181.

Setting parameters:

[TRACE] MARKER | BURST | LEVATT | CW MODE | HOP | MAP

Name of the marker or control signal.
For ARB waveforms, it is only meaningful to define marker signals; in the ARB multi-segment waveforms these tags are ignored.

[#] 1 to 1

Sets the marker or control trace number; supported is only `LEVATT LIST 1`.

Pos Specifies in ASCII format the position (i.e. sample number or data value), with the effect from which the binary `State` of the marker or of the control signal changes.
If you use the marker mode tag, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$. See `{MARKER MODE [#]: GENERATOR}` on page 181.

State 0 | 1

Specifies the binary state of the marker or of the control signal from Pos_N to Pos_{N+1} exclusive in ASCII format.

Example:

```
{MARKER LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'MARKER LIST 1'
```

Queries the content of the `MARKER LIST 1` tag of the selected control list file.

```
Response: '0:0;10:1;20:0;30:1'
```

The marker setting for samples 0 to 9 = 0 (low), for 10 to 19 = 1 (high) and for 20 to 29 = 0. From sample 30 onward, the marker setting is 1 (high).

Example:

```
{LEVATT LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'LEVATT LIST 1'
```

Queries the content of the `LEVATT LIST 1` tag of the selected control list file.

```
Response: '0:0;10:1;20:0;30:1'
```

Level attenuation applies to data values 10 to 19 (high) and from data value 30 onward.

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 122

{WAVEFORM-Length: #l0Q0l1Q1...lxQx...lN-1QN-1…}

(mandatory for waveforms)

Setting parameters:

Length — Sets the number of bytes in a `WAVEFORM` tag and is calculated as follows:
`Length` = `Number of I/Q pairs * 4` (2 bytes per I and 2 bytes per Q value) + `1 byte` (the length of the `#`)

IxQx — `IxQx…` represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each component consists of 2 bytes in little endian format representation, i.e the least significant byte (LSB) first.
The values of the 2 bytes in an I component and a Q component are in the range 0x0 to 0xFFFF (-32767 to +32767). This value is transferred to the D/A converter.
This tag is also used to store multi-segment waveforms. The I/Q streams of the individual waveforms are directly concatenated to one collective waveform I/Q stream.
The number of segments and the start offset and length of the individual segments inside the total waveform I/Q stream is determined by the additional tags `MWV_SEGMENT_COUNT`, `MWV_SEGMENT_START`, and `MWV_SEGMENT_LENGTH`.
Further `MWV_SEGMENT_...` tags are also available, for example for level and clock information.

Example: **One segment waveform**
{WAVEFORM-401:#I_0,Q_0,I_1,Q_1,I_2,Q_2,...I_{99}, Q_{99}}
100 I/Q pairs with 4 bytes each are transmitted - none multi-segment.

Example: **Multi-segment waveform**
{WAVEFORM-1201:
#$I_{0,Seg0}$,$Q_{0,Seg0}$,$I_{1,Seg0}$,$Q_{1,Seg0}$,...$I_{99,Seg0}$,$Q_{99,Seg0}$,$I_{0,Seg1}$,$Q_{0,Seg1}$,$I_{1,Seg1}$, $Q_{1,Seg1}$,… $I_{199,Seg1}$,$Q_{199,Seg1}$}
2 segments: segment 0 with 100 I/Q pairs; segment 1 with 200 I/Q pairs. Each I/Q pair consists of 2*16 bites = 4 bytes.
The data is transmitted using the SCPI command `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`.

Usage: Setting only

4.6.7.3 Tags for multi-segment waveforms

The following tags apply to multi-segment waveforms exclusively. For all tags, see "Supported tags:" on page 176.

Multi-segment waveform tags

{MWV_SEGMENT_COUNT: NumOfSeg}....185
{MWV_SEGMENT_DURATION: SegDur0, SegDur1, …, SegDurN-1}....185
{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1}....185
{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}....186
{MWV_SEGMENT_CLOCK_MODE: Mode}....186
{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1}....186
{MWV_SEGMENT_LEVEL_MODE: Mode}....187
{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}....187
{MWV_SEGMENT_SETTINGS_FILE: SegSettingFilePath}....188
{MWV_SEGMENT_FILES:
“FileNameSeg0.wv”, “FileNameSeg1.wv”, …, “FileNameSegN-1.wv”}....188
{MWV_SEGMENTx_COMMENT: text}....188
{CONTROL LIST WIDTH4–Length: #m0m1…mx…mM-1}....188

{MWV_SEGMENT_COUNT: NumOfSeg}

(mandatory for multi-segment waveforms)

The tag contains the number of segments in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_COUNT: 2}`
Multi-segment waveform with 2 segments

Usage: Setting only

{MWV_SEGMENT_DURATION: SegDur0, SegDur1, …, SegDurN-1}

(optional for multi-segment waveforms)

The tag gives the time duration (in seconds) per segment.

Example: `{MWV_SEGMENT_DURATION: 1,0.5}`
Multi-segment waveform with 2 segments, lasting 1 s and 0.5 s each.

Usage: Setting only

{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample lengths for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_LENGTH: 100,200}`
2 segments: 100 samples in segment 0 and 200 samples in segment 1.

Usage: Setting only

{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample start offsets for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_START: 0,100}`
2 segments with 100 samples in segment 0 and 200 samples in segment 1.
The start offset of first segment is 0 samples, start offset of next segment 1 is the sample length of segment 0 = 100 samples.

Usage: Setting only

{MWV_SEGMENT_CLOCK_MODE: Mode}

(mandatory for multi-segment waveforms)

The tag contains a string in ASCII format which supplies the clock rate mode. The calculation of the multi-segment output waveform uses this clock rate mode. See also "Clock" on page 205.

The tag `CLOCK` contains always the highest clock rate of all segments. The tag `MWV_SEGMENT_CLOCK` contains the clock rates of the individual segments.

Setting parameters:

Mode

UNCHANGED
The segments can have different clock rates; each segment is output with the clock rate defined in its waveform file.

HIGHEST
All segments are output at the highest available clock rate.

USER
All segments are output at the clock rate defined by the user.
Note: Only upsampling is allowed, no downsampling.

Example: `{MWV_SEGMENT_CLOCK_MODE: UNCHANGED}`

Usage: Setting only

{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of clock frequencies for every segment in the multi-segment waveform in ASCII floating point format.

Example: `{MWV_SEGMENT_CLOCK: 100e6,80e6}`
2 segments: clock of segment 0 is 100 MHz, the clock of segment 1 is 80 MHz.
Note: If the segments have different clock frequencies, there are some restrictions on signal output, i.e. seamless switching between segments is only possible, if all segments have the same clock frequency. Software resampling (upsampling) can be used to bring all segments to the same clock.

Usage: Setting only

{MWV_SEGMENT_LEVEL_MODE: Mode}

(optional for multi-segment waveforms)

The tag contains a string in ASCII format which supplies the clock rate mode, that was used for calculation of the multi-segment output waveform.

Setting parameters:

Mode

UNCHANGED
Concerning the level settings, the segments are output exactly as defined in the individual files.
The value displayed with the parameter "Task bar > Level" applies only to the segment with the highest RMS value. The remaining segments are output at a lower level than the displayed value.

EQUALRMS
Segments are output so that all segments have the same RMS value. The value displayed with the parameter "Task bar > Level" applies to all segments.

Example: `{MWV_SEGMENT_LEVEL_MODE: UNCHANGED}`

Usage: Setting only

{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of level pairs in ASCII floating point format, one pair for every segment in the multi-segment waveform. The first value of a level pair defines the rms offset and the second value the peak offset relative to the 16-bit full-scale modulation (-32767; + 32767) = 0 dB. The meaning of one level value pair is the same as in the `LEVEL OFFS` tag for normal waveforms.

Example: `{MWV_SEGMENT_LEVEL_OFFS: 3.0,0.0,6.0,0.0}`
2 segments: The RMS level of segment 0 is 3 dB below full scale; RMS level of segment 1 is 6dB below full scale.
The peak level of both segments is 0 dB full scale.

Usage: Setting only

{MWV_SEGMENT_SETTINGS_FILE: SegSettingFilePath}

(optional for multi-segment waveforms)

The tag contains the file path and filename of the multi-segment file, used for the calculation of the multi-segment waveform.

Example: `{MWV_SEGMENT_SETTINGS_FILE: "/var/user/Settings.inf_mswv"}`
Multi-segment file path and filename.

Usage: Setting only

{MWV_SEGMENT_FILES: "FileNameSeg0.wv", "FileNameSeg1.wv", …, "FileNameSegN-1.wv"}

(optional for multi-segment waveforms)

The tag contains a list of filenames for every segment in the multi-segment waveform in ASCII format.

Example: `{MWV_SEGMENT_FILES: "/var/user/temp/sine.wv", "/var/user/temp/rect.wv"}`

Usage: Setting only

{MWV_SEGMENTx_COMMENT: text}

(optional for multi-segment waveforms)

The tag contains a user comment for a specific segment `x = [0…NumOfSeg-1]` in the multi-segment waveform in ASCII format.

Example: `{MWV_SEGMENT1_FILES: segment 1 contains a QPSK signal.}`

Usage: Setting only

{CONTROL LIST WIDTH4–Length: #m0m1…mx…mM-1}

(optional for waveforms and multi-segment waveforms)

The tag contains a binary marker element stream, which is output synchronously to the I/Q sample sequence. One marker element `mx` consists of 4 bites, which are assigned to the 1 possible marker traces of the instrument (1 bit per marker trace). One 4-bit marker element is required for every I/Q sample in the `WAVEFORM` tag. Hence, the number of marker elements `m` is equal to the number of I/Q samples. The `CONTROL LENGTH` tag has to contain the number of all marker elements `m`.

MSB 7	Byte						LSB 1
Marker element m_x (synchronous to I/Q Sample x)				Marker element m_{x+1} (synchronous to I/Q Sample x+1)			
Marker 4	Marker 3	Marker 2	Marker 1	Marker 4	Marker 3	Marker 2	Marker 1

Figure 4-22: Marker element in 4-bit binary format bit order

For standard waveforms, the `MARKER LIST x` tags are a more compact way to define markers. In principle, however, the `CONTROL LIST WIDTH4` format can also be used instead of the `MARKER LIST x` tags.

For multi-segment waveforms, the `CONTROL LIST WIDTH4` format is required for marker definition. The binary marker streams of the individual segments are directly concatenated (without any gap) to one collective marker stream.

Setting parameters:

Length — Sets the number of bytes in the `CONTROL LIST WIDTH4` tag in ASCII Format and is calculated as follows:
*Length = size of "#" (1 byte) + number of marker elements m_x * (4 bit) / (8 bits/byte)*
The value is rounded up for byte alignment.

mx — Marker element in 4-bit binary format.

Example: {CONTROL LIST WIDTH4-51: #$m_0m_1…m_x…m_{99}$}
100 marker elements, each marker element with 4 bits

Usage: Setting only

4.6.7.4 Tags for data lists

The following tags apply to data lists exclusively. For all tags, see "Supported tags:" on page 176.

{DATA BITLENGTH: BitLength}..... 189
{DATA LIST-Length: #d0d1...dx...dN-1…}..... 190

{DATA BITLENGTH: BitLength}

(mandatory for data lists)

The tag defines the length of the data field in the `DATA LIST` tag in bits in ASCII format.

Example:
```
{DATA BITLENGTH: 444}
BB:DM:DLIS:SEL "/var/user/dl"
BB:DM:DLIS:TAG? "dl","DATA BITLENGTH"
```
Queries the content of the `DATA BITLENGTH` tag of the selected data list file.
```
Response: '444'
```
The data list is 444 bits long.

Usage: Setting only

{DATA LIST-Length: #d0d1...dx...dN-1…}

(mandatory for data lists)

The tag contains the actual bit sequence of the data list in binary format.

Setting parameters:

Length — Defines the number of bytes in the `DATA LIST` tag in ASCII Format (see `{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}` for details).

dx — Data bits in binary format (8-bit unsigned characters, MSB first).

Example: `{DATA LIST-17: #d0d1...dx...d127}`
16 bytes containing 128 data bits, first bit is the MS bit of the first byte.

Usage: Setting only

4.6.7.5 Tags for control lists

The following tags apply to control lists exclusively. For all tags, see "Supported tags:" on page 176.

{CONTROL LENGTH: ControlLength}.....190
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....191

{CONTROL LENGTH: ControlLength}

(optional / recommended for marker and control lists)

The tag specifies the length of *all* control or marker list in ASCII format.

The control length influences the way the marker and control lists are processed, in particular the way traces are repeated; see Figure 4-20.

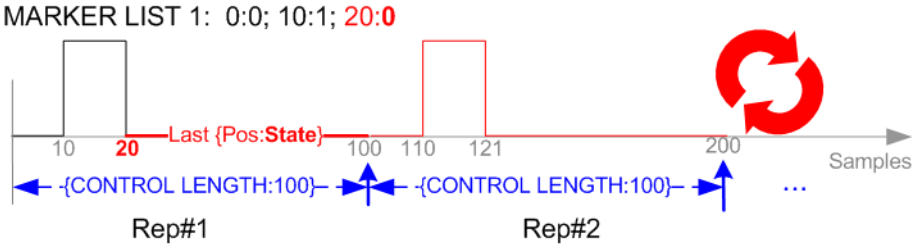


Figure 4-23: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

If the CONTROL LENGTH tag is not used, the marker and control list length are determined by the last position, that is the last {**Pos**:State} couple, defined in the particular [TRACE] LIST tag; see Figure 4-21.

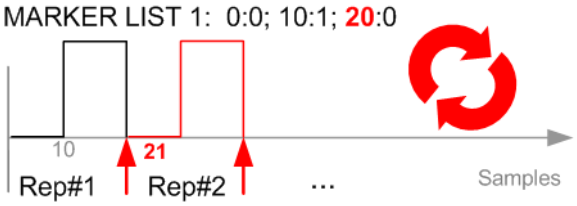


Figure 4-24: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

To maintain marker signals and waveform data synchronized, set the CONTROL LENGTH to be equal to the number of samples specified with the tag SAMPLES.

See also Section 4.6.4.5, "Defining periodically repeating traces", on page 164.

Example:
```
{CONTROL LENGTH: 500}
SOURce:BB:ARBitary:CLISt:TAG? 'CONTROL LENGTH'
```
Queries the length of the control list.
```
Response: 500
```

Manual operation: See "Total List Length" on page 122

{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}

(mandatory for control lists / optional for waveforms)

The tag contains the data for the marker and control signals in the control list or the marker signals of ARB waveforms.

Depending on the control length, the instrument processes traces differently, see {CONTROL LENGTH: ControlLength} on page 179.

How to: Section 4.6.4.5, "Defining periodically repeating traces", on page 164

Also, the processing of the marker traces (MARKER LIST) depends on the presence of the marker mode tag. See {MARKER MODE [#]: GENERATOR} on page 181.

Setting parameters:

[TRACE] MARKER | BURST | LEVATT | CW MODE | HOP | MAP

Name of the marker or control signal.
For ARB waveforms, it is only meaningful to define marker signals; in the ARB multi-segment waveforms these tags are ignored.

[#] 1 to 1

Sets the marker or control trace number; supported is only `LEVATT LIST 1`.

Pos Specifies in ASCII format the position (i.e. sample number or data value), with the effect from which the binary `State` of the marker or of the control signal changes.
If you use the marker mode tag, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$. See `{MARKER MODE [#]: GENERATOR}` on page 181.

State 0 | 1

Specifies the binary state of the marker or of the control signal from Pos_N to Pos_{N+1} exclusive in ASCII format.

Example:
```
{MARKER LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'MARKER LIST 1'
```
Queries the content of the `MARKER LIST 1` tag of the selected control list file.
```
Response: '0:0;10:1;20:0;30:1'
```
The marker setting for samples 0 to 9 = 0 (low), for 10 to 19 = 1 (high) and for 20 to 29 = 0. From sample 30 onward, the marker setting is 1 (high).

Example:
```
{LEVATT LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'LEVATT LIST 1'
```
Queries the content of the `LEVATT LIST 1` tag of the selected control list file.
```
Response: '0:0;10:1;20:0;30:1'
```
Level attenuation applies to data values 10 to 19 (high) and from data value 30 onward.

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 122

4.7 Reducing the crest factor

Reducing the crest factor of waveforms requires the option R&S SMCVB-K548 Crest Factor Reduction.

See user manual R&S SMCVB-K548 Crest Factor Reduction.

4.8 Generating multi-segment waveform files

Modern chip technologies implement several communication standards within one chip and rise special verification and test requirements. To fulfill the requirements of these test systems and to enable rapid alternation between different waveforms with differing

test signals, the R&S SMCV100B provides the functionality to generate multi-segment waveform files.

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

4.8.1 Required options

See Section 4.6.1, "Required options", on page 138.

Also, multi-segment waveform files require the corresponding digital standard options (R&S SMCVB-K2xx) of all included standards.

4.8.2 About the multi-segment waveforms

A multi-segment waveform is a composed signal that contains several multiple independent waveforms called segments. You can output each segment with its own marker and clock settings.

The figure Figure 4-25 shows the principle of building a multi-segment waveform.

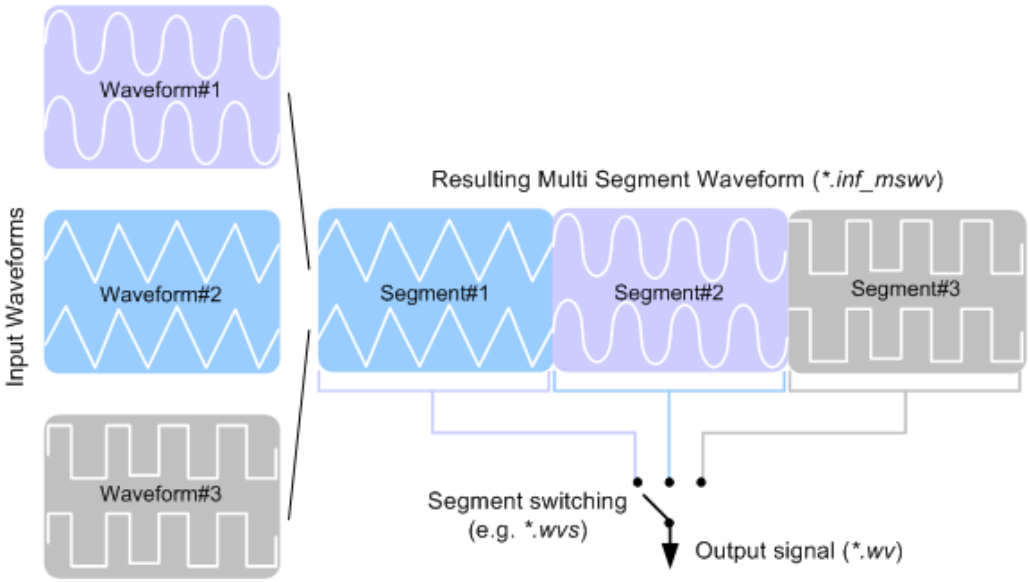


Figure 4-25: ARB multi-segment waveform concept

It is also possible to create and output a blank segment. These segments contain zero signal.

For typical applications of multi-segment waveforms, see Section 4.8.4, "Working with multi-segment waveform files", on page 214.

4.8.2.1 Multi-segment waveform processing

Processing of the waveform is triggered by the "Create" or "Create and Load" function. To process the waveform, the instrument loads the entire multi-segment waveform into the memory. It is therefore possible to alternate between the individual waveforms without delay due to loading. You can define the output order of the segments, and the segment intended to be output at any given moment.

When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day. You can also acquire information about the waveform in the dedicated "Waveform Info" dialog.

4.8.2.2 ARB sequencer mode

If your setup requires a high switch-over speed, you can continuously scroll through the test signals with an external trigger or apply a predefined "Play List".

The R&S SMCV100B provides settings to define a sequence of different segments. Also you can set the number of repetitions for playing the segment and adjust the transition between the segments.

Correct and fast processing and seamless transition between multiple waveforms requires segments with a common sample rate. If the combined waveforms feature different sample rates, set a common sample rate by resampling. Another advantage of this procedure is the scaling of the instantaneous amplitude of the various waveforms to a common RMS level.

4.8.2.3 File concept

To provide flexible configuration, the building of a composed multi-segment waveform file involves different stages; by completing of each of them, the R&S SMCV100B creates and saves a dedicated file. The following files are used:

- The "Configuration List" is a dedicated file with details on how a multi-segment waveform is made up from different waveforms, the level and the clock rate settings, and the filename. The file extension is `*.inf_mswv`.
  You can create any number of configurations as a basis for defining further multi-segment waveforms.
- The "Output File" is the multi-segment waveform file. You can enter a filename, the file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file, for example user comments.
- The "Sequencing List" contains files created in the "Multi Segment Waveform Sequencing" dialog, when using the ARB sequencer mode. See Section 4.8.2.2, "ARB sequencer mode", on page 194.
  The sequencing list file has an extension `*.wvs` and is automatically assigned to but independent from the multi-segment file. By default, both files have the same name and are located in the same file directory. You can create more than one sequencing list file per multi-segment waveform file.
  The sequencing list file carries information only about the segment number, the corresponding waveform filenames are retrieved from the assigned multi-segment

waveform file. That is, the same sequencing list file can be reused for different multi-segment waveform files with the same number of segments.
Changes and recalculations of a multi-segment waveform file cause a recheck of whether the assigned sequencing list files are still valid. A message is displayed to inform about necessary corrections in the “play list”.

4.8.2.4 Impact of the marker settings

The general purpose of the marker signal is the triggering of the DUT (device under test) and the synchronization with other measurement instruments.

For better flexibility, the instrument provides several possibilities to define marker signals:

- Segment markers
  Because the multiple segments are standalone waveforms, they can already carry marker signals. You can define how the instrument processes these available marker signals. The instrument can ignore them or use them in the composed multi-segment waveform.
- Additional segment restart and sequence restart markers
  Additional marker signal can be defined to restart the multi-segment sequence or to restart each of the multiple segments. A marker output configured and defined for one of these purposes overwrites markers that use the same output connector and that are defined in the individual waveforms.

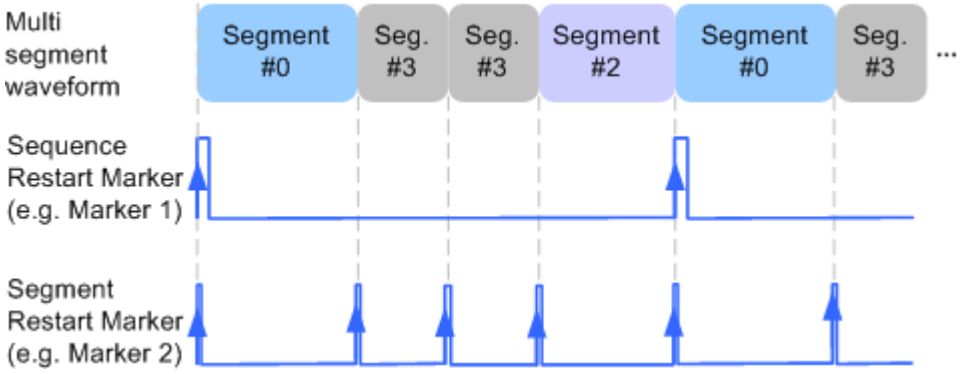


Figure 4-26: Example of marker signals

The segment start is defined by the low-high slope of the marker, which applies for switching between two segments and if there is a segment replay.

- General marker signals for the composed multi-segment waveform
  The "ARB" dialog also provides access to the standard marker settings. Settings other than "unchanged" overwrite existing markers in the waveforms or markers defined for the multi-segment waveform.

The Figure 4-27 shows schematically how the instrument evaluates the priorities of the different marker signals, if multiple marker signals are mapped to the same connector.

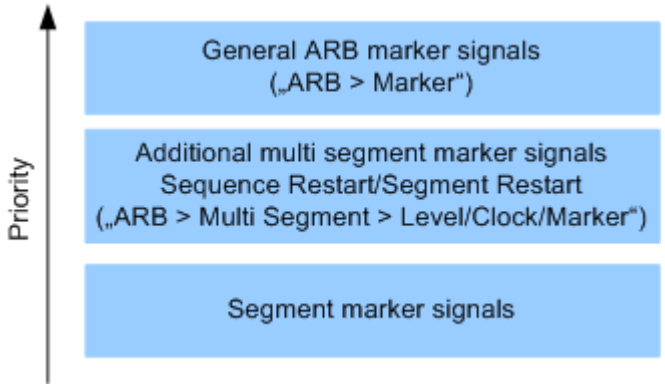


Figure 4-27: Marker priority and assigning of marker signals

4.8.2.5 Impact of the trigger settings and next segment settings

The ARB dialog provides the standard (regular) trigger settings. Use these settings to trigger of the composed multi-segment waveform as a sequence in one file. For background information, see also Section 4.4.1.5, "About trigger signals", on page 84.

This section focuses on the additional settings provided for triggering of the individual segments building the composed multi-segment waveform. These settings are enabled and visible only if a multi-segment waveform is loaded for processing. The settings are grouped in the "Multi Segment Waveform Options/Next Segment Trigger In" section.

The Figure 4-28 illustrates how trigger events affect the processing of the multi-segment waveforms.

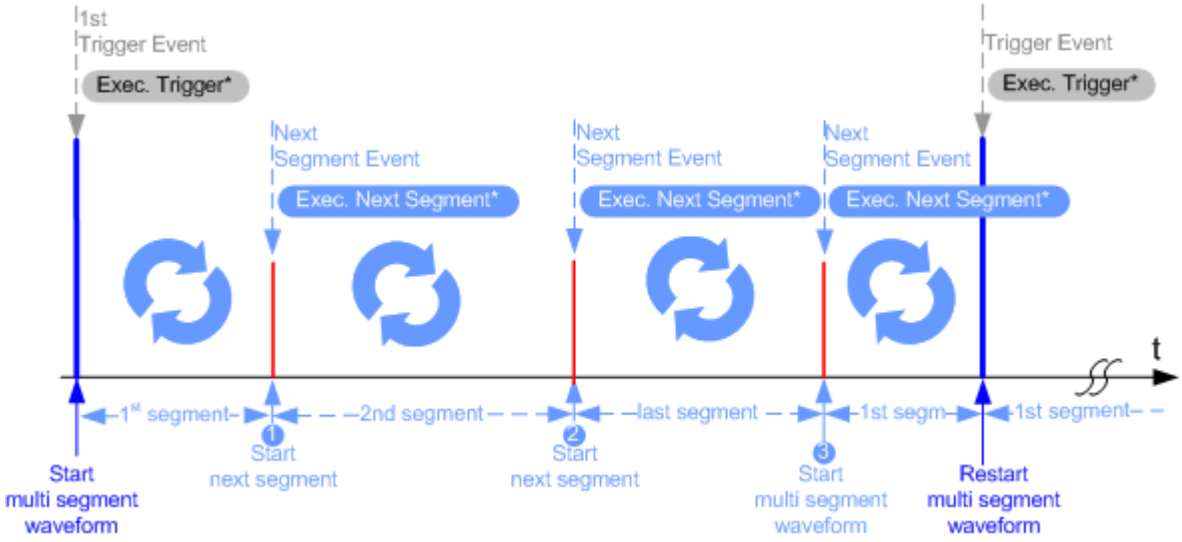


Figure 4-28: Principle of segment triggering

* = To simplify the description, an internal next segment trigger event ("Exec. Next Segment") and an internal trigger event ("Execute Trigger") are used; an external trigger event has the same effect on the signal generation.

1, 2 = Any next segment trigger event (internal or external) causes a switch over to the subsequent available segment in the waveform. The current output segment (segment filename and segment index) is indicated at "Current Segment".

3 = When the last segment of the multi-segment waveform is output, the sequence starts again with the output of the first segment after the next trigger event. Use a sequence of external next segment trigger events to output the segments in the multi-segment file cyclically.

Defining the next segment source

As with the standard trigger system, provided are the following two sources for the next segment signal:

- **Internal**: the switch over to the subsequent segment is triggered manually with the "Execute Next Segment" function.
  To trigger a switch over to any segment within the multi-segment waveform, change the value of the parameter "Segment".
- **External**: the instrument expects a trigger event ("Global Next Segment") on one of the two provided and configured User connectors.

Defining subsequent segments

By default, the instrument replays the segments in incremental order, for example "Segment#1". If you want to change the order is required, use one of the following possibilities:

- "Next Segment": defines the subsequent segment while triggering the segments manually, i.e. by "Next Segment Source" > "Internal"
- "Sequencing List": the subsequent segment is defined in the selected play list.

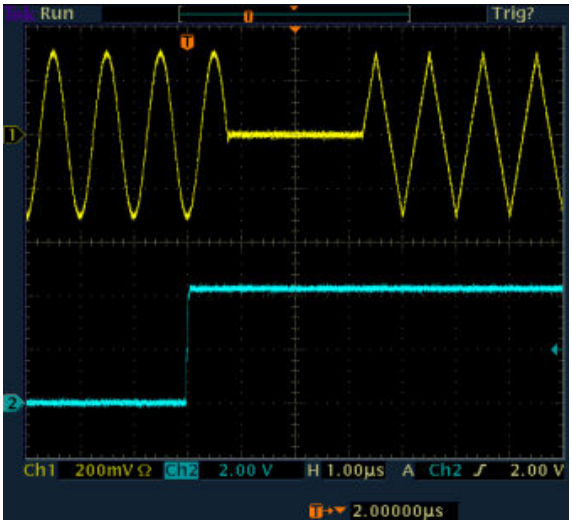
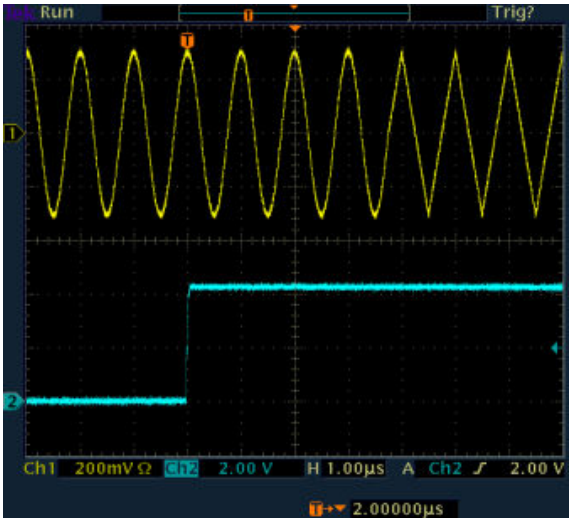
Defining the transition between the segments

The R&S SMCV100B provides the parameter "Next Segment Mode" to define the transition to the next segment, see the table Table 4-13.

- "Next Segment": by receiving a next segment event, the ARB aborts immediately the playing of the current waveform and starts playing the next segment waveform, see Table 4-13.
- "Next Segment Seamless": by receiving a next segment event, the ARB completes the processing of the current waveform before starting the next segment waveform, see Table 4-13.
  Use this setting to avoid signal gaps and wrap-around problems. Seamless transition requires segments with equal clock rates.
  Another way to generate a multi-segment signal without signal gaps between the segments is to use the provided ARB sequencer mode, see Section 4.8.3.4, "Multi-segment waveform sequencing", on page 207.

The table Table 4-13 shows two examples of the transition from a sine-wave signal segment to a sawtooth segment (I channel, upper curve). The triggering mode is the next segment external triggering. The left graphic displays an abrupt transition. The right graphic displays the seamless transition case.

Table 4-13: Transition examples

Next segment switching	Next segment seamless
	

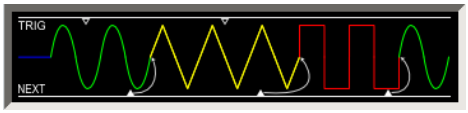
Understanding the trigger examples

A simplified diagram in the ARB dialog is intended to explain the effect of the triggering on the signal processing. The currently enabled settings for trigger and next segment mode are considered.

The curves plotted in the dialog are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and the next segment settings more clearly.

- The triangle on the top line denotes a trigger event. A filled triangle on the bottom line denotes a next segment event.
- A green sine wave (or other shape) over a full period indicates one replay cycle of a segment. A shorter example signal indicates a replay cycle which was interrupted, e.g. due to a next segment event (compare the two graphics in Table 4-14).

Table 4-14: Trigger examples in the ARB dialog

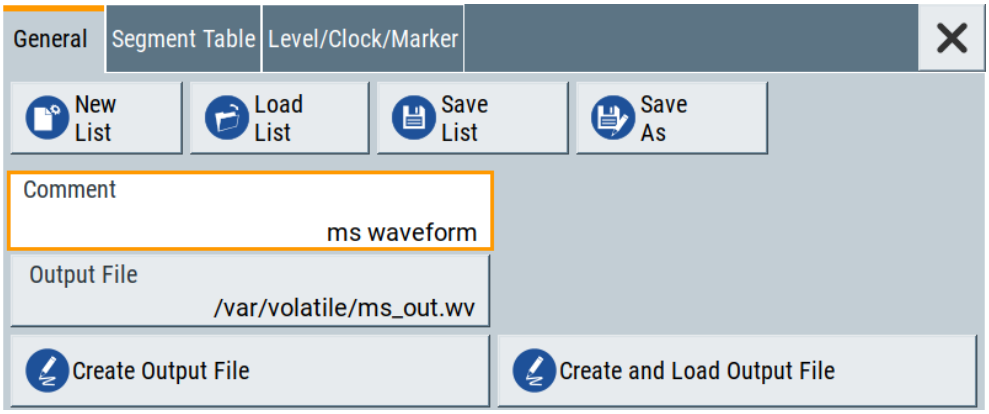
"Next Segment Mode = Next Segment"	"Next Segment Mode = Next Segment Seamless"
	

4.8.3 Multi-segment settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".

The "ARB: Multi Segment" dialog enables direct assignment of waveforms to the multiple segments, adjusting the clock, level, and marker settings of the composed waveform and selecting the output file.



For description on the provided settings, refer to:
Section 4.8.3.1, "General settings", on page 200,
Section 4.8.3.2, "Segment table", on page 202 and
Section 4.8.3.3, "Level/Clock/Marker settings", on page 204

2. Select "ARB: Multi Segment" > "General" > "Create and Load Output File" to save and load the current multi-segment file.
3. Select "Multi Segment" > **"Sequencing List"** to access the settings for configuring a sequencing "Play List" for fast automatic processing of the multi-segment waveform.
   For a description of the provided settings, refer to Section 4.8.3.4, "Multi-segment waveform sequencing", on page 207.
4. Select "Baseband" > "ARB" > "General".

   The "Load Waveform" confirms that the current multi-segment file is loaded (filename as defined with "Output File").

   Note: The provided settings depend on the current waveform.
   The "Sequencing List" function requires the following:
   - Created multi-segment file via "Create Output File" or "Create and Load Output File".
   - The "Sequence Table" contains more than one segment.
5. Select "Baseband" > "ARB" > "Trigger In (MSW)".
   For related settings, see Section 4.8.3.5, "Multi-segment waveform trigger settings", on page 211.
6. Select "Baseband" > "ARB" > "General" > "State" > "On" to generate the multi-segment waveform.

The remote commands required to define these settings are described in Section 14.16.4.3, "SOURce:BB:ARBitrary subsystem", on page 709.

- General settings....200
- Segment table....202
- Level/Clock/Marker settings....204
- Multi-segment waveform sequencing....207
- Multi-segment waveform trigger settings....211

4.8.3.1 General settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".

   The "General" tab provides standard functions for file handling, like selecting and loading of files, or determining the output filename.

2. Perform one of the following:
   - Select "New List" to create a multi-segment waveform file
   - Select "Load List" to load an existing one

3. Add a comment.

4. Select "Output File" to set the filename of the multi-segment waveform.

   Note: The provided settings depend on the current waveform.
   The "Sequencing List" function requires the following:
   - Created multi-segment file via "Create Output File" or "Create and Load Output File".
   - The "Sequence Table" contains more than one segment.

Settings:

New List.... 200
Load List....200
Save List/Save List As.... 201
Sequencing List....201
Comment....201
Output File....201
Create Output File/Create and Load Output File.... 201

New List
Opens the standard "Create Multi Segment Waveform List" function to enter the name of the new file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect` on page 734

Load List
Opens the standard "File Select" function to select the configuration file to be edited.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog? on page 731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 734
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete on page 732

Save List/Save List As...
Saves the current entries of the Segment table in a configuration list (file), including the level mode, clock mode, segment marker mode, and output filename settings.

See also Section 4.8.2.3, "File concept", on page 194.

Consider also the following remote control commands:
- To define the configuration file (`*.inf_mswv`) used by the calculation of the output file:
  - [:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate
  - [:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad
- To define the filename of the output waveform file (`*.wv`):
  [:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe

Remote command:
n.a.

Sequencing List
Requires a loaded multi-segment file.

Opens the dedicated dialog for configuring the associated play lists, see Section 4.8.3.4, "Multi-segment waveform sequencing", on page 207.

Remote command:
n.a.

Comment
Adds a comment to the composed multi-segment file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent on page 732

Output File
Opens the standard "File Select" dialog function and requests the filename for the multi-segment waveform to be calculated.

An output filename is required for further processing of the multi-segment waveform:
- For the internal storage triggered by the "Save List" function
- For the calculation and creation of the multi-segment waveform, triggered by the "Create" or "Create and Load" function.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe on page 733

Create Output File/Create and Load Output File
Creates a multi-segment waveform as follows:

"Create Output File"	Creates a multi-segment waveform using the current entries in the segment table, see Section 4.8.3.2, "Segment table", on page 202.

"Create and Load Output File" Creates a multi-segment waveform and loads it in the ARB.

The R&S SMCV100B saves the multicarrier waveform as a file with filename, see"Output File" on page 201.

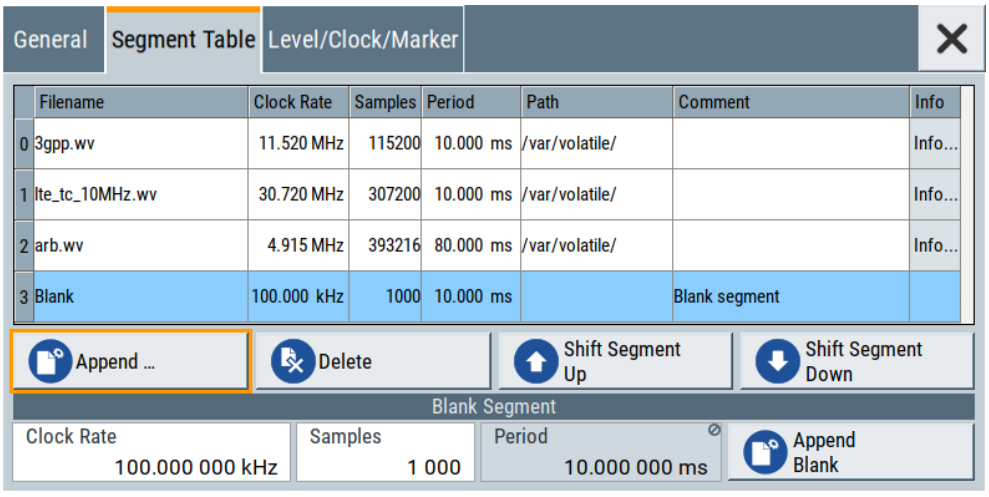
Depending on the configuration of the multicarrier waveform, calculation takes some time. Use the "Abort" function to interrupt the calculation.

Remote command:
To define the configuration file (`*.inf_mswv`) used by the calculation of the output file:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate`
Or `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad`
To define the filename of the output waveform file (`*.wv`):
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe`

4.8.3.2 Segment table

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment ...".
2. In the "ARB: Multi Segment" > "General" dialog, select an existing list.
3. Select "ARB: Multi Segment" > "Segment Table".
4. Select "Append" to add waveform segments.
5. Select "Append Blank" to add a bank segment
6. Configure the "Blank Segment Settings" as required.



This section provides settings to create and adjust the contents of the multi-segment file.

Settings:

Segment Table 203
Append/Delete/Shift Segment Up/Shift Segment Down 203
Blank Segment 204

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

"Segment#" Indication of segment index. Within the manual and remote control configuration, this segment index indicates the segment explicitly.
Tip: Use the segment index, for example, to define the subsequent sequence to be output in next segment Mode "Next Segment" or "Next Segment Seamless".

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

"Clock Rate"
Indication of the clock rate of the selected waveform.

"Samples"
Indication of the number of samples in the segment.

"Period"
Indication of the segment duration.

"Path"
Indication of the location of the waveform file used for the corresponding segment.

"Comment"
Indication of the possible comments contained in the waveform.

"Info"
Indication of the possible comments contained in the waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?`
on page 728

Append/Delete/Shift Segment Up/Shift Segment Down
Standard handling functions:

"Append" Opens the standard "File Select" dialog for navigation to and selection of the waveform file to be added on the end of the existing list. Only non-multi-segment waveforms can be loaded.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend` on page 733

"Delete" Removes the selected entry from the table. The waveform file itself is however not deleted.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete` on page 733

"Shift Segment Up"/"Shift Segment Down"
Rearranges the segments, i.e. moves the selected segment up and down.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP` on page 734
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN` on page 733

Blank Segment
Comprises the settings of a blank segment. A blank segment is a zero signal with a defined clock rate and number of samples.

"Clock Rate" Selects the clock rate of the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 731

"Samples" Selects the number of samples for the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 731

"Period" Displays the resulting period for the blank segment.

"Append Blank"
Adds the blank segment to the multi-segment file.

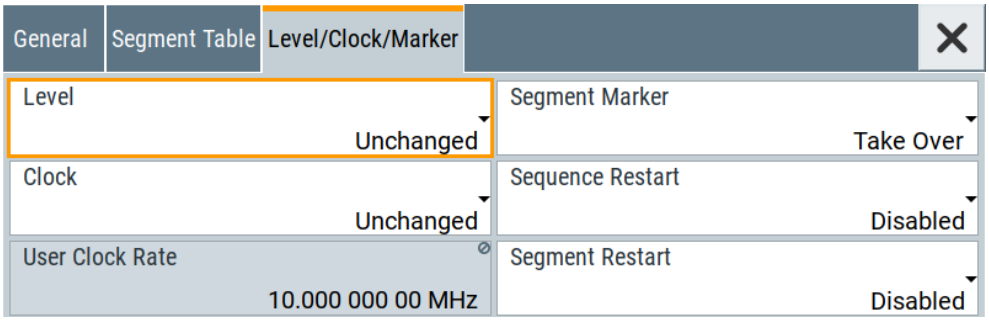
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 731

4.8.3.3 Level/Clock/Marker settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".
2. In the dialog "ARB: Multi Segment" > "General", select an existing list.
3. Select "ARB: Multi Segment" > "Segment Table" to configure the segments.
4. Select "ARB: Multi Segment" > "Level/Clock/Marker".

   The "Level/Clock/Marker" tab provides settings to configure the level, marker and clock settings of the multi-segment waveform file.



Settings:

Level....205
Clock....205
User Clock Rate....206
Segment Marker....206
Sequence Restart....206
Segment Restart....206

Level
Defines the way that the instrument determines the output level of each of the multiple waveforms.

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

"Equal RMS" The output segments have the same RMS value. The displayed "Level" applies to all segments.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]`
on page 732

Clock
Defines the clock mode to set the clock rate of each of the multiple waveforms.

"Unchanged" Each segment has the clock rate as in its waveform file.

Note: For "Next Segment Mode" > "Next Segment Seamless", the segments require equal clock rates.

"Highest" All segments have the highest available clock rate.

Note: Trade-off between fast switch over and computing time. This mode provides short switch-over times between segments. But the computing time increases because the individual segments are resampled.

"User" All segments are output at the clock rate, the "User Clock Rate". Also, this mode is a trade-off between fast switch over and computing time.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE
on page 732

User Clock Rate
Display or sets the sample rate for multi-segment waveform output. Setting requires "Clock" > "User".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk on page 731

Segment Marker
Defines the way the marker information within the separate segments is processed, see also Section 4.8.2.4, "Impact of the marker settings", on page 195.

"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 729

Sequence Restart
Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Section 4.8.2.4, "Impact of the marker settings", on page 195.

"Disabled" No additional marker is generated.

"Marker 1"/"Marker 2"/"Marker 3"
Generates a restart marker signal at the beginning of the first segment of the complete multi-segment sequence.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment
on page 730

Segment Restart
Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Section 4.8.2.4, "Impact of the marker settings", on page 195.

"Disabled" No additional marker is generated.

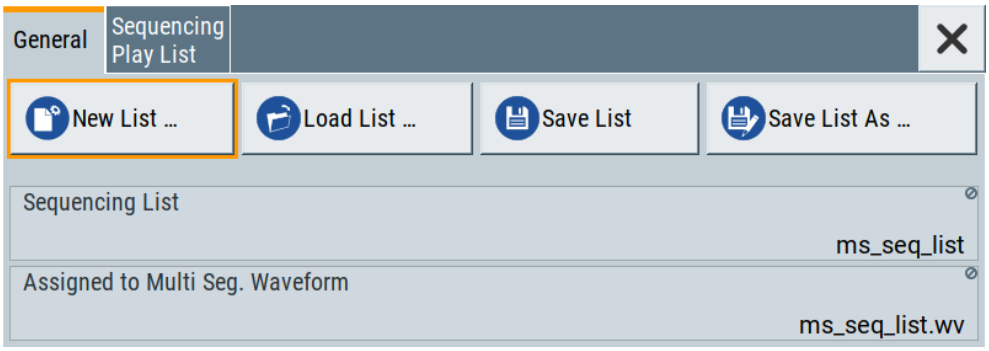
"Marker 1"/"Marker 2"/"Marker 3"
Generates a restart marker signal at the beginning of each segment. The segment start is defined by the low-high slope of the marker signal, which applies for switching between two segments and if there is a segment replay.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment
on page 730

4.8.3.4 Multi-segment waveform sequencing

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".
2. In the "ARB: Multi Segment" > "General" dialog, select an existing list.
3. Select "ARB: Multi Segment" > "Segment Table".
4. Configure a waveform with more than one segment.
5. Select "ARB: Multi Segment" > "Level/Clock/Marker"
6. Adjust the clock settings so that all segments use the same clock rate.
7. Select "ARB: Multi Segment" > "General"
   > **"Create Output File/Create and Load Output File"**.
8. Select "Sequencing List...".
9. Select "New" or "Load" to load a sequencing list file.

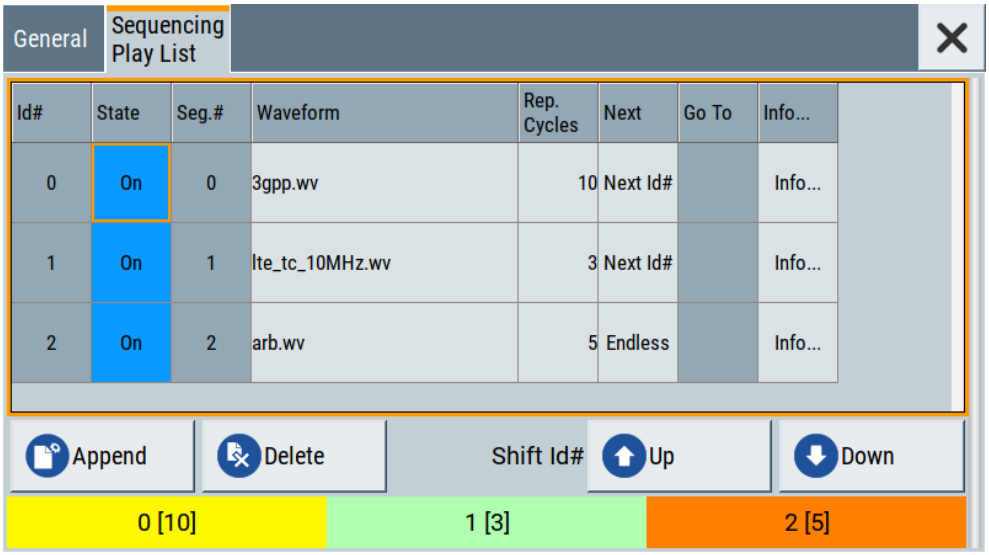


10. Select "ARB: Multi Segment Waveform Sequencing" > "Sequencing Play List" to create a "Play List".

    A new sequencing list contains no information.

11. Use the "Append"/"Delete" and "Up"/"Down" functions to configure the order of processing the segments.

    The user interface shows the configured play list in the form of a "Sequencing Graphic".



For related settings, see "Sequencing play list settings" on page 209.

12. Select "ARB: Multi Segment Waveform Sequencing" > "General" > "Save" to save the "Play List".
13. Select "ARB: Multi Segment" > "General" > "Create and Load Output File".
14. To use the "Play List", select "ARB" > "Next Segment Waveform Options" > "Next Segment Mode" > "Sequencer".

Settings:

- General settings....208
- Sequencing play list settings....209

General settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Segment" > "Sequencing List...".

Settings:

New Sequencing List/Load Sequencing List....208
Save List/Save List As....209
Sequencing List....209
Assigned to Multi Seg. Waveform....209

New Sequencing List/Load Sequencing List
Opens the standard "Select Sequencing List" function to define the name of the new play list file or select of an existing one.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect` on page 728

Save List/Save List As
Saves the current entries of the table in a play list file. Play list files have the file extension `*.wvs`.

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

Sequencing List
Displays the name of the selected sequencing list file, i.e. the file with the “play list” settings (see Section 4.8.2.3, "File concept", on page 194).

Remote command:
n.a.

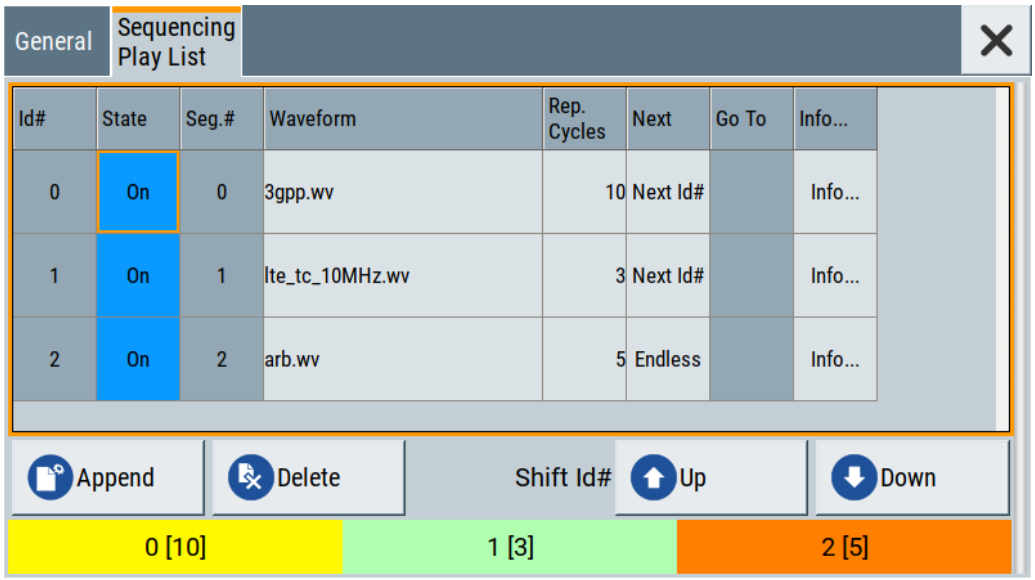
Assigned to Multi Seg. Waveform
Displays the name of the multi-segment waveform file within the current sequencing list file.

Remote command:
n.a.

Sequencing play list settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Segment" > "Sequencing List..." > "Sequencing Play List".



Settings:

Sequencing Play List....210
└ Next....210
└ Append....210

└ Delete....211
└ Shift Id# Up/Shift Id# Down....211
Sequencing Graphic....211

Sequencing Play List
The "Sequencing Play List" table defines the sequence order for processing the waveform file segments. Also, you can set the repetition of individual segments.

"Id#" Indicates the row number.

"State" Enables/disables the selected row. Only active segments are processed.

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

"Waveform" Indicates the waveform file mapped to the corresponding segment.
The R&S SMCV100B reads out this filename from the multi-segment waveform file.
Available are only waveform files from the pool of segments of the selected multi-segment waveform file.

"Repetition Cycles"
Sets the number of times the selected segment is cyclically repeated before the next segment in the sequence is processed.

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

Remote command:
See "Append" on page 210.

Next ← Sequencing Play List
Determines the action after completing the current segment. For example, determines which segment the R&S SMCV100B is processes after the processing the current segment.

"Next Id#" The next active segment in the play list is processed.

"Blank" After the processing of the current segment is completed, the signal output is stopped until a signal restart like a retrigger signal is received.
A restart signal causes a complete restart of the sequencing play list.

"Endless" The current segment is replayed until a signal restart like a retrigger signal is received and the complete sequencing play list is restarted.
Only active segments are considered.

"Goto Id#" Determines the row number of the segment to be processed next.
This feature is limited to the first 32 rows.

Append ← Sequencing Play List
Inserts a new row at the end of the sequencing play list table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect on page 728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend on page 728

Delete ← Sequencing Play List
Deletes the selected row.

Shift Id# Up/Shift Id# Down ← Sequencing Play List
Rearranges the rows that means moves the selected row up and down.

Sequencing Graphic
Displays the play list graph according to the current configuration.

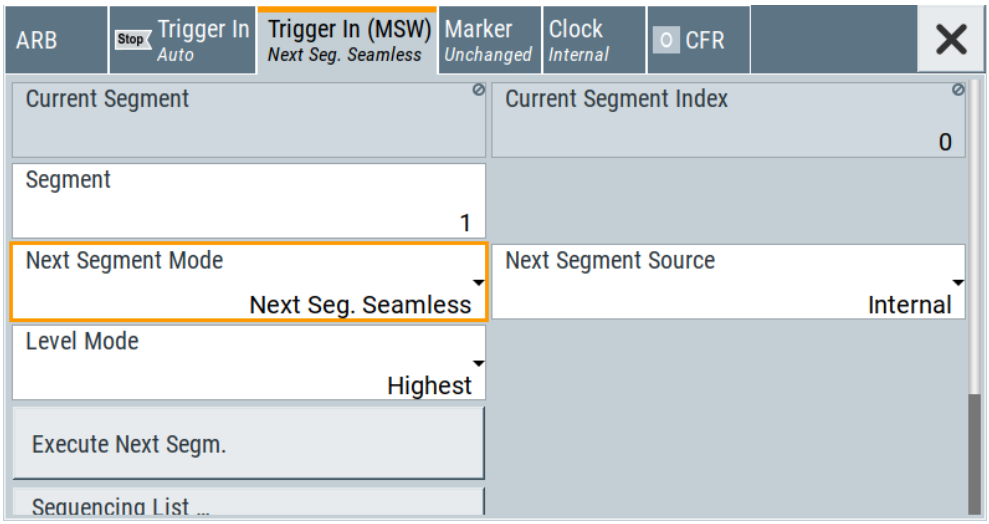
The graph shows the segment sequence, the segment number, and the number of times the segment is repeated; considered are only the active segments.

4.8.3.5 Multi-segment waveform trigger settings

The settings in the "Trigger In (MSW)" tab are visible only if a multi-segment waveform is loaded into the ARB.

Access:

1. Load a multi-segment waveform in the ARB.
   See Section 4.8.3, "Multi-segment settings", on page 198.
2. Select "Baseband" > "ARB" > "Trigger In (MSW)".



The tab provides settings to configure the trigger for switching between the segments of a multi-segment waveform. The parameters depend on the selected trigger source.

Settings:

Current Segment/Current Segment Index....212
Segment....212
Next Segment Mode....212
Next Segment Source....213
Level Mode....213
Execute Next Segment....214
Sequencing List....214
Trigger Example....214

Current Segment/Current Segment Index
Indicates the waveform segment (segment filename and index) that is output.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment?` on page 726
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?` on page 726

Segment
Selects the waveform segment to be output after the segment indicated as "Current Segment". This parameter determines the start segment when switching on the ARB and enables switching over to any other segment.

The following events cause a switch over:
- A trigger event of an external next segment
- An internal segment trigger that is a change in the segment index in the "Segment" field

Use the parameter Next Segment Mode to define whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around). The subsequent trigger event after the last segment causes the first segment to be output again.

For more information, see Section 4.8.2.5, "Impact of the trigger settings and next segment settings", on page 196.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT` on page 727

Next Segment Mode
Defines the way the **switch over between the segments** in a multi-segment waveform is executed.

The regular trigger mode for starting the waveform generation and **triggering the whole multi-segment sequence** is set with the parameters in the "ARB > Trigger" tab. The segment currently being output is displayed at "Current Segment". The "Trigger Example" graph displays schematically the waveform output, depending on the activated trigger and the next segment settings.

For background information, refer to Section 4.8.2.5, "Impact of the trigger settings and next segment settings", on page 196.

For detailed information on how the regular trigger signal affects the multi-segment waveform processing in combination with the different values for "Next Segment Mode", refer to Section 4.8.5, "Reference to triggering of multi-segment waveforms", on page 220.

Note: The seamless switch over and the sequencer mode require segments with equal sample rate.

"Same Segment"
The processing of the multi-segment waveform file is similar to the processing of a non-multi-segment waveform. There is no switching to consecutive segments upon the receiving of a trigger event.
To trigger switching between the segments, change the segment index in the "Segment" field.

"Next Segment"
The current segment ceases to be output when a trigger event for a new segment occurs, and the new segment starts to be output after a system-imposed signal gap.

"Next Segment Seamless"
If all segments have the same sample rate, the new segment is not output until all segments are output (wrap around), i.e. the signal transition is seamless.

"Sequencer" The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (`*.wvs`) assigned to the multi-segment waveform file.
This “play list” is defined in the Multi-segment waveform sequencing dialog.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe` on page 730

Next Segment Source
Selects whether the next segment is switched upon receiving of an external trigger signal or upon executing of software next segment trigger (see Figure 4-28).

This parameter is disabled if a sequencing play list is used.

"Internal" Switch over to any segment is triggered manually with the "Execute Next Segment" function.

"External Global Next Segment"
The trigger event for switching to the next segment is input as configured on one of the User x connectors.

See also Section 12.2, "Configuring global connectors", on page 456.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce` on page 727

Level Mode
Sets how the instrument levels the individual segments in a multi-segment signal. The parameter is important if waveforms with different crest factors are used.

"Highest" All segments are output at the highest available crest factor.

"Unchanged" Each segment is output with the crest factor defined in its waveform file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe` on page 727

Execute Next Segment
For "Next Segment Source = Internal", triggers manually switch over to the subsequent segment in the multi-segment file. The subsequent segment can be any segment within the multi-segment file and is defined by the parameter "Segment".

This parameter is disabled if a sequencing play list is enabled.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute` on page 727

Sequencing List
Opens a dialog box for defining the “play lists”, see Section 4.8.3.4, "Multi-segment waveform sequencing", on page 207.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect` on page 728

Trigger Example
Displays an example of a multi-segment waveform. The currently enabled trigger and next segment mode are considered. After the instrument is switched on, the graph of the last loaded waveform is displayed.

Note: The curves plotted in this dialog box are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and next segment settings more clearly.

Remote command:
n.a.

4.8.4 Working with multi-segment waveform files

This section provides step-by-step instructions on how to configure and use the multi-segment settings. The Figure 4-29 shows the essential stages of multi-segment waveform configuration, together with the corresponding user interface dialogs and if applicable, the corresponding file extensions. Perform the necessary settings, enable the signal generation, and provide the trigger signal.

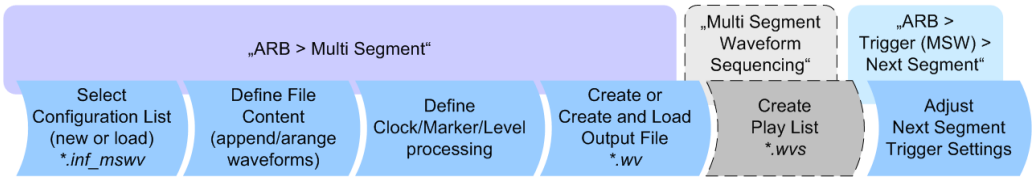


Figure 4-29: Basic workflow for generation of multi-segment waveforms

To generate a multi-segment waveform file

1. In the "ARB" > "General" > "Create Multi Segment" > "General" dialog, select "New List" to create an empty list.
2. Use the "ARB: Multi Segment" > "Segment Table" > "Append" function to add multiple waveform files.

3. In the "ARB: Multi Segment" > "Level/Clock/Marker" dialog, adjust the "Level", "Clock", and "Segment Marker" settings.
4. Select the "ARB" > "Create Multi Segment" > "General" > "Output File" to enter the filename.
5. Select "Save List" to save the configuration file.
6. Select "Create Output File" or "Create and Load Output File".
7. Select "State" > "On".

The following description emphasizes on the settings required to fulfill the particular task or achieve the desired performance; standard basic settings are not discussed.

All provided examples use the example segment sequence as shown on Figure 4-30.

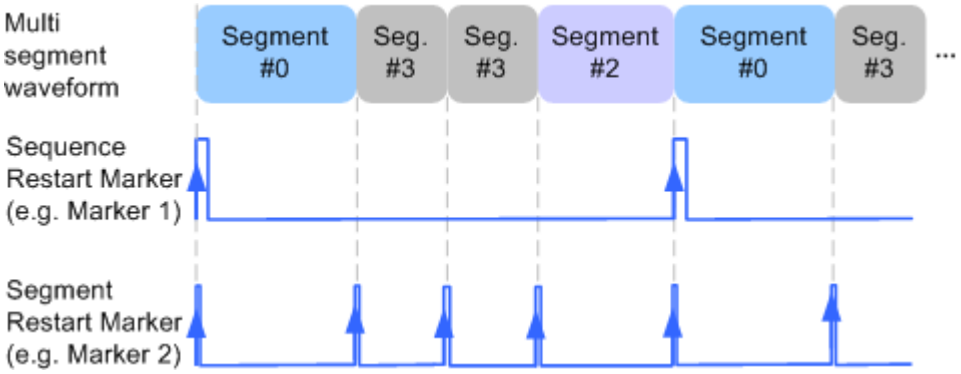


Figure 4-30: Example: multi-segment sequence with marker signals

See how to:

- "To switch output segments manually" on page 215
- "To generate a multi-segment signal without signal interruptions" on page 216
- "To enable external triggering for high-speed switch over" on page 217
- "To use the play list function" on page 218
- "To add marker signals" on page 219

To switch output segments manually

When testing a DUT using different test signals, you want to switch dynamically and flexibly between any of the test signals. For example, switching due to the outcome of the previous test. The following settings enable flexible dynamic switch over between the segments in a multi-segment waveform.

We assume that a multi-segment sequence composed of 4 segments ("Seg#0", "Seg#1", "Seg#2" and "Seg#3") is created and loaded in the ARB. See "To generate a multi-segment waveform file" on page 214). The required output order of the segments is "Seg#0", "Seg#3", "Seg#2". The instrument is operated manually, the ARB is enabled, and the instrument output is on.

1. Select "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".

The transition between the segments is abrupt.

2. To enable manual next segment triggering, select "ARB" > "Trigger In (MSW)" > "Next Segment Source" > "Internal".
3. To enable manual triggering, proceed as follows:
   a) Select "ARB" > "Trigger In" > "Mode" > "Armed Auto".
   b) Select "Source" > "Internal".
   c) Tap "Execute Trigger" to trigger the signal generation.

   The "ARB" > "Trigger In (MSW)" settings display the current output segment: "Current Segment Name = Seg#0" and "Curent Segment Index = 0". Outputs the "Seg#0" continuously.
4. Set "ARB" > "Trigger In (MSW)" > "Segment" > "3" to output the second segment in the sequence order.

   The parameter "Current Segment Index" changes to segment index 3. "Seg#3" is output continuously.
5. In the "ARB" > "Trigger In" dialog, tap "Execute Trigger" to restart "Seg#3".
6. Set "ARB" > "Trigger In (MSW)" > "Segment" > "2" to output the third segment in the sequence order.

   The sequencer outputs "Seg#2" continuously.
7. To switch over to "Seg#0", change the "ARB" > "Trigger In (MSW)" > "Current Segment Index", etc.

The ARB sequencer mode provides settings to achieve the same goal in a more convenient way, see "To use the play list function" on page 218.

Faster flexible dynamic switch over

When controlling remotely via an external computer, the following settings enable switching times of about 20 ms. These times apply for segments with the same sample rate and about 200 ms for segments with different sample rates:

- "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".
- "ARB" > "Trigger In" > "Mode" > "Auto"
- "ARB" > "Trigger In" > "Source" > "Internal"

To generate a multi-segment signal without signal interruptions

Testing receivers requires a continuous output of different test signals without interrupting the signal. The test signals then produce a complex total signal with no signal gaps on switch over. Control procedures can use a simulated back channel of the receiver (trigger line or remote control).

Switching times depend on the length of the segment currently being output, because the switch over to the next segment does not take place until the current segment ends.

To overcome wrap-around problems and generate multi-segment signals without signal gaps between the segments, consider the following settings:

1. Enable "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment Seamless"
2. Select "ARB" > "Trigger In" > "Mode" > "Auto"
3. Select "ARB" > "Trigger In" > "Source" > "Internal"
4. Change the value of the parameter "ARB" > "Trigger In (MSW)" > "Segment" to select the segment index processed after completing the current one.

   The R&S SMCV100B outputs a segment ("Current Segment") continuously as long as you do not change the value of the parameter "Segment".
5. The seamless transition between the segments requires waveforms with equal clock rate.
   If the waveforms feature different sample rates, select "ARB" > "Create Multi Segment" > "Level/Clock/Marker" > "Clock Mode" > "Highest" or "Clock Mode" > "User" to resample the waveforms.

To enable external triggering for high-speed switch over

Testing a DUT or a chip with different test signals at high throughput requires a fast switch over. For example, when testing ATE devices during manufacturing.

We assume that you created and loaded the required multi-segment sequence into the ARB, see "To generate a multi-segment waveform file" on page 214. The instrument outputs the segments in incremental order.

The instrument is in manual operation mode, the ARB is enabled and the instrument output is on. An external global or local trigger source is connected to the instrument and the corresponding connectors are configured.

The following settings enable switching times of about 5 us and the test signals are scrolled through with the aid of an external trigger signal:

1. Select "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".
2. Select "ARB" > "Trigger In (MSW)" > "Next Segment Source" > "External (NEXT)".
3. Do not change the displayed segment index via "ARB" > "Trigger In (MSW)" > "Segment".
4. Select "ARB" > "Trigger In" > "Mode" > "Auto".
5. Select "Source" > "External Global Trigger".

6. If the waveforms in the multi-segment file feature different sample rates, select "ARB" > "Create Multi Segment" > "Level/Clock/Marker" > "Clock Mode" > "Highest" or "Clock Mode" > "Highest" to resample the waveforms.

   The switch over between the segments is triggered by the receiving of an external trigger event. The segments are output in incremental order. As long as the instrument receives a new trigger event, it outputs the "Current Segment" continuously. A new trigger event aborts the output of the current segment immediately and starts the processing of the next one in the sequence.
   Tip: To output the segments in any order, use the ARB sequencer mode, see "To use the play list function" on page 218.

See also Section 12.2, "Configuring global connectors", on page 456.

To use the play list function

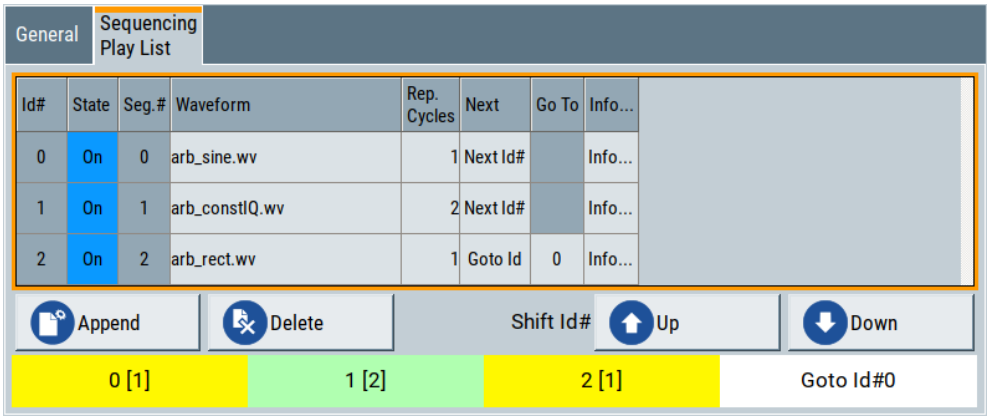
The ARB sequencer mode requires waveform files with equal clock rate.

We assume that you created and loaded a multi-segment sequence with four segments into the ARB, see "To switch output segments manually" on page 215. The required output order of the segments is "Seg#0", "Seg#3" (twice) and "Seg#2". The instrument is in manual operation mode, the ARB is enabled and the instrument output is on.

The following settings show an example of how to configure this segment output order with the help of the ARB sequencing function.

1. In the "ARB: Multi Segment" dialog, select "Create and Load".
2. Select "General" > "Sequencing List".

   The "Multi Segment Waveform Sequencing" dialog opens. It displays the new play list and the current multi-segment waveform file.
3. Select "Sequencing Play List".
4. Configure the settings as follows:
   a) "Id#" = "0": "Seg#" = "0", "Rep. Cycles" = "1", "Next" = "Next Id#"
   b) "Id#" = "1": "Seg#" = "3", "Rep. Cycles" = "2", "Next" = "Next Id#"
   c) "Id#" = "2": "Seg#" = "2", "Rep. Cycles" = "1", "Next" = "Goto Id", "Go To" = "0"
      This setting creates a loop to the first segment in the sequence.



5. To save the configuration, select "General" > "Save List".
6. To use this play list, select "ARB" > "Trigger (MSW)" > "Next Segment Mode" > "Sequencer".
7. Select the trigger mode "Mode" = "Armed Auto".
8. Select the trigger source "Source" = "Internal".

   The segments are played back (output) as defined in the sequencing list. The switch over to the next segment is performed automatically according to the rules and segment order defined in the "Sequencing Play List".

To add marker signals

We assume that a multi-segment sequence composed of the segments Seg#0 [1], Seg#3 [2], Seg#2 [1] is created and loaded in the ARB (see "To use the play list function" on page 218). The multi-segment sequence starts with Seg#0 and this segment is output once. The instrument is operated manually, the ARB is enabled and the instrument output is switched on.

To add marker signals at the beginning of each segment and at the beginning of the sequence (see Figure 4-30), two additional marker signals, "Marker 2" and "Marker 1", are enabled and inserted into the multi-segment waveform.

1. Select "ARB > Marker > Marker Mode > Marker 1/Marker2 = Unchanged" to enable taking over of the marker signals defined inside the multi-segment sequence.
   If necessary, adjust the marker delay settings.
2. Select the "Trigger/Marker/Clock" to map the "Logical Signals > Marker 1/Marker 2" to the desired connectors ("Global Connectors > User x > Direction = Output" and "Signal = Baseband Marker 1/Baseband Marker 2")
3. In the "ARB > Multi Segment > Level/Clock/Marker" dialog, select "Segment Marker = Ignore"
4. Enable "Level/Clock/Marker > Sequence Restart = Marker 1"

5. Enable "Level/Clock/Marker > Segment Restart = Marker 2"

   An extra restart marker signal is generated at the beginning of each segment and the beginning of the waveform. These restart markers *overwrite* the existing Marker 1 and Marker 2 trace signals defined in the waveforms of the individual segments.

4.8.5 Reference to triggering of multi-segment waveforms

Signal generation of multi-segment waveforms takes place differently according to the trigger selected in the "ARB > Trigger In" section. The sections provide a detailed explanation of the effect of a trigger event on the multi-segment waveform processing, depending on the enabled "Next Trigger Mode". Refer to Section 4.8.2.5, "Impact of the trigger settings and next segment settings", on page 196 for background information.

4.8.5.1 Triggering in "Next trigger mode = same segment"

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

Table 4-15: Waveform triggering: "Next Trigger Mode = Same Segment", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Trigger events are ignored. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Retrigger"	Output starts at once and the segment is generated continuously, a trigger event causes a restart. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Retrigger"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs.

4.8.5.2 Triggering in "Next trigger mode = next segment"

Depending on the trigger setting, the segment selected under "Segment" is output either immediately or after a trigger event. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

Table 4-16: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

Table 4-17: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = External"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to output the subsequent segment, following a system-imposed signal gap. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap. The subsequent trigger event after the last segment causes the first segment to be output again.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to output the subsequent segment, following a system-imposed signal gap. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.
"Single"	Output starts after the first trigger event. The segment is then generated once. Each trigger event (re-) starts the segment; each next segment trigger event switches over to outputting the subsequent segment. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.

For a description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.8.5.3 Triggering in "Next trigger mode = next segment seamless"

The segment selected under "Segment" is output. This mode is only available if all segments have the same sample rate.

Table 4-18: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts at once and the segment is generated continuously. Each trigger event (re-) starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.

Table 4-19: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = External"

"Trigger Mode"	Description
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Each trigger event (re-) starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.

For a description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.8.5.4 Triggering in "Next trigger mode = sequencer"

The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (`*.wvs`) assigned to the multi-segment waveform file.

4.9 Generating multicarrier waveform signals

To simulate complex multicarrier scenarios with different baseband signals, the R&S SMCV100B provides the possibility to generate multicarrier waveforms. These waveforms can consist of up to 512 carriers, each modulated by the same or by different user-selectable baseband signal.

The multicarrier waveform is a practical solution for the generation of a complex broadband signal, for example:

- Multicarrier waveforms build from signals of different communication standards (e.g. CDMA2000 or 3GPP FDD)
- Multicarrier waveforms composed of several signals from the same communication standard as in LTE Advanced.

4.9.1 Required options

See Section 4.6.1, "Required options", on page 138.

Multicarrier waveform files require the corresponding digital standard options (R&S SMCVB-K2xx) of all included standards.

4.9.2 About the multicarrier waveforms

This chapter provides background information on the ARB functionality for generating of multicarrier signals and the impact of the provided settings. See Section 4.9.4, "Using the multicarrier function", on page 238 for information on how to use the provided settings to configure a multicarrier signal.

The multicarrier waveforms are a convenient way to configure the broadband test signals required for transmitter or receiver tests. Even complex multicarrier scenarios composed of signals from different digital standards can be created and used for these tests.

Because the multicarrier files are processed by the ARB, the composed waveform file must be created before it is loaded to and played by the ARB. The R&S SMCV100B saves the created multicarrier waveform file under a user-definable name; as with the single carrier waveforms, the used file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file. When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day.

Multicarrier waveforms versus multicarrier continuous wave signals

By default, the ARB multicarrier waveform application does not generate multicarrier continuous wave signals (CW) that are aligned to the center frequency. Signals generated by the digital standard "Multi Carrier CW" are aligned to the center frequency.

To generate a multicarrier CW, create a constant DC input signal, see "Create Test Signal" on page 148. Select a signal period that is matching the carrier frequency distances.

To reach a smooth transition between end and start signal, make sure that the actual carrier frequency offset is rounded: Select "Mode" > "Equidistant Carrier Spacing" to set a frequency resolution that is the inverse of the signal period of the output signal. See Section 4.9.2.1, "Defining the carrier frequency", on page 224.

General principle for composing the multicarrier signal

The following is a list of the general steps used for composing the multicarrier signal:

- In the default mode, the up to 512 carriers are equally spaced and centered toward the RF frequency or the baseband DC line.
  The carrier spacing is adjustable within the total available bandwidth. Make sure that the total RF bandwidth of the composed multicarrier signal does not exceed the available RF bandwidth.
- Another possibility is to define the center frequency of each of the carrier individually, see also Section 4.9.2.1, "Defining the carrier frequency", on page 224.
- Define each carrier separately in terms of power, phase and modulated input signal.
  To define the leveling of the composed multicarrier signal, use the parameter "Power Reference", see "Power Reference" on page 230.
- Optionally, optimize the crest factor of the multicarrier output signal, see Section 4.9.2.2, "Optimizing the crest factor", on page 225.
- After all multicarrier processing steps are completed, the instrument calculates the resulting peak and RMS power over the total signal. This value is then written in the waveform file.

For more information, refer to the specifications document.

4.9.2.1 Defining the carrier frequency

There are two ways to define the carrier frequency of the individual carriers in the multicarrier signal:

- Enable the arbitrary carrier frequency distribution and specify the carrier frequency of each carrier individually.
- Use the built-in equidistant carrier spacing distribution function.

About equidistant carrier spacing

Equidistant carrier spacing implies a uniform distribution around the RF frequency. This method derives the carrier frequencies automatically from the selected number of carriers and the carrier spacing.

The maximum carrier spacing Δf_{max} is a function of the available total bandwidth f_{tot} and the selected number of carriers n. Calculate Δf_{max} as follows:

$$\Delta f_{max} = \frac{f_{tot}}{n - 1}$$

The method rounds the value of the carrier spacing Δf_{round} so that the carrier that is closest to the center RF frequency shows no phase jump. Also, this method holds for

unmodulated carriers only. Rounding includes the output signal duration t_{output} and the actual carrier spacing Δf as follows:

- For an odd number of carriers:

$$\Delta f_{round} \simeq \frac{1}{t_{output}} * [\Delta f * t_{output}]$$

- For an even number of carriers:

$$\Delta f_{round} \simeq \frac{2}{t_{output}} * [0.5 * \Delta f * t_{output}]$$

To avoid wrap-around problems, you can slightly modify the effective applied carrier spacing. See also "Mode" on page 227.

4.9.2.2 Optimizing the crest factor

An introduction to the topic is provided in Section 4.4.1.9, "Methods for optimizing the crest factor", on page 96. This section focuses on the settings provided for and related to the multicarrier signals.

The R&S SMCV100B provides a crest factor reduction by an automatic optimization upon selected values for the following parameters:

- "Crest Factor Mode":
  This mode offers multicarrier output signals with minimized or maximized target crest factor values via internal phase corrections of the single carriers. For a disabled mode ("Off"), there are no phase corrections.
- "Clipping":
  Clipping reduces the peak power of the output multicarrier signal. The clipped peak power level is the sum of the RMS level of the unclipped multicarrier signal and the parameter "Target Crest Factor".
  Because clipping also reduces the RMS level, the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".
- "Target Crest Factor":
  Sets the target crest factor. A value above the crest factor of the unclipped multicarrier signal has no effect.
- "Filter Cut Off Frequency":
  This frequency is the lowpass filter frequency. If the cutoff frequency equals half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal. But lowpass filtering can also increase the resulting crest factor.

4.9.3 Multicarrier settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Carrier".

The "ARB: Multi Carrier" dialog opens. It provides general settings to configure the carrier distribution around the center frequency and to improve the output signal characteristics.
The tab "Carrier Table" allows selecting a waveform file per carrier. Use the "Carrier Graph" to visualize the configured signal.

The remote commands to define these settings are described in "Multicarrier commands" on page 734.

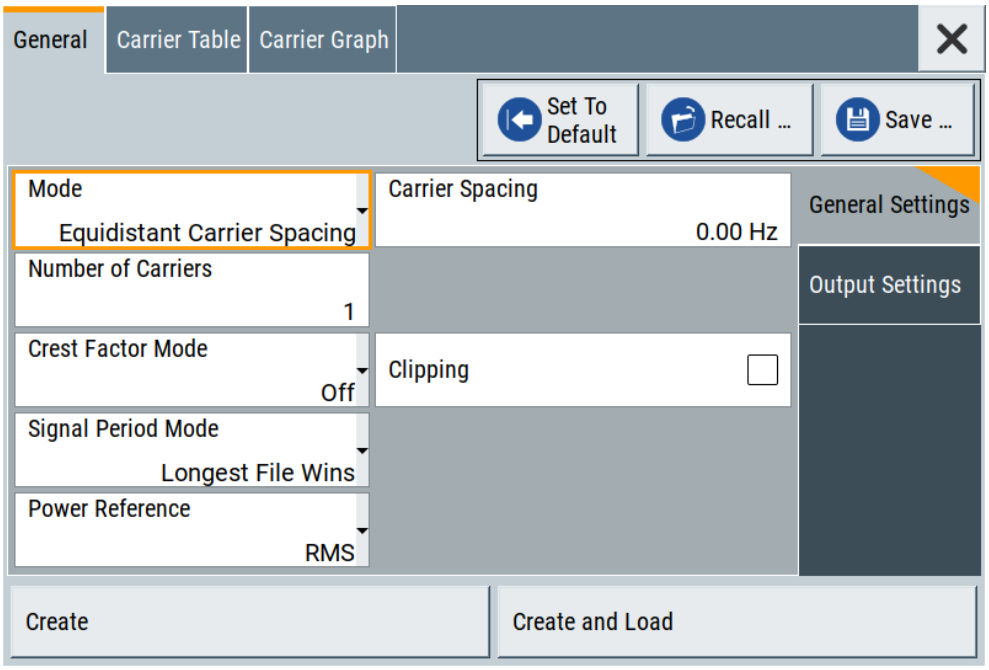
Settings:

- General settings....226
- Output settings....232
- Carrier table settings....233
- Carrier table assistant....235
- Carrier graph....238

4.9.3.1 General settings

Access:

► Select "Create Multi Carrier" > "General" > "General Settings".



This tab provides settings to select the output waveform file, to enable signal generation and to configure the distribution of the carriers.

Settings:

Set to Default 227
Save/Recall 227
Mode 227
Number of Carriers 228
Carrier Spacing 228
Crest Factor Mode 228
Clipping 228
Target Crest Factor 228
Filter Cut Off Frequency 229
Signal Period Mode 229
Signal Period Mode 229
Power Reference 230
Create/Create and Load 231

Set to Default
Calls the default settings.

Parameter	Value
"Number of Carriers"	"1"
"Carrier Spacing"	"0.00 Hz"
"Crest Factor Mode"	"Off"
"Signal Period Mode"	"Longest File Wins"

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet` on page 735

Save/Recall
Opens the standard "Save"/"Recall" dialog that is the standard instrument function for saving and recalling the complete dialog-related settings.

Save multicarrier settings in files with file extension `*.arb_multcarr`. Define the file-name and the directory of the file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?` on page 735
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD` on page 736
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe` on page 736

Mode
Selects the way that the carriers are distributed within the available bandwidth.

"Equidistant Carrier Spacing"
Sets an equidistant carrier spacing distribution, i.e. the carriers are equally spaced and centered toward the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.

"Arbitrary Carrier Frequency"
Set the carrier frequency of each carrier individually.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE on page 737

Number of Carriers
Sets the number of carriers for the multicarrier waveform. By default the multicarrier table lists one carrier. A maximum of 512 carriers can be configured and activated.

When the number of carriers is increased, new lines are added at the end of the table. If these carriers already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

See also Section 4.9.2.1, "Defining the carrier frequency", on page 224.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 736

Carrier Spacing
Sets the frequency spacing between adjacent carriers of the multicarrier waveform.

The distribution of the carriers is symmetric around the RF carrier. See also Section 4.9.2.1, "Defining the carrier frequency", on page 224.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing on page 737

Crest Factor Mode
Selects the mode for optimizing the crest factor by calculating the carrier phases. See also Section 4.9.2.2, "Optimizing the crest factor", on page 225.

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 738

Clipping
Enables baseband signal clipping.

Clipping reduces the peak power of the resulting multicarrier signal according to the input parameter "Target Crest Factor". See also, Section 4.9.2.2, "Optimizing the crest factor", on page 225.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] on page 739

Target Crest Factor
Requires "Clipping" > "On".

Sets the value of the target crest factor. A "Target Crest Factor" above the crest factor of the unclipped multicarrier signal has no effect. See also Section 4.9.2.2, "Optimizing the crest factor", on page 225.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor on page 738

Filter Cut Off Frequency
Requires "Clipping" > "On".

Sets the cutoff frequency of the lowpass filter before the output of the multicarrier signal.

See also Section 4.9.2.2, "Optimizing the crest factor", on page 225.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff on page 738

Signal Period Mode
Defines the way the resulting signal period of the multicarrier waveform is calculated. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF). Use the "Carrier Table" > "Info" function to obtain information on the sample rate and file length data of each carrier.

Note: Wrap-around and timing problems can occur when I/Q signals of different length are used. Thus, demodulation of a carrier can be difficult or even impossible.
We recommend that you proceed as follows:

- Consider the timing when creating the input I/Q files.
- Adjust the signal duration to the carrier which is then demodulated.
  Other carriers interfere with the signal.

These problems do not arise with signals of the same standard, for example, 3GPP signals.

The following modes are available:

"Longest File Wins"
: The longest I/Q file in the carrier table defines the resulting signal period. Shorter I/Q files are periodically repeated.

"Shortest File Wins"
: The shortest I/Q file in the carrier table defines the resulting signal period. Longer I/Q files only use the first part.

"User"
: Sets the signal period manually, see "Signal Period Mode" on page 229. Repeats shorter I/Q files periodically and uses only the first part of longer I/Q files.

"Least Common Multiple"
: The output file duration is the least common multiple of all input file durations.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE on page 739

Signal Period Mode
Sets the signal period in signal duration mode "User". Repeats shorter I/Q files periodically and for longer I/Q files, uses only the first part.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME on page 737

Power Reference
Sets the method of leveling individual carriers in a composed multicarrier signal. The difference between the provided modes is especially important if signals with different crest factors are composed together into a multicarrier signal.

"RMS" The individual carriers are leveled based on their RMS power and the configured "Carrier Gain".

Example:

A multicarrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multicarrier signal, the *RMS power* of the second carrier signal is 3 dB lower than the RMS power of the first carrier signal.

"Peak" The individual carriers are leveled based on their peak power and the configured "Carrier Gain".

Example:

A multicarrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multicarrier signal, the *peak power* of the second carrier signal is 3 dB lower than the peak power of the first carrier signal.

Example: Multicarrier signal composed of waveforms with different crest factor

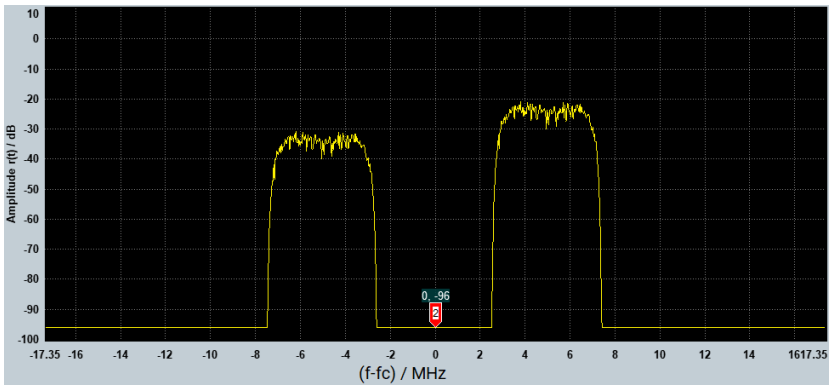
A multicarrier signal is composed from two waveform files with the following characteristics:

3GPP FDD signals with the same "Sample Rate" but *different "Crest Factors"*.

"Peak" = 0 dBFS

"Carrier Gain" = 0 dB

	State	Carrier Freq. Offs. / MHz	Gain / dB	Phase / deg	Delay / ns	File	Info	!!!
0	On	-5.000 000	0.00	0.00	0	/var/user/lte1	Info...	
1	On	5.000 000	0.00	0.00	0	/var/user/lte2	Info...	



The peak values of the carrier signals are equal, but the RMS values are different.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 739

Create/Create and Load
Creates a multicarrier waveform defined by the multicarrier table and general setting entries.

If you start the calculation with the "Create and Load" function, the instrument creates the waveform and loads it in the ARB.

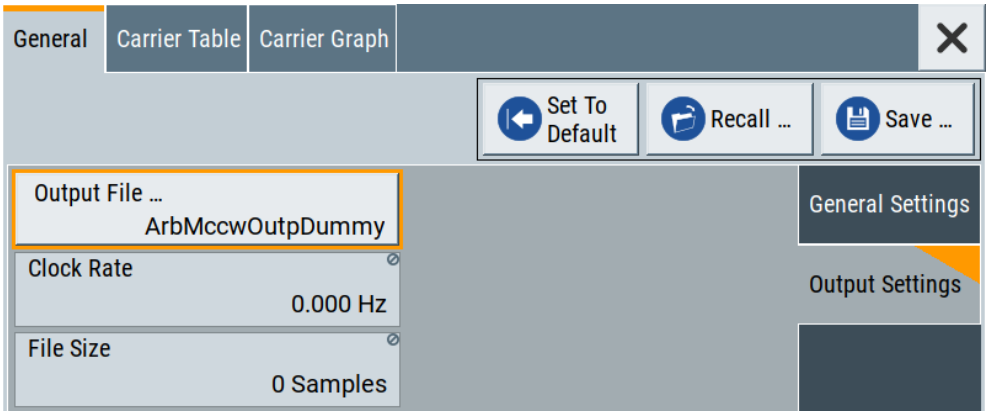
Also, saves this multicarrier waveform with filename as set in "Output File". Depending on the configuration of the multicarrier waveform, calculation can take some time. To stop the calculation, use the "Abort" function.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate` on page 740
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` on page 740

4.9.3.2 Output settings

Access:

► Select "Create Multi Carrier" > "General Settings" > "Output Settings"



This tab displays settings of the output file and related output multicarrier signal. These settings include the output filename, the clock rate and the file size.

Settings:

Output File....232
Clock Rate....232
File Size....233

Output File
Opens a standard "File Select" dialog to set the output filename of the multicarrier waveform to be calculated. As with normal waveforms, the file extension is `*.wv`.

To trigger the calculation and storage of this multicarrier waveform, select "Create" or "Create and Load".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe` on page 740

Clock Rate
Displays the resulting sample rate during the output of the multicarrier waveform is output at the ARB.

The output clock rate depends on the following:
- Number of carriers

- Carrier spacing
- Input sample rate of the leftmost or rightmost carriers.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk? on page 740

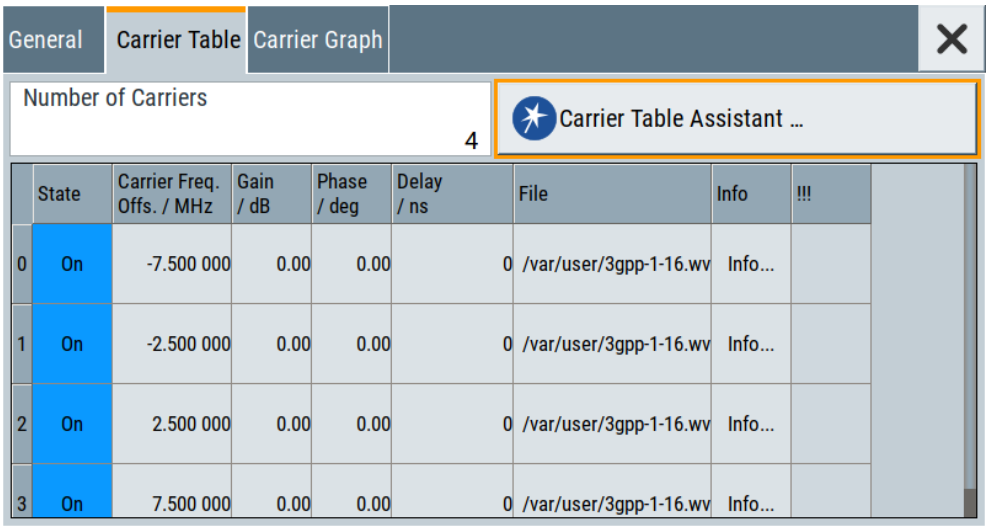
File Size
Displays the resulting number of samples of the multicarrier waveform.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles? on page 737

4.9.3.3 Carrier table settings

Access:

► Select "Create Multi Carrier" > "Carrier Table"



This tab provides the settings to configure the number of carriers and set individual carrier characteristics in a table. The number of lines equals the number of carriers. Note that valid phase settings "Phase (deg)" require disabled crest factor optimization: "Crest Factor Mode" > "Off".

Optionally, use the "Carrier Table Assistant" for simplified configuration of the individual carriers, see Section 4.9.3.4, "Carrier table assistant", on page 235. Use the "Carrier Graph" tab to visualize the configured multicarrier signal including its individual carriers, see Section 4.9.3.5, "Carrier graph", on page 238.

Settings:

Number of Carriers....234
Carrier number....234
State....234
Carrier Freq. Offs. (MHz)....234
Gain (dB)....234

Phase (deg)....234
Delay (ns)....234
File....235
Info....235
!!!....235

Number of Carriers
Defines the number of carriers of the multicarrier waveform, see "Number of Carriers" on page 228.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 736

Carrier number
Displays the number of an individual carrier. The numbering of these carriers ranges from 0 to the number of carriers - 1.

Remote command:
Set via suffix `CARRier<ch>`.

State
Enables an individual carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe` on page 741

Carrier Freq. Offs. (MHz)
Displays the carrier frequency offset. This offset indicates

Note: The carrier frequency can only be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency` on page 741

Gain (dB)
Sets the gain of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer` on page 742

Phase (deg)
Sets the starting phase of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe` on page 741

Delay (ns)
Sets the starting delay of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay` on page 742

File
Opens the standard "File Select" function for selecting the input file. The input file contains the I/Q signal that is modulated onto the carrier.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE on page 742

Info
Opens a waveform information dialog. This dialog lists the sample rate, the number of I/Q value pairs (number of samples) and the signal period.

Remote command:
n.a.

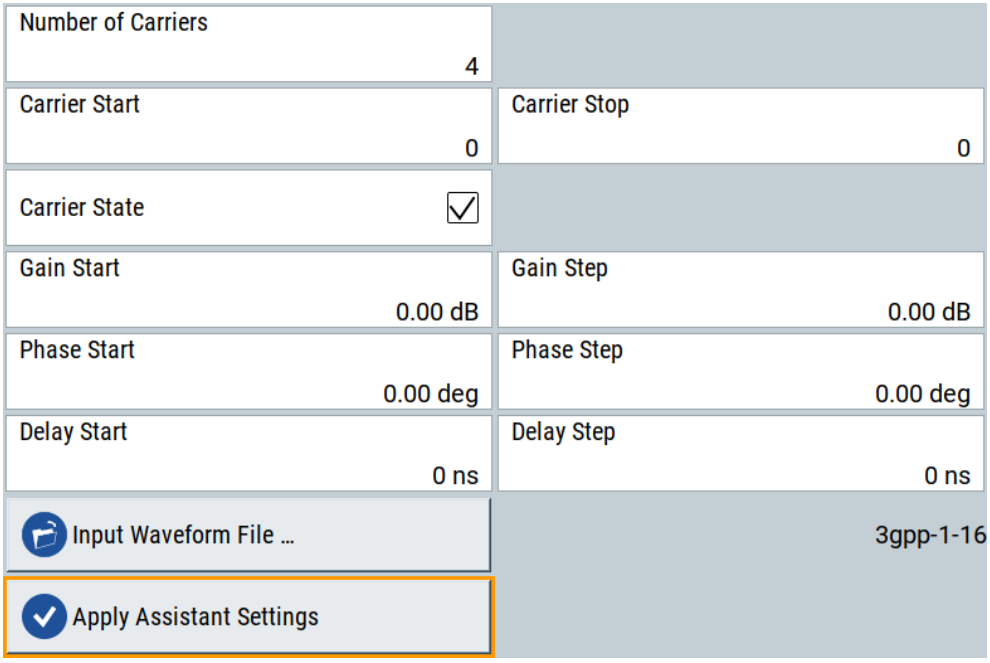
!!!
Indicates a conflict with a warning triangle. A conflict arises when the carriers overlap and is also indicated in the header of the "Carrier Table" tab.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?
on page 742

4.9.3.4 Carrier table assistant

Access:

1. Select "Create Multi Carrier" > "Carrier Table"
2. Select "Carrier Table Assistant".



The "Carrier Table Assistant" dialog enables the configuration of a selectable subset of carrier. The provided settings are an optional way to create a multicarrier scenario within a specified carrier range.

Settings:

Carrier State....236
Carrier Start....236
Carrier Stop....236
Gain Start....236
Gain Step....236
Phase Start....237
Phase Step....237
Delay Start....237
Delay Step....237
Input Waveform File....237
Apply Assistant Settings....237

Carrier State
Enables the carriers in the range "Carrier Start" to "Carrier Stop".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe` on page 743

Carrier Start
Sets the carrier start that is the first individual carrier for which the carrier assistant settings apply.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 743
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 743

Carrier Stop
Sets the carrier stop that is the last individual carrier for which the carrier assistant settings apply.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 743
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 743

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 744

Gain Step
Sets the step size that is used to increment the gain.

The resulting carrier gain in the carrier table equals:

Gain = "Gain Start" + n"Gain Step"*.

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP
on page 743

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 744

Phase Step
Sets the step size that is used to increment the phase.

The resulting phase in the carrier table equals:

Phase = "Phase Start" + n"Phase Step"*

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP
on page 744

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 745

Delay Step
Sets the step size that is used to increment the delay.

The resulting delay in the carrier table equals:

Delay = "Delay Start" + n"Delay Step"*,

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP
on page 745

Input Waveform File
Opens the standard "File Select" function for selecting the input file. The input file contains the I/Q modulation signal for all carriers of the selected carrier range.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE on page 746

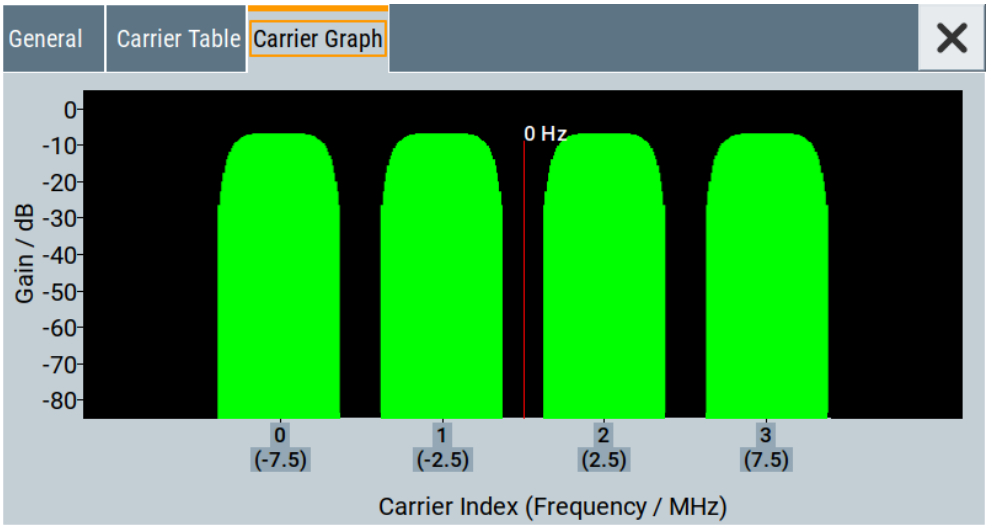
Apply Assistant Settings
Transfers the assistant settings to the carrier table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute
on page 746

4.9.3.5 Carrier graph

Access:

► Select "Create Multi Carrier" > "Carrier Graph".



The carrier graph is a graphical representation of the current multicarrier configuration in the frequency domain.
The height of the bars corresponds to the gain of each individual carrier. The bars width indicates the bandwidth of the carriers signals.

4.9.4 Using the multicarrier function

This section provides step-by-step instructions on how to configure and use the multicarrier settings.

To create a multicarrier waveform file

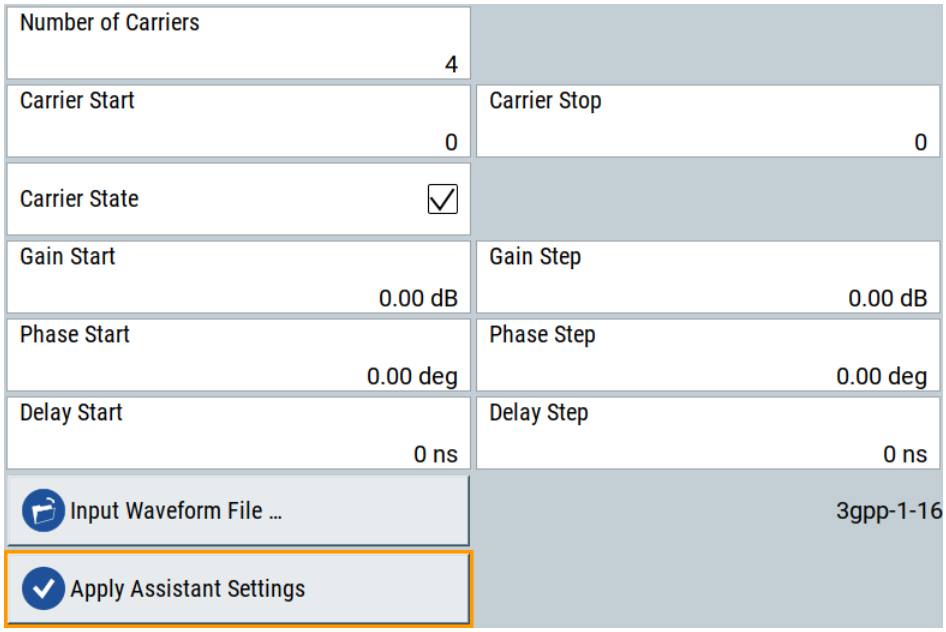
1. To configure the general settings, select "Baseband" > "ARB" > "General".
2. To configure the carrier table, select "ARB" > "Multi Carrier" > "Carrier Table"
3. To enter the filename of the multicarrier waveform, select "ARB" > "Multi Carrier" > "Output File"
4. To save or load a multicarrier waveform, select "ARB" > "Multi Carrier" > "Create" or "Create and Load".

To generate a multicarrier signal for standard transmitter tests

High-power amplifiers of multicarrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance.

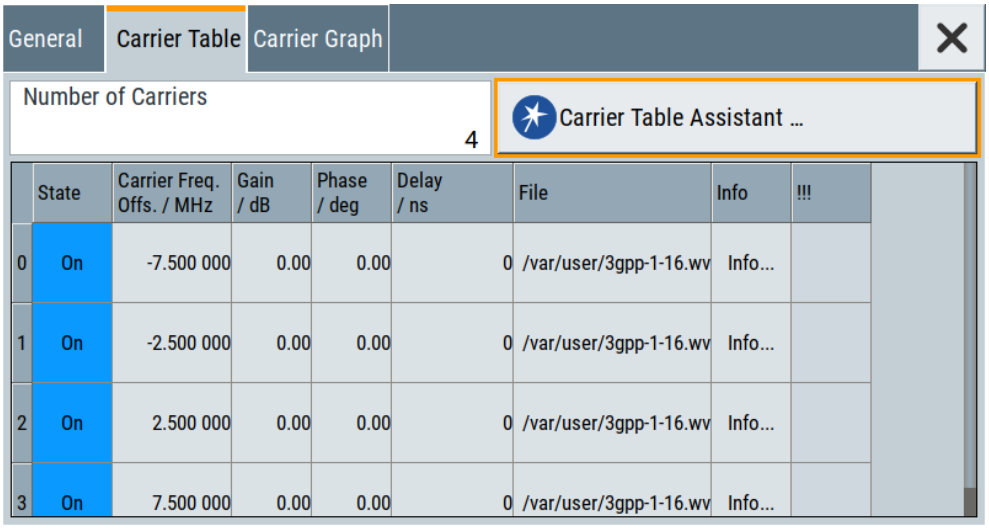
To set up a standard transmitter test, proceed as follows:

1. Open the "Baseband" > "3GPP FDD" dialog. Proceed as follows:
   a) Select "3GPP FDD" > "Basestations" > "Test Setups/Models".
   b) Select "3GPP FDD: Downlink/Test Model" > "Test_Model_1_16channels".
   c) To confirm, tap "Select".
2. To enable signal generation, select "3GPP FDD" > "General" > "On".
3. To create a 3GPP ARB file, select "3GPP FDD" > "Generate Waveform".
   Enter the name of the waveform that you want to generate, for example: `3gpp_1_16`.
4. Confirm with "Save"
5. To set up a multicarrier scenario with 4 carriers and a carrier spacing of 5 MHz, select "Baseband" > "ARB" > "Create Multi Carrier".
   Perform the following:
   a) In the "General" dialog, select "Number of Carriers" = "4" and "Carrier Spacing" = "5 MHz".
   b) To load the generated waveform file to all 4 carriers, select "Carrier Table" > "Carrier Table Assistant".
   c) Select "Carrier Start" = "0" and "Carrier Stop" = "3".
   d) To load the generated waveform file to all 4 carriers, select "ARB Multi Carrier Table" > "Input Waveform File".
   e) Select the generated waveform file `3gpp_1_16`.
   f) Select "ARB Multi Carrier Table" > "Carrier State" > "On".

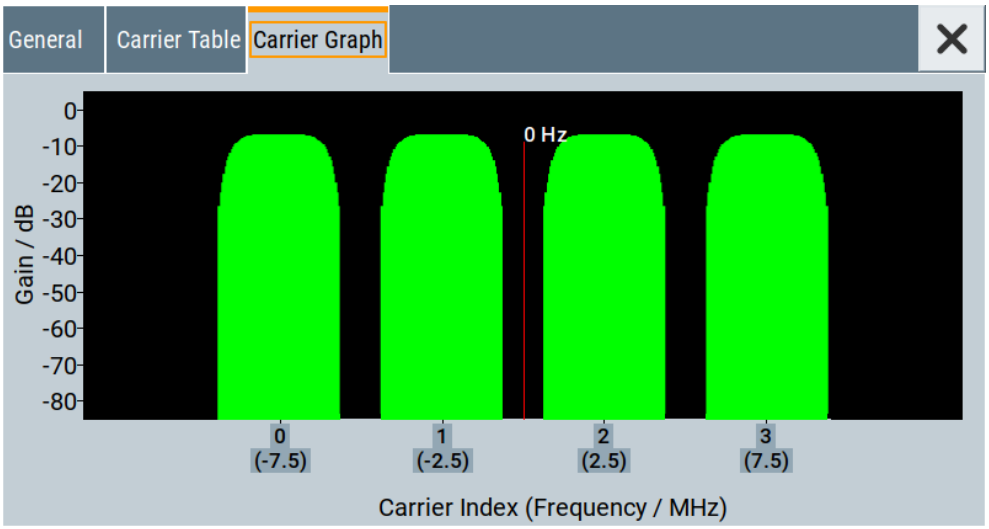


   g) Select "ARB Multi Carrier Table" > "Apply Assistant Settings".
   h) Close the dialog.

   The "ARB: Multi Carrier" > "Carrier Table" dialog confirms the configuration.



6. Select "ARB: Multi Carrier" > "Carrier Graph" to visualize the configuration.



7. Select "ARB: Multi Carrier" > "General" > "Output Settings" > "Output File".
8. Enter the name of the output file, for example `4x5MHz_3gpp_1_16`.
9. To load the waveform in the ARB, select "ARB: Multi Carrier" > "General" > "Create" or "Create and Load".
10. Select "ARB" > "General" > "Load Waveform", to select the multicarrier output file.
11. Select "ARB" > "State" > "On" to enable the ARB.

4.10 Generating FM/PhiM/AM/Pulse Modulation signals

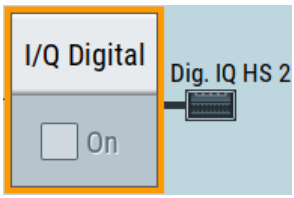
Required options

Additional to the minimum configuration, generating "FM"/"Phi(Φ)M"/"AM"/"Pulse Modulation" signals at the R&S SMCV100B requires additional options:

- Option Basic AM/FM/PhiM (R&S SMCVB-K197)
- Option Pulse Modulation (R&S SMCVB-K198)

Signal routing to the instrument output

You can output "FM"/"Phi(Φ)M"/"AM"/"Pulse Modulation" signals at the RF output connector. Routing to these signals to the digital I/Q output interface is not possible, the "I/Q Digital" block is not configurable.



Settings:

- FM/PhiM/AM configuration and settings 241
- Pulse modulation configuration and settings 245

4.10.1 FM/PhiM/AM configuration and settings

Option: R&S SMCVB-K197

Access:

► Select "Baseband > FM/ΦM/AM".

The dialog provides settings to generate digital baseband signals for frequency modulation (FM), phase modulation (PhiM/ΦM) and amplitude modulation (AM). You can generate FM and AM signals and ΦM and AM signals in parallel. FM and ΦM cannot be generated at the same time. Activating the FM state deactivates the ΦM state and vice versa.

Settings:

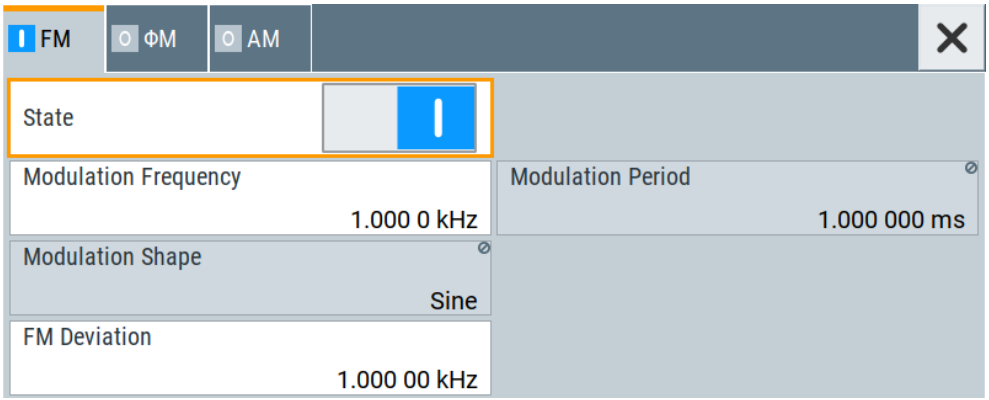
- FM settings 241
- PhiM settings 243
- AM settings 244

4.10.1.1 FM settings



Access:

1. Select "Baseband > FM/ΦM/AM > FM".
2. If enabled, the baseband block displays "FM > On".



The tab provides settings necessary to configure basic frequency modulation.

The remote commands required to define these settings are described in "FM commands" on page 756.

Settings:

State....242
Modulation Frequency....242
Modulation Period....242
Modulation Shape....242
FM Deviation....243

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
`[:SOURce<hw>]:BB:GENeral:FM[:STATe]` on page 757

Modulation Frequency
Sets the frequency of modulation signal.

Remote command:
`[:SOURce<hw>]:BB:GENeral:FM:FREQuency` on page 756

Modulation Period
Displays the period of the modulation signal.

Remote command:
`[:SOURce<hw>]:BB:GENeral:FM:PERiod` on page 756

Modulation Shape
Displays the shape of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:FM:SHAPe on page 757

FM Deviation
Sets the frequency modulation deviation in kHz.

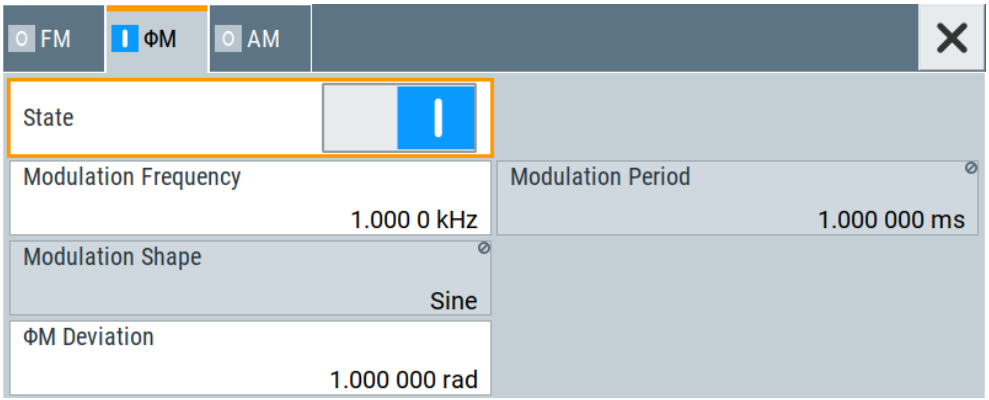
Remote command:
[:SOURce<hw>]:BB:GENeral:FM:DEViation on page 756

4.10.1.2 PhiM settings



Access:

1. Select "Baseband > FM/ΦM/AM > ΦM".
2. If enabled, the baseband block displays "ΦM > On".



The tab provides settings necessary to configure basic phase modulation.

The remote commands required to define these settings are described in "PM commands" on page 759.

Settings:

State....243
Modulation Frequency....243
Modulation Period....244
Modulation Shape....244
PhiM Deviation....244

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM[:STATe] on page 760

Modulation Frequency
Sets the frequency of modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:FREQuency on page 759

Modulation Period
Displays the period of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:PERiod on page 759

Modulation Shape
Displays the shape of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:SHAPe on page 760

PhiM Deviation
Sets the deviation of the phase modulation ΦM in radians or degrees.

The maximal deviation depends on the RF frequency and the selected modulation mode. The value is clipped automatically, if the set is too high for the particular frequency.

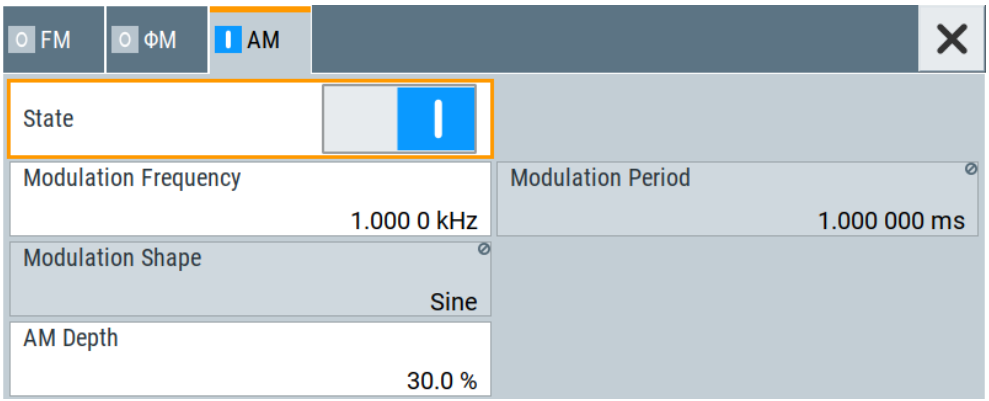
Remote command:
[:SOURce<hw>]:BB:GENeral:PM:DEViation on page 759

4.10.1.3 AM settings



Access:

1. Select "Baseband > FM/ΦM/AM > AM".
2. If enabled, the baseband block displays "AM > On".



The tab provides settings necessary to configure basic amplitude modulation.

The remote commands required to define these settings are described in "AM commands" on page 757.

Settings:

State....245
Modulation Frequency....245
Modulation Period....245
Modulation Shape....245
AM Depth....245

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
`[:SOURce<hw>]:BB:GENeral:AM[:STATe]` on page 759

Modulation Frequency
Sets the frequency of modulation signal.

Remote command:
`[:SOURce<hw>]:BB:GENeral:AM:FREQuency` on page 758

Modulation Period
Displays the period of the modulation signal.

Remote command:
`[:SOURce<hw>]:BB:GENeral:AM:PERiod` on page 758

Modulation Shape
Displays the shape of the modulation signal.

Remote command:
`[:SOURce<hw>]:BB:GENeral:AM:SHAPe` on page 758

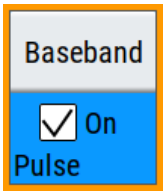
AM Depth
Sets the depth of the modulation signal in percent.

The depth is limited by the maximum peak envelope power (PEP).

Remote command:
`[:SOURce<hw>]:BB:GENeral:AM:DEPTh` on page 757

4.10.2 Pulse modulation configuration and settings

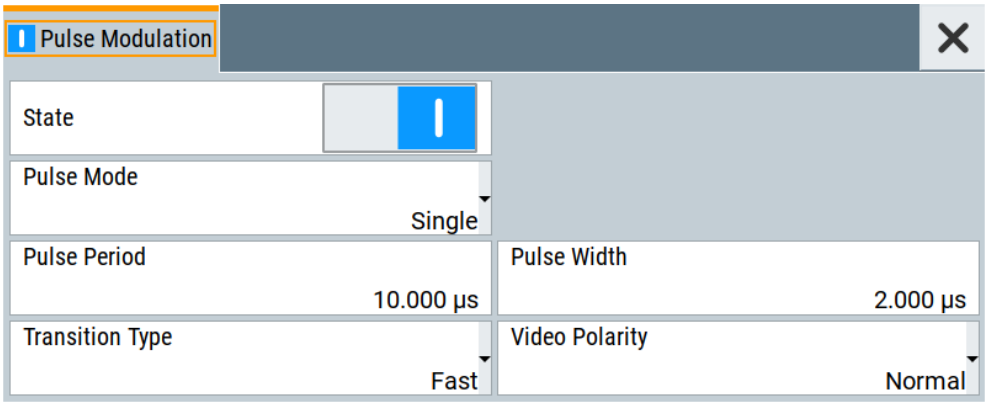
Option: R&S SMCVB-K198



Access:

1. Select "Baseband > Pulse Modulation".

2. If enabled, the baseband block displays "Pulse > On".



The tab provides settings necessary to configure pulse modulation.

The remote commands required to define these settings are described in "PULM commands" on page 760.

Settings:

State....246
Pulse Mode....246
Pulse Period....246
Pulse Width....247
Double Pulse Delay....247
Double Pulse Width....247
Transition Type....247
Video Polarity....247

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM[:STATe]` on page 762

Pulse Mode
Sets the pulse mode.

"Double" The signal consists of a double pulse.

"Single" The signal consists of a single pulse.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:MODE` on page 761

Pulse Period
Sets the pulse period in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:PERiod` on page 761

Pulse Width
Sets the pulse width in microseconds.

Remote command:
[:SOURce<hw>]:BB:GENeral:PULM:WIDTh on page 762

Double Pulse Delay
Requires "Pulse Mode > Double".

Sets the double pulse delay in microseconds.

Remote command:
[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay on page 760

Double Pulse Width
Requires "Pulse Mode > Double".

Sets the double pulse width in microseconds.

Remote command:
[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh on page 761

Transition Type
Sets the transition type of the pulse modulation signal that is the slew rate (slope).

"Smooth" Flattens the slew rate, resulting in longer rise/fall times. Use this mode if you are working with devices that are sensitive to steep slopes.

"Fast" Enables fast transitions with short rise and fall times.

Remote command:
[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE on page 761

Video Polarity
Defines the video polarity.

"Normal" The pulse has normal video polarity.

"Inverse" The pulse has inverted video polarity.

Remote command:
[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity on page 762

4.11 Shifting the baseband signal

The R&S SMCV100B provides settings to offset the frequency or phase of a baseband signal.

4.11.1 About baseband offsets

The applied baseband frequency and phase offset and path gain affect the signal on the output of the corresponding block, "Baseband" or "BB Input". The shifting of the central frequency of the baseband signal is one of the tasks of the resampler.

4.11.1.1 Impact of the frequency offset

For some applications, it is helpful to shift the baseband signal with a user-defined baseband frequency offset to a different center frequency to improve signal characteristics.

The frequency-offset function shifts the center frequency of the wanted baseband signal. The function also provides a quick way to shift the used frequency band in the RF frequency domain without modifying the RF settings.

See Section 4.11.3, "Improving signal characteristics by shifting the baseband signal", on page 251.

Limitations

The complex I/Q bandwidth of the shifted signal cannot exceed the total available baseband bandwidth. The setting range of the frequency offset is then calculated as follows:

$-(TotalBasebandBandwidth/2) + f_{use}/2 \leq f_{offset} \leq (TotalBasebandBandwidth/2) - f_{use}/2$,
where the following applies:

f_{use} is the complex useful bandwidth of the I/Q signal before the offset

f_{offset} is the frequency offset

The Figure 4-31 illustrates the setting range of the frequency offset.

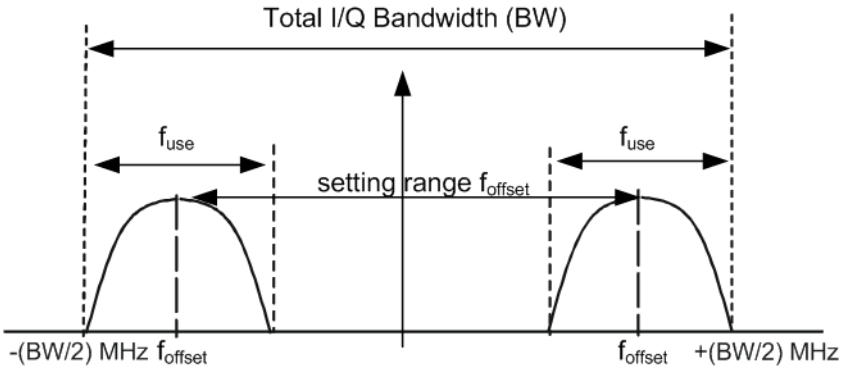


Figure 4-31: Setting range of frequency offset

For more information, refer to the specifications document.

Example: To calculate the maximum frequency offset

This example uses the following signal:

- Standard: "Baseband" > "Custom Digital Mod"
- "Set according to Stanard" > "WCDMA-3GPP"
- "Symbol Rate" = "3.84 Msym/s" or 3.84 MHz
- "Filter" > "Root Raised Cosine (RRC)"
- "Roll Off Factor" = "0.22"

The complex useful bandwidth of a filtered signal is calculated as follows (see "Impact of the filter parameters" on page 94):

- f_{use} = *(1 + "Roll Off Factor") * "Symbol Rate"*
- f_{use} = (1+ 0.22) * 3.84 MHz = 4.6848 MHz

For an instrument with a total available I/Q bandwidth of 160 MHz, the valid range of values for the frequency offset is then:

- -160 MHz/2 + 4.6848 MHz/2 ≤ f_{offset}≤ 160 MHz/2 - 4.6848 MHz/2 or
- -77.6576 MHz ≤ f_{offset}≤ 77.6576 MHz

To observe the effect of offsetting the frequency

Use the built-in real-time graphical display. Select "System Config" > "Graphics" > "Power Spectrum" and observe the power spectrum of the signal with and without frequency offset.

See "To set and verify a baseband frequency offset" on page 406.

4.11.1.2 Impact of the phase offset

The "Phase Offset" determines the phase offset between the different baseband signals. A phase offset rotates each point of an I/Q constellation diagram by the specified phase offset.

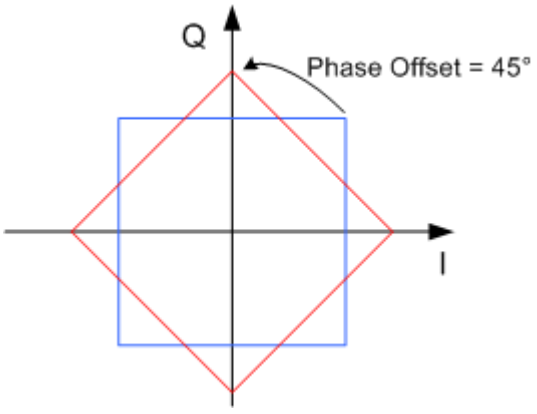


Figure 4-32: I/Q constellation diagram: Effect after offsetting the phase by an angle of 45 °

To observe the effect of offsetting the phase

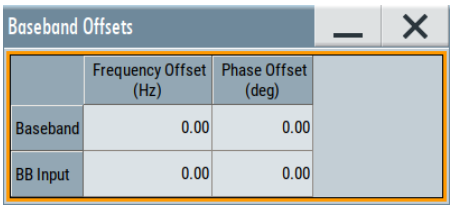
Use the built-in real-time graphical display. Select "System Config" > "Graphics" > "Constellation" and observe that the points on the I/Q constellation diagram are turning counterclockwise.

See Section 9, "Monitoring baseband signal characteristics", on page 392.

4.11.2 Baseband offset settings

Access:

► Select "Baseband"/"BB Input" > "Baseband Offsets".



The "Baseband Offsets" dialog provides settings to offset the frequency or phase of the baseband signal.

The block diagram shows an icon Δf on the signal path. This icon indicates an enabled frequency offset.

Settings:

Frequency Offset
Sets the frequency offset of the baseband signal and shifts the useful baseband signal in the center frequency.

Use this function, for example, to shift the baseband signal relative to an AWGN signal.

See also the following sections:
- Section 4.11.3, "Improving signal characteristics by shifting the baseband signal", on page 251
- Section 4.11.3, "Improving signal characteristics by shifting the baseband signal", on page 251

Remote command:
`[:SOURce<hw>]:BB:FOFFset` on page 681
`[:SOURce<hw>]:BBIN:FOFFset` on page 681

Phase Offset
Sets the phase offset for a baseband signal. This phase offset affects the signal after the "Baseband" block.

Use this parameter, for example, to change the start phase of the baseband signal.

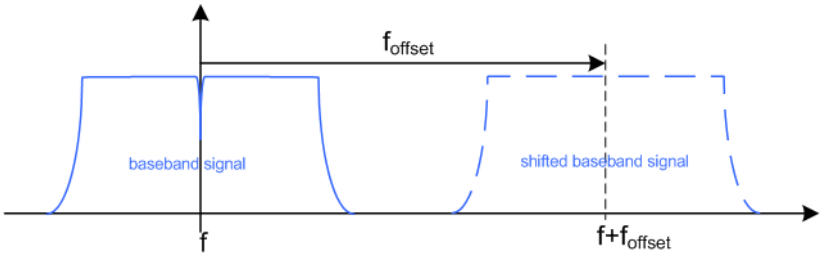
See also Section 4.11.1.2, "Impact of the phase offset", on page 249.

Remote command:
[:SOURce<hw>]:BB:POFFset on page 681
[:SOURce<hw>]:BBIN:POFFset on page 681

4.11.3 Improving signal characteristics by shifting the baseband signal

Shifting of the generated baseband signal is useful in the following cases:

- You analyze the generated signal with a signal analyzer and the displayed signal spectrum indicates a carrier leakage (a signal drop) at the current RF frequency.



  Shifting the baseband signal to a different center frequency can eliminate the carrier leakage problem.

In the following examples, we assume that:

- The R&S SMCV100B generates a baseband signal
- A spectrum analyzer is connected to the R&S SMCV100B, the analyzed is configured and measures the required signal characteristics.

To shift the generated baseband signal

1. Select "Baseband" > "Baseband Offsets".
2. To apply an offset to the baseband signal, select for example "Frequency Offset" = "10 MHz".

To verify characteristics of the generated signal

► Use the built-in real-time graphical display.
See Section 3.3.5, "Verifying the generated signal", on page 52.

To observe the effect of applied frequency offset and gain

► Use the built-in real-time graphical display.
See Section 3.3.5, "Verifying the generated signal", on page 52.

5 Configuring external baseband signals

R&S SMCV100B is rarely used as a standalone instrument. Usually, the instrument is connected to a device under test (DUT) or other measurement equipment.

Test setups have different requirements, for example:

- Test setups comprising two or more instruments often require a common reference frequency.
- Generation of beamforming signals requires phase coherent signals.
- Some test setups also require control of the signal generation start and an exact generation start time, for example determined by a defined trigger event.
- In other cases, you would need time-aligned simultaneous signals between multiple instruments.
- etc.

R&S SMCV100B provides several settings that help fulfilling these requirements. This section explains main principles and gives an overview of the related settings and step-by-step instructions.

- Overview of the input and output signals and interfaces 252
- System configuration settings 257
- Digital baseband input settings 270
- I/Q digital output settings 275
- Generating time-aligned baseband signals 281

5.1 Overview of the input and output signals and interfaces

Designed as a signal generator with various application fields, the R&S SMCV100B uses a hardware concept that enables you to define and customize some of the input and output signals and interfaces. Depending on the configuration, digital interfaces can be used as input or output connectors. The different logical settings of the same physical interface are grouped in different dialogs.

Logical signals, streams and channels at the interfaces

This section provides **background information** and introduction to the topics. For an overview of the interfaces and their characteristics, refer to:

- Section 5.1.1, "Overview of the baseband signal sources", on page 253
- Section 5.1.2, "Overview of the baseband and RF output signals", on page 253
- Section 5.1.4, "Important signal parameters and interface characteristics", on page 254

5.1.1 Overview of the baseband signal sources

The Table 5-1 gives an overview of the available input signals and the connectors they are supplied at. Any of the specified input signals can be processed by the I/Q modulator and output at the RF outputs.

Table 5-1: Physical input signals

Type	Input signal	Input connector	GUI element	Refer to
BB	Internal digital signal	-	"Baseband"	Section 4, "Configuring internal baseband signals", on page 73
BB	External digital signal	Dig. IQ HS 1	"BB Input"	Section 5.3, "Digital baseband input settings", on page 270

Input interface for the external digital baseband signal

The digital interface Dig. IQ HS 1 can be used as input for digital signals. The interface provides direct communication with other Rohde & Schwarz instruments, like:

- Signal generators
- R&S FSW signal and spectrum analyzer
- R&S IQW I/Q wideband recorder

Application examples of the externally supplied digital baseband signal

Provided the instrument is equipped with the required options, the externally applied signals can be used for and further processed as follows:

- Used as a standalone baseband source and processed separately, e.g. detuned, or loaded with noise or directly applied to the I/Q modulator
- Used as a user-specific signal **instead of** the internally generated signal

5.1.2 Overview of the baseband and RF output signals

As shown in Table 5-2, the R&S SMCV100B can output the digital baseband signal at the digital I/Q interface Dig. IQ HS 2 or at the analog RF output connector RF 50 Ω.

Table 5-2: Physical output signals

Type	Output signal	Output connector	GUI element	Refer to
RF	RF signal	RF 50 Ω	"RF"	Section 8, "Configuring the RF signal", on page 307
BB	Digital signal	Dig. IQ HS 2	"I/Q Digital" Dig. IQ HS 2	Section 5.4, "I/Q digital output settings", on page 275

You can only use one output at a time, see Section 5.1.3, "Interdependencies", on page 254.

5.1.3 Interdependencies

The following functions deactivate each other. You can only use one of these functions at a time:

- The internal baseband generator ("Baseband" block) and the external digital baseband input ("BB Input" block)
- The RF output ("RF" block) and the digital I/Q output ("I/Q Digital" block)

5.1.4 Important signal parameters and interface characteristics

Correct signal processing of the externally supplied input signals in the instrument and correct processing of the output signal in the next connected instrument require information of signal parameters. These signal parameters are sampling rate, crest factor and signal level, expressed as peak or as RMS level value.

Sample rate

The sample rate of the digital input and output signal can be defined manually or automatically retrieved from the input and estimated for the output signal. The bandwidth and thus the sample rate of the digital input signal is not limited by the installed sample rate options.

For more information, refer to the specifications document.

Crest factor

According to its definition, the crest factor gives the difference in level between the peak level and RMS level value in dB (see Figure 5-1).

The R&S SMCV100B uses the crest factor to calculate the power levels that is the instrument compensates the RMS levels of the externally supplied signal by the crest factor. For example, the crest factor of the external signal is important for the calculation of the RF output power.



Figure 5-1: Relation between the level settings

Test setups often involve an upconverter connected to the I/Q connectors of the generator or feeding of external signal to the digital input of the R&S SMCV100B. As a rule, whenever an I/Q signal is transferred between two instruments, *the crest factor and the peak levels of the two involved instruments have to be coordinated*.

To ensure proper signal settings and correct results, check if the peak level values and crest factor values are equal. Equal values hold for the I/Q outputs of the R&S SMCV100B and the I/Q inputs of the upconverter are equal.

In the R&S SMCV100B, level values are represented as relative to full-scale values (see Figure 5-1).

Where to find the necessary values

- Dialog "BB Input"
  Section 5.3, "Digital baseband input settings", on page 270
- Dialog "Digital I/Q Out"
  Section 5.4, "I/Q digital output settings", on page 275

Avoiding overflow of the input signal and output signal

The R&S SMCV100B constantly monitors the input and output digital signal and indicates an overflow status.

- Overflow of the **input signal** (crest factor and peak level) is indicated if the entered "Peak Level" (in dBFS) value does not correspond to the real value
  Tip: The overflow status is indicated as long as the signal level is not reduced and the peak level value corrected. Trigger "Auto Level Set" to collect the required values and adjusts the settings automatically.
- Overflow of the **output signal** is indicated if the digital signal is clipped, i.e. if the level of the output signal, or the noise level (AWGN) are too high.

5.1.4.1 Specifics of the digital I/Q interfaces

Mapping digital channels to the baseband signal path

The external digital signals supplied at the Dig. IQ HS x interfaces of the instrument can contain more than one, possibly even multiplexed, digital channels. The R&S SMCV100B processes each of these digital channels as a separate signal.

Signal processing prerequisites for external baseband signals

This section focuses on the way that these requirements are fulfilled and explains how the instrument deals with signals deviating from the expected values:

- **Crest factor peak level and RMS level**

  These values can be adjusted in one of the following ways:

  – Adjusted manually
    If you have knowledge about these values, enter them directly.
  – Estimated automatically by the internal measurement function
    Use the function Auto Level Set to trigger the R&S SMCV100B to measure the input signal, estimate the peak level and RMS level and calculate the crest factor out of them.
    Tip: For a correct signal leveling:
    1) Enable an appropriate measurement time.
    2) Execute one measurement for each baseband source.
    3) Set the measurement period to a time value that is long enough to capture several periods of the input signal.

– Determined automatically
The R&S SMCV100B can receive the values from the connected transmitter. If the external digital signal source is a second Rohde & Schwarz instrument, it signals the peak level and the RMS level of the signal over the digital input interface. To enable the R&S SMCV100B to receive these values, enable the parameter "DIG IQ Auto Setting" on page 275.

In the second automatic way, the R&S SMCV100B adjusts the corresponding input fields with the measured/received values. The internal gain control mechanism uses these received values to adjust the input signal gain to achieve an optimal dynamic range.

- **Sample rate**
External input signals with sample rates different than the system clock are resampled, as illustrated on Figure 5-2.

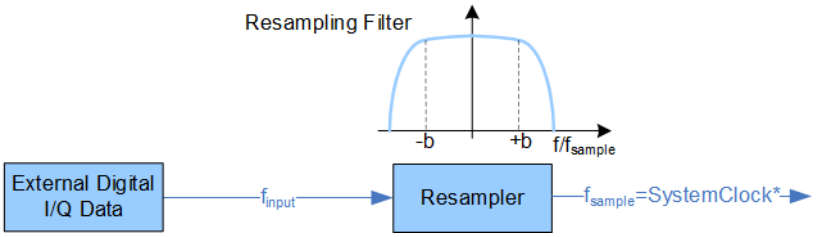


Figure 5-2: Resampling principle of external digital baseband signals

* = Max. sample rate depends on connected device
f_{input} = Max. sample rate

The R&S SMCV100B can process digital signals with sample rate f_{input} = 400 Hz to 100 MHz, where the maximum value ($f_{sample, max}$) depends on the capabilities of the connected transmitting/receiving device.

- **Maximum modulation bandwidth**
A baseband signal with a sample rate $f_{smaple} < f_{smaple, max}$ (i.e. smaller than the used system clock) is interpolated, see Figure 5-2. The resulting modulation bandwidth is calculated as *sample rate * 0.8*.
With a sample rate $f_{sample, max}$ of exactly 600 Msample/s, the modulation bandwidth is 240 MHz.

Estimating or defining the sample rate

The sample rate of the signal at the digital interface can be determined with one of the following methods:

- **Estimated sample rate**
Enable the instrument to evaluate the received I/Q data clock
- **User-defined sample rate**
Provide both the external signal source and the receiving instrument with a common external reference signal and set the sample rate value.

5.2 System configuration settings

The settings in this dialog comprise the I/Q mapping and the processing of the generated I/Q streams. Form this dialog, you can control and configure the connections to instruments connected to the RF and I/Q connectors.

Required options

The equipment layout includes:

- Base unit
- Option digital baseband outputs R&S SMCVB-K19
- Optional, option frequency R&S SMCVB-KB106

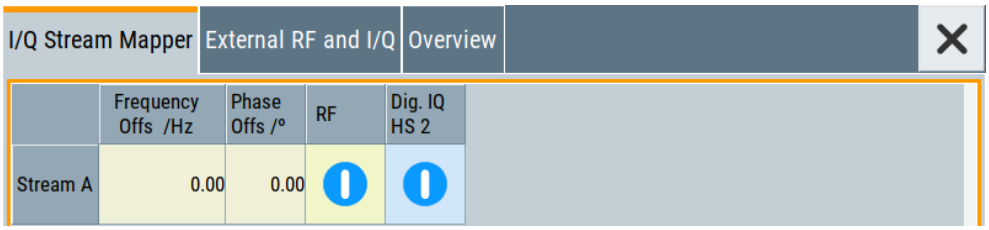
Settings:

- I/Q stream mapper settings 257
- External RF and I/Q settings 258
- External instrument configuration settings 263
- Overview 269

5.2.1 I/Q stream mapper settings

Access:

► In the block diagram, select "I/Q Stream Mapper".



The dialog provides the settings for routing of the signal streams to the available output connectors.

Settings:

Frequency Offset 257
Phase Offset 258
Map stream x to connector 258

Frequency Offset
Sets an absolute frequency offset f_{offset}.

Tip: Use this parameter to shift the used frequency band in the RF frequency section without modifying the RF settings.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset` on page 650

Phase Offset
Sets the phase offset of the corresponding stream.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset` on page 651

Map stream x to connector
The mapping of the generated stream to the output connectors is represented as a stream matrix. A blue circle at a matrix element routes the stream to the selected connector.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:RF:STReam<st>:STATe` on page 650
`:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe` on page 650

5.2.2 External RF and I/Q settings

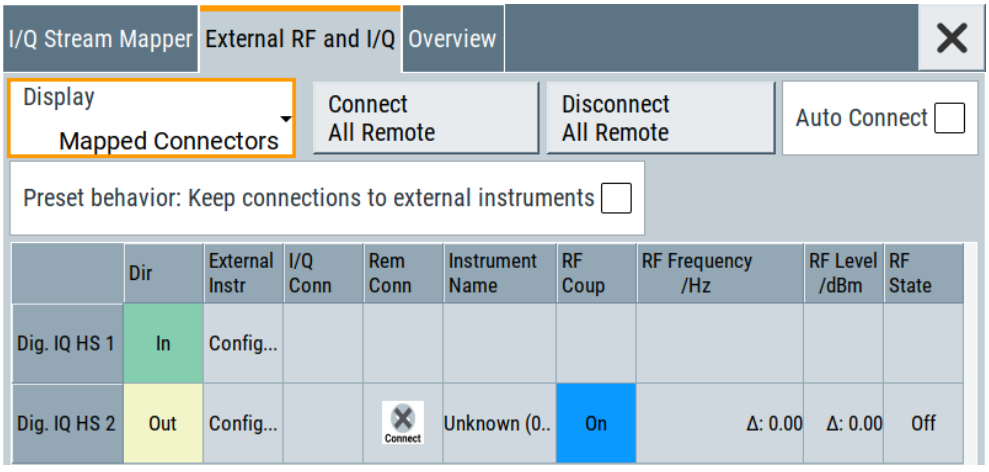
Prerequisites for connections to external instruments

Connecting external instruments to the R&S SMCV100B requires the following signals and connections.

Signal	Interface	Remark
Control	LAN or USB	The control connection is enabled.
Input Output	Analog I/Q or digital I/Q Analog I/Q, digital I/Q or RF	The physical input signal or output signal is present at the interface.
Reference	Reference input or output	The external instrument and the R&S SMCV100B have a common reference frequency signal.

Accessing the external RF and I/Q settings

► On the taskbar, select "System Config" > "System Configuration" > "External RF and I/Q".



The dialog provides an overview of all available I/Q input and output connectors and comprises the settings necessary to establish the connection to the external instruments. Displayed is an overview of the currently connected external instruments together with relevant information like the connection status and the RF level and frequency that these external instruments use.
The dialog provides access to some additional short information on each of the connected instruments. It also provides a show connector function for an easy localization of the selected connector on the instrument front or rear panel.

Settings:

Display 259
Auto Connect 259
Connect/Disconnect All Remote 260
Preset behavior: Keep connections to external instruments 260
Connector Name 260
Direction 260
External Instrument 261
I/Q Connection 261
Remote Connection Status 261
Instrument Name 262
RF Couple 262
(Delta) RF Frequency/ RF Level 262
RF State 262

Display
Filters the displayed connectors upon one of the following criteria:

"All Connectors"
No filter is applied.

"Mapped Connectors"
Displayed are only the connectors to which a stream is mapped.

Note: To prevent faults, use this filter before you further configure the external instruments.

"Input Connectors/Output Connectors"
Filters the display according to connector direction.

Remote command:
`:SCONfiguration:EXTernal:DISPlay` on page 652

Auto Connect
With enabled auto connect function, the instrument automatically detects connected external instruments and establishes the required connection.

If the "Auto Connect" > "Off", however, after a R&S SMCV100B startup you have to revise the test setup and perform the following:

- Check whether the necessary connections between the R&S SMCV100B and the external instruments are still existing.
- Prove that the remote control of the particular instruments is required.
- Select "Connect All Remote" or "Disconnect All Remote".

Remote command:
:SCONfiguration:EXTernal:ACONnect on page 652

Connect/Disconnect All Remote
Triggers the instrument to:
- Establish the remote connections to all configured external instruments.
- Terminate all existing remote connections.
  The external instruments are not removed from the list of external instruments.
  Only the remote connection status changes.

You can toggle the remote connection status with the parameter "Rem Conn".

Note:
External instruments connected to the R&S SMCV100B are preset (:DEVice:PRESet) whenever:
- The connection to the external instrument is established or terminated ("Connect/Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMCV100B is preset ([Preset]).

To ensure that the remote connections to the external instruments will be automatically established after instrument's start-up or a reboot, enable "Auto Connect > On".

Remote command:
:SCONfiguration:EXTernal:REMote:CONNect[:ALL] on page 652
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL] on page 652

Preset behavior: Keep connections to external instruments
Sets the effect of R&S SMCV100B preset ([Preset] or *RST) on the following:
- The connection status between the instrument and the connected external instruments.
- The R&S SMCV100B itself and the preset values.
- The connected instruments.

"Preset behavior..."	Off	On
R&S SMCV100B and preset values	Standard R&S SMCV100B preset See Table 11-1.	
Connection status	Terminated ("Disconnect All Remote")	Unchanged
Connected instruments	External instrument preset (:DEVice:PRESet)	External instrument preset

Remote command:
:SCONfiguration:EXTernal:PBEHaviour on page 652

Connector Name
Displays the connector name.

Remote command:
Via keyword in the SCPI syntax, e.g. HSDigital<ch>

Direction
Displays the connector direction as a color coded field.

Connector	Direction/Color	Enabled in the "I/Q Stream Mapping"
Dig. IQ HS 1	In	-
Dig. IQ HS 2	Out	Yes

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:DIRection?` on page 653

External Instrument
Opens a dialog with settings to establish the connection to the external instrument for the selected signal path.

See Section 5.2.3, "External instrument configuration settings", on page 263.

See also "Prerequisites for connections to external instruments" on page 258.

I/Q Connection
Depends on the interface type:

- Digital I/Q interfaces:
  Indicates the status of the I/Q connection of the digital interfaces.
  The indication includes a status LED and an icon for the used connector (Dig. IQ HS 1 and Dig. IQ HS 2) used.

Indication	Designation
green LED and an icon	The Dig. IQ HS 1 interface is used as an **input** connector.
yellow LED and an icon	The Dig. IQ HS 2 interface is used as an **output** connector.
No icon displayed	No connection

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe?`
on page 653

Remote Connection Status
Indicates the status of the remote connection. Click the status indicator to toggle the remote connection status.

Note:
External instruments connected to the R&S SMCV100B are preset (`:DEVice:PRESet`) whenever:

- The connection to the external instrument is established or terminated ("Connect/Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMCV100B is preset ([Preset]).

Note: An active "Rem. Conn." and an "RF State" > "On" do not mean that an I/Q stream is mapped to this connector.

Use the "System Configuration > External Rf and I/Q > Display > Mapped Connectors" filter to list only the connectors with a mapped I/Q stream.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DISConnect on page 659
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO? on page 658

Instrument Name
Displays useful information on the connected external instrument, like the instrument designation and the RF path the RF settings are coupled to.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:INAMe? on page 653
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO? on page 658

RF Couple
If enabled, this parameter couples all major RF setting (like the "RF Frequency", the "RF Level" and the "RF State") of the external instrument to the R&S SMCV100B.

The R&S SMCV100B acts as a primary instrument, i.e the external instruments synchronize their settings and the RF output state to the R&S SMCV100B. You can apply delta frequency and level offset to the signal.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:RF:COUPling on page 654

(Delta) RF Frequency/ RF Level
In uncoupled mode, sets the RF frequency and RF level of the external instrument.

With enabled "RF Coupled" parameter, applies a frequency and level offset. The RF frequency of the external instrument is calculated as follows:

$RF_{ExtInstr} = RF_{Instrument} + Delta_{Freq}$

Both the RF frequency and the RF frequency offset are applied at the external instrument.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency on page 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency:OFFSet on page 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer on page 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer:OFFSet on page 655

RF State
With enabled "RF Coupled" parameter, displays the RF output state of the connected external instrument. The parameter is coupled to the state of the RF output of the R&S SMCV100B.

In uncoupled mode, enables/disables the RF output in the external instrument.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe on page 655

5.2.3 External instrument configuration settings

Access:

1. On the taskbar, select "System Config" > "System Configuration".
2. Select "External RF and I/Q" > "External Instrument" > "Config...".

   The dialog provides settings to configure the connection to the external instrument and to control to the external instrument. Also you can find out the related connector at the R&S SMCV100B.

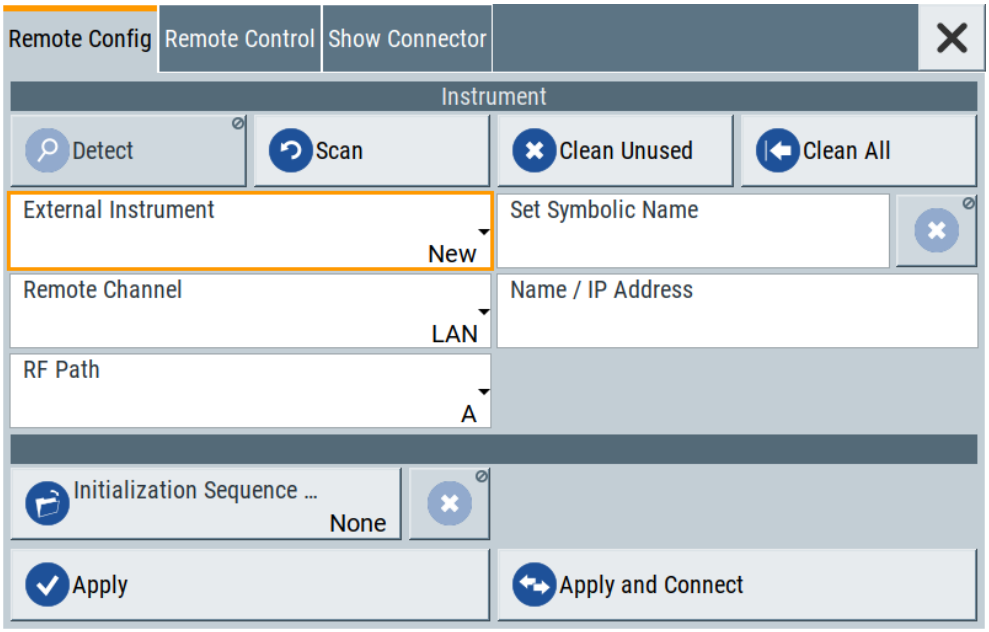
Settings:

- Remote instrument settings 263
- Remote control settings 267
- Show connector 269

5.2.3.1 Remote instrument settings

Access:

1. Select "External RF and I/Q" > "External Instrument" > "Config...".
2. Select "Remote Instrument".



The tab provides settings to configure the connection settings of the remote instrument.

Settings:

Detect....264
Scan....264
Clean Unused/Clean All....264
External Instrument....265
Set Symbolic Name....265
Remote Channel....265
Remote Channel....266
Hostname or IP Address....266
Device ID....266
RF Path....266
Initialization Sequence....266
Remove Initialization Sequence....267
Apply....267
Apply and Connect....267

Detect
Requires an external instrument connected to the digital I/Q interface of the R&S SMCV100B.

Searches for these external instruments via the LAN or USB control interface. If detected, the "External Instrument" selection lists the external instrument including its configuration for the remote control connection.

Note: The first initialization of a connection to an external instrument can last several minutes. During the initialization procedure, you cannot search for the external instrument.

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect?` on page 657

Scan
Searches for external instruments via the remote control interface, for example, via the LAN interface. If detected, the "External Instrument" selection lists the external instrument including its configuration for the remote control connection.

The R&S SMCV100B can search, for example, the following instruments:

R&S SMW equipped as wideband instrument (R&S SMW-B9)

Note: The scan function searches throughout the entire network and can last several minutes.
The first initialization of a connection to an external instrument can last several minutes. During the initialization procedure, you cannot search for the external instrument.

Remote command:
`:SCONfiguration:EXTernal:REMote:SCAN` on page 655
`:SCONfiguration:EXTernal:REMote:SCAN:STATe?` on page 655

Clean Unused/Clean All
Removes partly or fully the configuration of external instruments the R&S SMCV100B controls via the LAN interface.

This function does not affect USB control connections.

"Clean Unused"
Removes external instrument configurations from unused LAN connections. The configurations for used LAN connections remain. These connections are the enabled and configured control connections. Also, this function allows you to update the external instruments list for a new pool of valid instruments.

Remote command:
:SCONfiguration:EXTernal:REMote:PURGe on page 659

"Clean All" Disconnects and removes all connections of configured external instruments. Also removes all instruments from the list of external instruments.

Remote command:
:SCONfiguration:EXTernal:REMote:CLEan on page 660

External Instrument
Lists all available instruments, found by the Scan function.

To connect an external instrument, use one of the following:
- Enable "Select Instrument > New" and configure the settings manually
- Select "Select Instrument", navigate trough the pool of available instruments, and select the required. The required settings are retrieved and updated automatically.

Select "None" to disable the connection.

Execute "Apply" to confirm the settings.

Remote command:
:SCONfiguration:EXTernal:REMote:LIST? on page 656
:SCONfiguration:EXTernal:REMote:ADD on page 656
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect on page 657

Set Symbolic Name
Sets the alias name of the instrument.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 656
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO? on page 658

Remote Channel
Displays or selects the remote or hardware channel for control of the external instrument.

"LAN" Control via the LAN interface.

"USB" Control via the USB interface.

"Frontend Connection"
Fixed remote channel for control of external frontends via the LAN interface.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 656
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO? on page 658

Remote Channel
Displays or selects the remote or hardware channel for control of the external instrument.

"LAN" Control via the LAN interface.

"USB" Control via the USB interface.

"Frontend Connection"
Fixed remote channel for control of external frontends via the LAN interface.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 656
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 658

Hostname or IP Address
Displays or sets the hostname or IP address of the connected external instrument.

See also "Prerequisites for connections to external instruments" on page 258.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 656
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 658

Device ID
Sets/displays the device identifier that is a unique string with the following structure:

`<frontend type>-<serial number>`

For a defined "External Instrument", the information is read out automatically.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 656

RF Path
In a two-path instrument, determines the RF output to be used.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 656
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 658

Initialization Sequence
Accesses the standard "File Select" dialog for loading an existing initialization file (extension `*.iec`).

When you establish the connection to an external instrument ("Rem Conn" is active), the R&S SMCV100B performs the following:

- Sends the command `:DEVice:PRESet`
- Sends the content of the initialization sequence file to reconfigure the external instrument

If necessary, perform further settings and configuration of the external instruments.

Remote command:
:SCONfiguration:EXTernal:REMote:INITialization:CATalog?
on page 659
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INITialization:FILE on page 659

Remove Initialization Sequence
Deletes the loaded sequence.

Apply
Confirms the settings and displays the external instrument in the "External RF and I/Q" dialog.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect on page 657

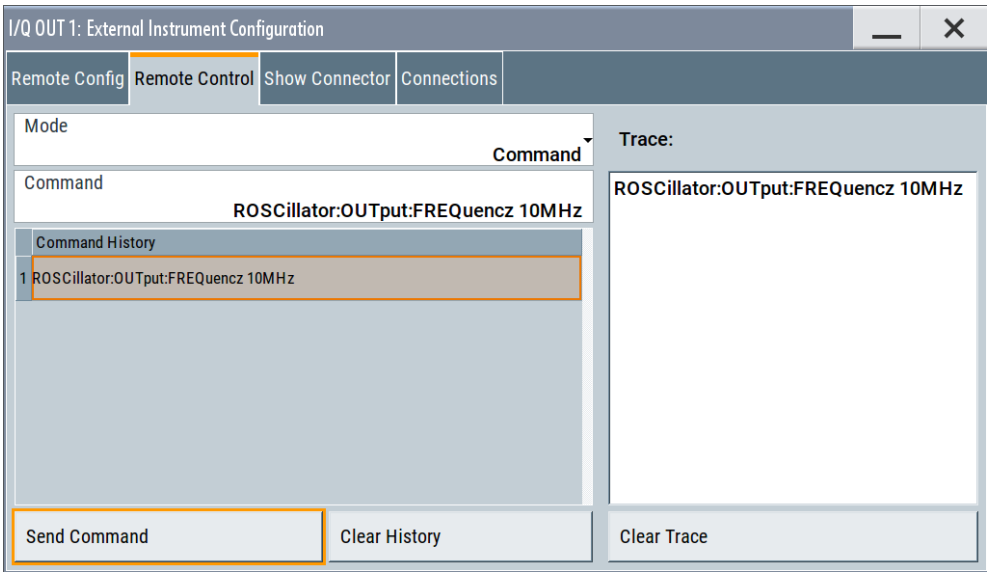
Apply and Connect
Confirms the settings and triggers the connection establishment. In the connected instruments, the status of this active remote connection is displayed by the "Remote" indication.

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect on page 657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:CONNect on page 658

5.2.3.2 Remote control settings

Access:

1. Select "External RF and I/Q" > "External Instrument" > "Config...".
2. Select "Remote Control".



In this dialog, you can send individual SCPI commands or a sequence of SCPI commands to the connected instruments.

The sent commands and their results are displayed in the "Command Trace" field, as long as the trace is not deleted "Clear Trace". The sent commands are also listed in the "History" list. As long as this history list is not deleted ("Clear History"), you can select a command from the list and send it again.

Settings:

Mode....268
Command/Send Command....268
File/Command Sequence/Send Sequence....268
Command History/Clear History....268
Trace/Clear Trace....268

Mode
You can send a single command ("Command") or a command sequence ("Sequence") to the connected instrument.

Command/Send Command
Entry field for the SCPI commands.

You can enter a new command or select a previously sent command from the "History".

If the remote connection is active, select "Send Command" to execute the command.

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:SEND` on page 660

File/Command Sequence/Send Sequence
Opens the standard "File Select" dialog for loading of user-defined files with extension `*.iec`.

The provided navigation possibilities in the dialog are self-explanatory.

When a file is selected, its name and content are displayed, and the first command is selected. You can send the commands one by one ("Send Command") or send the entire sequence at once ("Send Sequence").

After a command is sent, the next command form the sequence is selected.

See also "Initialization Sequence" on page 266.

Command History/Clear History
List of the sent commands.

As long as this history list is not cleared ("Clear History"), you can select a command from the list and send it again.

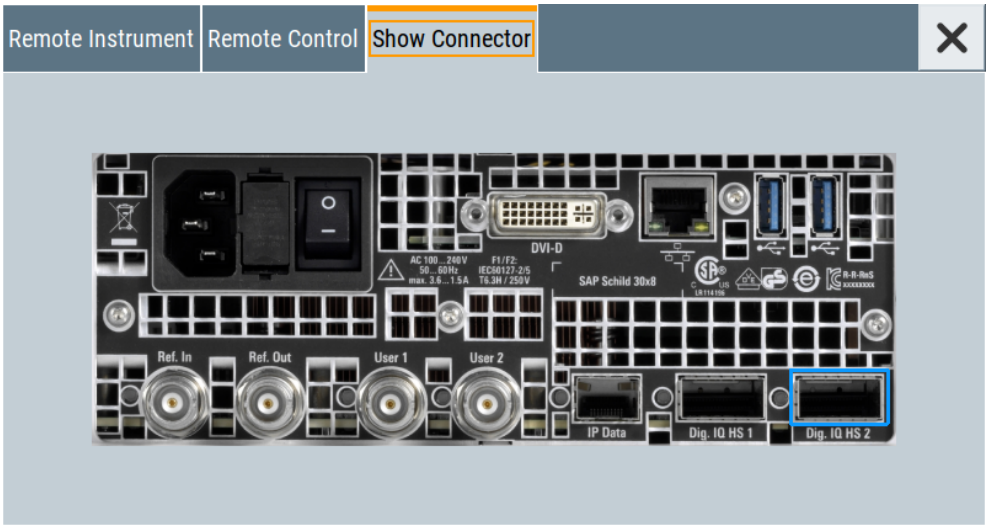
Trace/Clear Trace
List of the sent commands and their results, where the results are displayed in blue color.

To delete the trace, select "Clear Trace".

5.2.3.3 Show connector

Access:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector.
   Select "External Instruments > Config ...".
3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Show Connector".



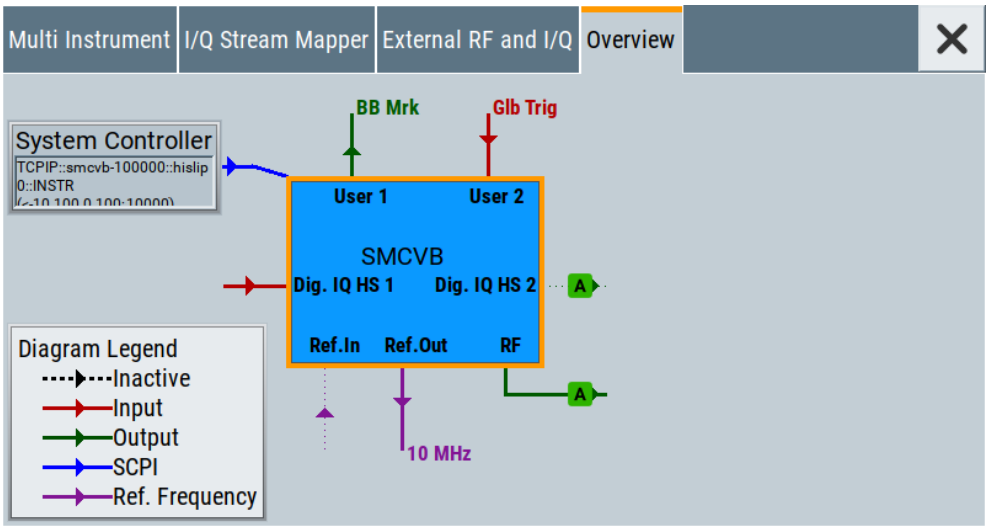
The dialog displays the location of the selected connector.
The "Show Connector" function triggers the instrument to identify the connector on the rear panel. The LED next to the selected connector blinks.

5.2.4 Overview

You can check current connections, interfaces, input signals and output signals of the R&S SMCV100B in the "Overview" tab.

Access:

► Select "System Configuration" > "Overview".



The overview tab shows information on the following:

- Input signals and output signals: Type (RF, reference, HS Dig IQ, User 1/2) and state (active, inactive)
- Input and output interfaces
- Current stream mapping to the output interfaces.
  See Section 5.2.1, "I/Q stream mapper settings", on page 257.
- Connected controller ("System Controller") and connection ("SCPI").
  See Section 5.2.2, "External RF and I/Q settings", on page 258.
- Connections for remote control of connected external devices

Hotspots for fast access to the required settings

Several of the displayed elements are hotspots. Select an element to access the related dialog.

5.3 Digital baseband input settings

The R&S SMCV100B provides the Dig. IQ HS 1 interface to feed an external digital baseband signal into the signal path.

Required options

The equipment layout for applying an external baseband signal includes:

- Base unit
- Option frequency R&S SMCVB-B103
- Option digital baseband input/output R&S SMCVB-K19
  (incl. the digital interface Dig. IQ HS 1 used as input)

For more information, refer to the specifications document.

To access and configure the "Baseband Input" settings

The "BB Input" block provides access to the settings for frequency offset and path gain, and to the available configuration parameters of the external baseband signal.

The digital baseband input interface Dig. IQ HS 1 is located on the R&S SMCV100B rear panel, see Section 5.1, "Overview of the input and output signals and interfaces", on page 252.

In the default instrument state, the block diagram displays the connector in an unfolded state. The digital input interface is off.

1. To fold out the "BB Input" block, select the connector symbol:

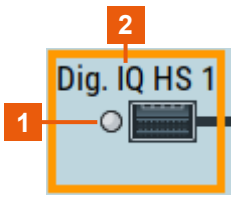
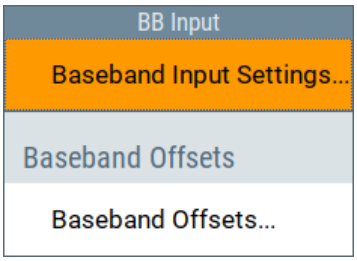


Figure 5-3: Representation of the digital baseband input interface Dig. IQ HS 1

1 = Digital input interface state: gray = inactive; blue = active
2 = Connector name

If you click on the "BB Input" block, you can access baseband input settings or baseband offset settings.



2. To access the baseband offset settings, select "BB Input" > "Baseband Offsets". See Section 4.11, "Shifting the baseband signal", on page 247.
3. To access the dialog box for configuring the external signal input, select "BB Input" > "Digital I/Q In" > "Baseband Input Settings".

   The "Baseband Input Settings" dialog provides settings necessary to define the used connector. Also, it provides settings to adjust the signal parameters, like the sample rate and the baseband input level.
   In this dialog, you access the settings of the Dig. IQ HS 1 connector.
4. To set the input connector, select "BB Input" > "General" > "Interface" > "Dig. IQ HS x"
5. To enable the input signal, select "BB Input" > "On".

The remote commands required to define these settings are described in Section 14.16.3, "SOURce:BBIN subsystem", on page 673.

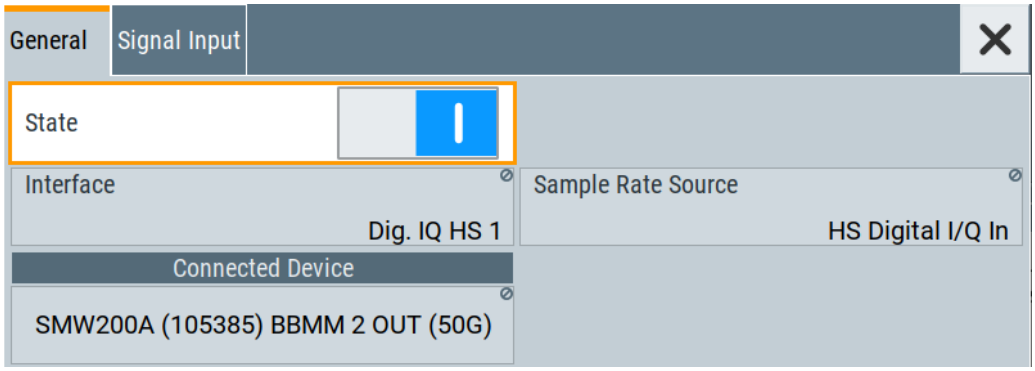
Settings:

- General settings....272
- Signal input settings....273

5.3.1 General settings

Access:

► Select "BB Input" > "Baseband Input Settings".



Settings:

State....272
Interface....272
Sample Rate Source....272
Connected Device....273

State
Enables the feeding of the selected external digital signals into the baseband.

Remote command:
`[:SOURce<hw>]:BBIN:STATe` on page 675

Interface
Displays the digital interface for input, that is Dig. IQ HS 1.

Remote command:
`[:SOURce<hw>]:BBIN:DIGital:INTerface` on page 675

Sample Rate Source
Indicates the digital interface used to estimate the sample rate.

"HS Digital I/Q In"
Estimates the sample rate value based on the information transmitted by the transmitter.
Resulting value per channel is displayed by the parameter Sample Rate.

Remote command:
[:SOURce<hw>]:BBIN:SRATe:SOURce on page 677

Connected Device
If the connection to the external device is properly established and signal transmission is active, this parameter displays information on the instrument connected to the Dig. IQ HS 1 interface:

- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

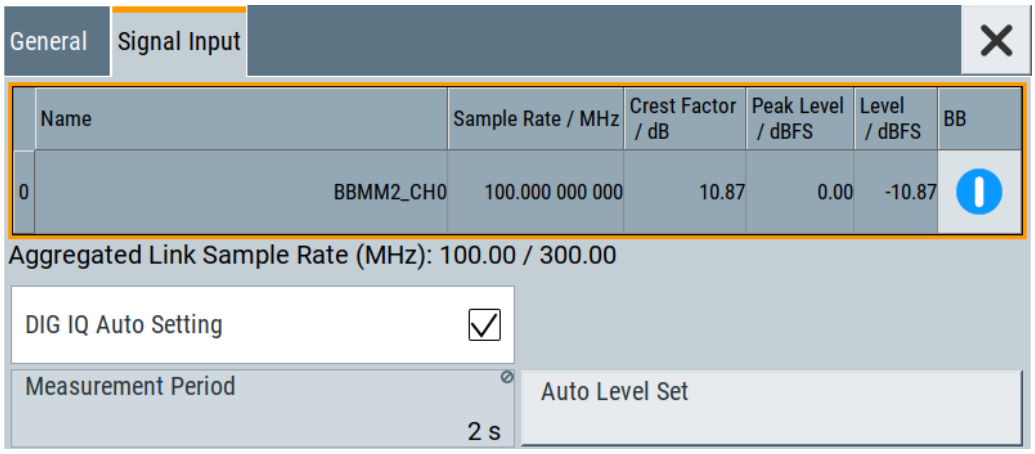
"None" indicates that no device is connected.

Remote command:
[:SOURce<hw>]:BBIN:CDEVice? on page 675

5.3.2 Signal input settings

Access:

1. Select "BB Input > Digital I/Q In > Baseband Input Settings > Interface = HS DIG I/Q".
2. Select "Signal Input".



Settings:

Channel Table 274
└ Number 274
└ Name 274
└ Sample Rate 274
└ Crest Factor 274
└ Peak Level 274
└ Level 274
└ BB 274
Aggregated Link Sample Rate 275

DIG IQ Auto Setting..... 275
Measurement Period.....275
Auto Level Set.....275

Channel Table
Displays information on the up to 8 digital channels at the Dig. IQ HS 1 interface:

Number ← Channel Table
Subsequent number.

Name ← Channel Table
Channel indication, set by the transmitter.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME` on page 676

Sample Rate ← Channel Table
Displays the used sample rate per channel.

For information on the maximum sample rate and the aggregated link sample rate, see "Aggregated Link Sample Rate" on page 275.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe` on page 677

Crest Factor ← Channel Table
If DIG IQ Auto Setting > "Off", sets the crest factor per channel.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor` on page 676

Peak Level ← Channel Table
If DIG IQ Auto Setting > "Off", sets the peak level per channel. The value is set as attenuation in digital baseband domain.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK` on page 676

Level ← Channel Table
Indicates the level, set automatically depending on the selected peak level and crest factor.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS` on page 676

BB ← Channel Table
Activates the channel.

You can only activate one channel at a time. Toggle the state of the channel to test all channels one after another.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe` on page 675

Aggregated Link Sample Rate
Indicates the aggregated sample rate and the maximum sample rate, where:

- The aggregated sample rate is the sum of the sample rates of all active channels. It cannot exceed the maximum sample rate.
- The R&S SMCV100B supports two standard max. sample rate values. This parameter indicates the currently selected one, where the max. sample rate is selected depending on the capabilities of the transmitter/receiver.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:BBIN:SRATe:SUM?` on page 678
`[:SOURce<hw>]:BBIN:SRATe:MAX?` on page 678

DIG IQ Auto Setting
Activates an automatic adjustment of the baseband input signal.

The R&S SMCV100B receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Remote command:
`[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe` on page 678

Measurement Period
Sets the recording duration for measuring the baseband input signal by "Auto Level Set".

Note: For accurate level measurements, set the measurement period to a time value that is long enough to capture several periods of the input signal.

Remote command:
`[:SOURce<hw>]:BBIN:MPERiod` on page 679

Auto Level Set
Starts measuring the input signal for estimating the crest factor, the peak level, and the Revel of the input signal.

Remote command:
`[:SOURce<hw>]:BBIN:ALEVel:EXECute` on page 679

5.4 I/Q digital output settings

Required options

The equipment layout for output of a baseband signal includes:

- Base unit
- Option digital baseband input/output R&S SMCVB-K19 (incl. the digital interface Dig. IQ HS 2 used as output)

The current firmware does not support output of baseband signal at the Dig. IQ HS 2 interface.

For more information, refer to the specifications document.

To access and configure the "I/Q Digital Output" settings

The connector is located on the rear panel.

In the default instrument state, the block diagram displays the Dig. IQ HS 2 connector in a folded state. The digital output interface is inactive (gray LEDs).

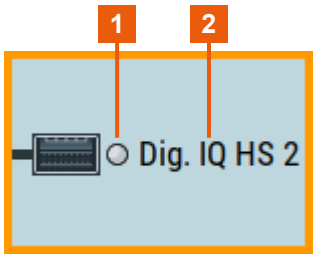


Figure 5-4: Unfolded view of the digital output interface Dig. IQ HS 2

1 = Digital output interface state: gray = inactive; blue = active
2 = Digital output connector name

1. Select the Dig. IQ HS 2 symbol to unfold the "I/Q Digital" block.

   You access the settings of the Dig. IQ HS 2 connector.

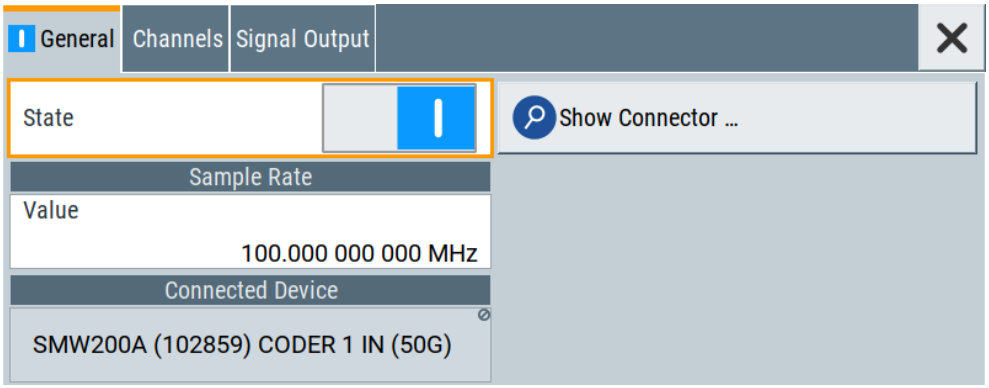
2. To access the dialog box for configuring the digital output signal, select "I/Q Digital > I/Q Digital Out".

   The remote commands required to define these settings are described in Section 14.16.9.1, "SOURce:IQ:OUTPut:DIGital commands", on page 783.

5.4.1 General settings

Access:

► Select "I/Q Digital > I/Q Digital Out".



Settings:

State....277
Show Connector....277
Value....277
Connected Device....277

State
Displays the digital I/Q output state, that is deactivated.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe` on page 784

Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

Value
Sets/displays the sample rate of the digital I/Q output signal. The maximal sample rate depends on the connected receiving device.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe` on page 784

Connected Device
If the connection to the external device is properly established and signal transmission is active, this parameter displays information on the instrument connected to the Dig. IQ HS 1 interface:

- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

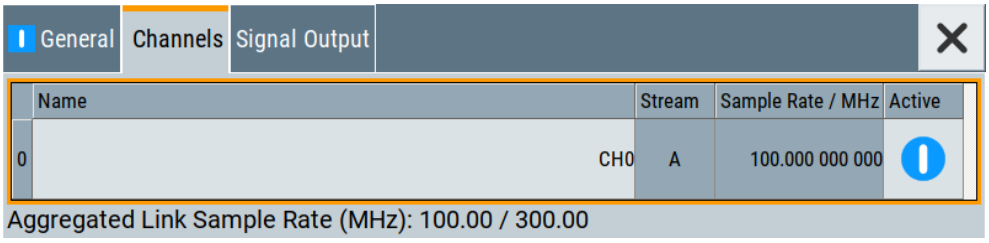
"None" indicates that no device is connected.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice?` on page 785

5.4.2 Channels settings

Access:

► Select "I/Q Digital > I/Q Digital Settings > Channels".



The channels are displayed in table form, where the number of rows corresponds to the number of channels.

Settings:

Number 278
Name 278
Stream 278
Sample Rate 278
Peak Level 278
Level 278
Active 279
Aggregated Link Sample Rate 279

Number
Subsequent number.

Name
Sets the name of the channel of the used interface.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME` on page 787

Stream
Indicates the streams that are routed to the channel.

Sample Rate
Sets the sample rate per channel.

For information on the max. sample rate and the aggregated sample rate, depending on the number of active channels, observe the indication Aggregated Link Sample Rate.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe` on page 787

Peak Level
Setting this parameter requires "Set Level Via > Peak Level".

Sets the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Option: R&S SMCVB-B9/-K19

Parameter is read-only in the configuration "Mode > Advanced" and "Signal Outputs > Analog&Digital".

Remote command:
For the output signal of a channel of the Dig. IQ HS x interfaces:
`[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:PEP` on page 785

Level
Setting this parameter requires "Set Level Via > Level".

Sets the RMS level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Remote command:
For the output signal of a channel of the Dig. IQ HS x interfaces:
`[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:LEVel` on page 786

Active
Activates the channel.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe` on page 787

Aggregated Link Sample Rate
Indicates the aggregated sample rate and the maximum sample rate, where:

- The aggregated sample rate is the sum of the sample rates of all active channels. It cannot exceed the maximum sample rate.
- The R&S SMCV100B supports two standard max. sample rate values. This parameter indicates the currently selected one, where the max. sample rate is selected depending on the capabilities of the transmitter/receiver.

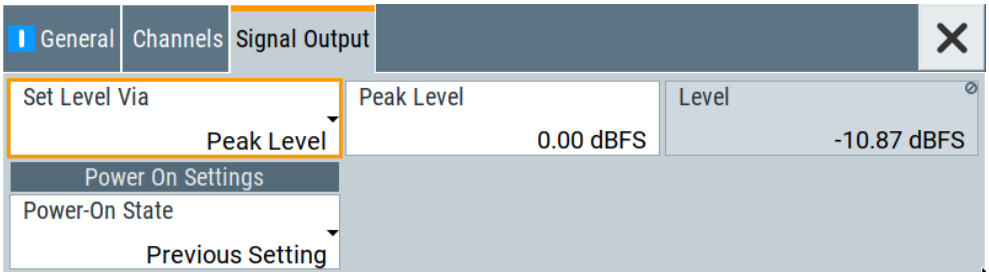
For more information, refer to the specifications document.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM?` on page 788
`[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX?` on page 788

5.4.3 Signal output settings

Access:

► Select "I/Q Digital > I/Q Digital Settings > Signal Output".



The tab comprises settings necessary to configure the I/Q digital signal output parameters.

Settings:

Signal output level settings 280
└ Set Level Via 280
└ Peak Level 280
└ Level 280
Power-On State 280

Signal output level settings
Comprises the level settings of the digital IQ output signal. The signal level is expressed as a peak or RMS level value.

Note: The "Level" display always refers to both signal components, i.e. $SQR(I^2+Q^2)$.

Set Level Via ← Signal output level settings
Selects whether the signal level is expressed as a peak or as RMS level value.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA` on page 785

Peak Level ← Signal output level settings
Setting this parameter requires "Set Level Via > Peak Level".

Sets the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Option: R&S SMCVB-B9/-K19

Parameter is read-only in the configuration "Mode > Advanced" and "Signal Outputs > Analog&Digital".

Remote command:
For the output signal of a channel of the Dig. IQ HS x interfaces:
`[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:PEP`
on page 785

Level ← Signal output level settings
Setting this parameter requires "Set Level Via > Level".

Sets the RMS level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Remote command:
For the output signal of a channel of the Dig. IQ HS x interfaces:
`[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:LEVel`
on page 786

Power-On State
Selects the state which the I/Q digital output connector Dig. IQ HS 2 is to resume after the instrument is switched on.

"I/Q Out Off" On power-on, the output is deactivated.

"Previous Setting"
Resumes the state that was active before the last switch off.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:PON` on page 787

5.5 Generating time-aligned baseband signals

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

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

One possible way to achieve quasi-simultaneous signal start is to trigger the instruments by the same trigger event, for example from a **common trigger source**.

Because of the trigger signal propagation time and the signal processing time, however, this method does not achieve precise time aligned signals.

To generate **synchronous and time aligned signals** with multiple instruments, use the primary-secondary instrument mode.

This section explains how to use the provided settings to define the signal generation start in the basebands of **multiple instruments**.

- Triggering several instruments with a common trigger signal 281

5.5.1 Triggering several instruments with a common trigger signal

Using the same trigger event on several instruments is useful to synchronize the transmitted and received signals. Some test cases also require that you control the signal generation start and determine the exact generation start time by a defined trigger event. The signal generation start can be controlled, for example, by triggering the instrument internally or externally from the DUT.

To share common trigger signal:

- Let the primary instrument R&S SMCV100B#1 generate a dedicated signal that triggers all R&S SMCV100B instruments.
  See Example "Triggering several R&S SMCV100B instruments simultaneously" on page 281.
- Connect all instruments to a common external trigger source.

See also Section 3.3.4, "Enabling and configuring a marker signal", on page 50.

Example: Triggering several R&S SMCV100B instruments simultaneously

This example shows you how to trigger the several R&S SMCV100B instruments simultaneously. Also, it shows, how to connect several R&S SMCV100B instruments and distribute the trigger signal generated by a primary instrument.

Required cabling and connections:

- Connect the instruments in a star network, concerning the trigger signal.
  That is, connect the "User 1" output of the R&S SMCV100B#1 to the "User 2" input of all R&S SMCV100B instruments and the R&S SMCV100B#1 itself.
- Always use cables of the same length. Use cables that are as short as possible.

Required configurations at the R&S SMCV100B#1:

- Set the following for "User 1" connector: "System Config." > "Setup" > "Global Connectors" > "User 1" > "Direction" > "Output". The output signal is the marker signal "Baseband Marker".
- Select "Baseband" > "<Digital_Standard>" > "Trigger In" > "Trigger Source" > "External Global Trigger".

Required configurations at all R&S SMCV100B instruments:

- Use the default settings for the "User 2" connector: "Direction" > "Input" and "Signal" > "Global Trigger".
- Select "Baseband" > "<Digital_Standard>" > "Trigger In" > "Trigger Source" > "External Global Trigger".

To trigger the signal generation from the R&S SMCV100B#1, select "Execute Trigger".

The R&S SMCV100B#1 generates a short high signal and outputs it at the "User 1" connector. The signal acts as a common external trigger signal for all R&S SMCV100B instruments and all basebands.

6 Adding noise to and impairing the signal

The test case scenarios in accordance with the specifications often require a not "clean" signal but rather a signal that is impaired or interfered. To fulfill such requirements, the R&S SMCV100B is equipped with a noise generator and provides the possibility to impair the digital I/Q signal.

This section describes the following functions:

- Adding noise to the signal 283
- Impairing the signal 297

6.1 Adding noise to the signal

This section introduces the concept of the AWGN generator (Additive White Gaussian Noise). The section also describes the settings for generation of noise, sine wave interferer, and adding noise to the generated signal.

6.1.1 Required options

The equipment layout for generating an AWGN signal includes:

- Base unit
- Option Noise Generator (R&S SMCVB-K62)

6.1.2 About the AWGN generator

Provided the required options are installed, the R&S SMCV100B allows you to superimpose noise on the generated signal. The built-in internal noise generator generates an AWGN signal (Additive White Gaussian Noise) with selectable bandwidth and adds it to the digital baseband signal. The main characteristic of this kind of noise signal is the Gaussian distribution of the noise power density and uniform frequency distribution.

Generation of the AWGN signal

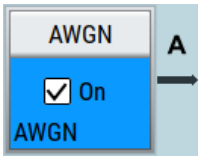
The Gaussian noise is generated with a feedback shift register with subsequent probability transformation. The switching configuration is such that ideal statistical characteristics are achieved:

- I and Q paths are decorrelated from each other.
- Small probabilities are ensured via the crest factor of ~15 dB
- The period of the noise signal is relatively long and depends on the selected system bandwidth.
- Scalable lowpass filters are used to produce a noise level with both a broad dynamic range and a broad bandwidth range.

AWGN modes

The AWGN generator generates signal in one of the following different modes:

- **"Additive Noise":** the generated noise signal superimposes the interference-free useful signal



- **"Noise Only":** a pure noise signal is generated and modulated to the carrier; the connection to the baseband is interrupted.

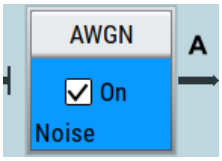
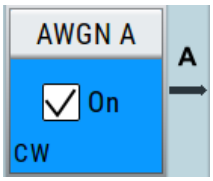


Figure 6-1: Representation of an AWGN > Mode > Noise Only in the block diagram

- **"CW Interferer":** a sinusoidal signal with an adjustable frequency offset and carrier-to-interferer (C/I) power ratio is added to the baseband signal.



Signal and noise parameters

The Figure 6-2 illustrates the relation between the signal and noise parameters.

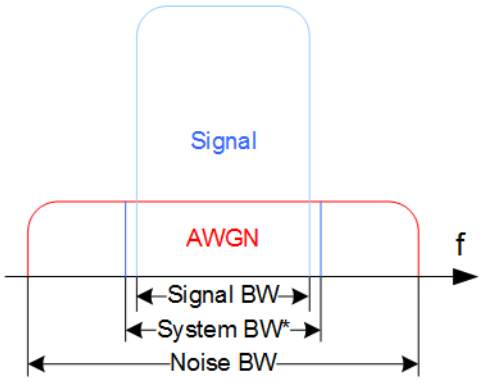


Figure 6-2: Graphical representation of the relation between system bandwidth and noise bandwidth (Minimum Noise/System BW = 2)

System BW* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and is therefore a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but with the target signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*. This indication corresponds to the "Level" value in the "Status bar" (see Figure 6-3).

To ensure flat noise within the selected system bandwidth, the **noise bandwidth** has to be larger than the system bandwidth. The minimum noise bandwidth is sometimes part of the specifications and is calculated as follows:

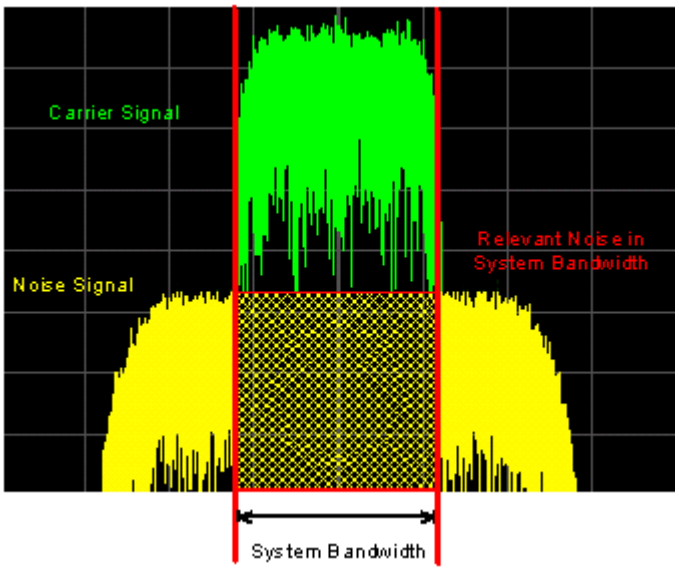
"Noise Bandwidth" = "System Bandwidth" x "Minimum Noise/System Bandwidth Ratio"

Logically, the calculated noise bandwidth does not exceed the total available bandwidth of the instrument.

For more information, refer to the specifications document.

By default, the **noise power** within the system bandwidth is not defined directly but calculated depending on the selected system bandwidth and the desired SNR. The noise power over the noise bandwidth is calculated respectively.

The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth, which means that the total measurable noise power usually exceeds the displayed value "Noise Power".



For a correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.

In the "Additive Noise" mode, the output signal is the *signal with the noise distribution*. Hence, the power level at the RF output corresponds to the **carrier+noise power** (see Figure 6-3).

The noise power of digitally modulated signal is characterized by the parameter $\mathbf{E_b/N_0}$ indicating the ratio of bit energy to noise power density. The correlation to the SNR is as follows:

C/N or S/N = $(E_b/N_0)*(f_{bit}/B_{sys})$, where B_{sys} is the system bandwidth.

Bit Rate f_{bit} = "Symbol Rate" * Modulation Value

Where the bit rate value is retrieved from?

The parameter "AWGN > Noise Power / Output Results > Bit Rate" indicates the value used by the C/N or E_b/N_0 calculation. The value is retrieved automatically depending on the configured baseband signal:

- For signals generated by the "Custom Digital Mod", the bit rate is determined by the selected standard
  (see parameter "Custom Dig Mod > General" > "Symbol Rate" and "Custom Dig Mod > Modulation Type").
- For signals generated in accordance to a digital standard, the bit rate is often a standalone parameter.
  Some test cases however, for example the 3GPP base station tests (TS 25.141), specify the E/N settings that apply to channel-coded data or block segments. Set the parameter "Bit Rate" to the required value, e.g. the bit rate before or after channel coding.

Understanding the displayed information

The following example explains the impact of the AWGN settings on the signal and noise parameters.

See Figure 6-3 for an example of an AWGN generation with the following configuration:

- "Baseband"
  - "Custom Digital Modulation > Set acc. to standard > WCDMA-3GPP"
  - "State > On".
  - "Symbol Rate = 3.840 Msym/s"
- "AWGN"
  - "General > Mode > Additive Noise"
  - "General > Min Noise/System Bandwidth Ratio = 3"
  - "General > State > On"
  - "Noise Power / Output Results > Show Results for Output > RF"
  - "Noise Power / Output Results > Reference Mode > Carrier"
  - "Noise Power / Output Results > Carrier/Noise Ratio = 10 dB"
- "RF > On"

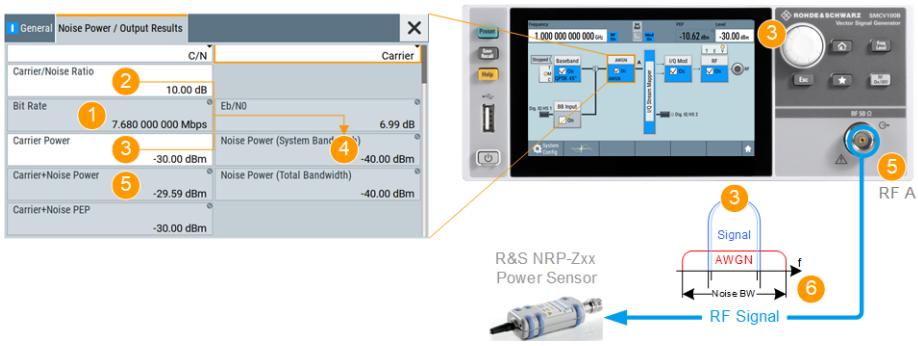


Figure 6-3: AWGN: Understanding the displayed information

1 = Bit Rate derived from the selected "Symbol Rate = 3.840 Msym/s"
2 = Selected Carrier/Noise Ratio
3 = Noise Power calculated from the "Carrier Power" and the "Carrier/Noise Ratio" = -30 dBm - 10 dB = -40 dBm
4, 7, 10 = Carrier Power = Status bar > Level = -30 dBm
5, 8 = Carrier+Noise Power = power at the RF 50 Ω output; i.e. the power a connected power meter would measure
6, 9 = Noise Bandwidth = System Bandwidth*Minimum Noise/System Bandwidth Ratio = 3.840 MHz*3 = 11.520 MHz

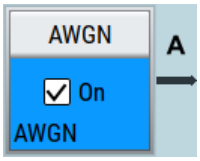
Use the built-in graphical signal monitoring function of the instrument to display the signal characteristics in real-time, see "To observe the effect of enabled additive noise (AWGN)" on page 409.

Application fields

Typically, the noise generator is required for the following tests:

- In receiver sensibility tests with predefined SNR of the receiver, see "To configure the AWGN for receiver sensibility tests" on page 295
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

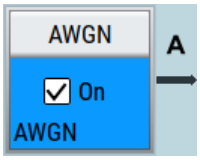
6.1.3 AWGN block



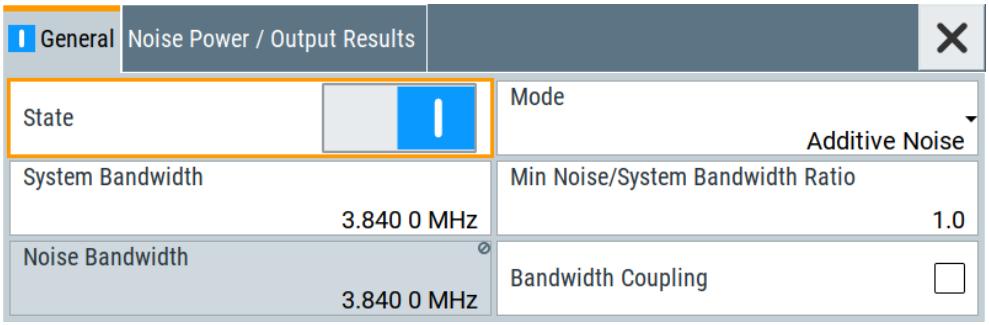
The "AWGN" block provides access to the settings for the **AWGN generator**, see Section 6.1.4, "AWGN settings", on page 288. The label in the AWGN block indicates the AWGN mode that is activated. The quickest way to activate or deactivate the AWGN generator is the "On/Off" switch in the AWGN block.

6.1.4 AWGN settings

Access:



1. Select "Block Diagram > AWGN".



   The dialog contains the settings for noise level configuration and CW interfering parameters.

2. To activate the AWGN generator, select "Block Diagram > AWGN > On".

   The remote commands required to define these settings are described in Section 14.16.2, "SOURce:AWGN subsystem", on page 665.

Settings:

6.1.4.1 General settings

Access:

► Select "Block Diagram > AWGN".

Settings:

State....288
Mode....289
System Bandwidth....289
Minimum Noise/System Bandwidth Ratio....289
Bandwidth Coupling....289
Target CW Frequency Offset....290

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 668

Mode
Activates/deactivates the generation of an AWGN signal. The interferer (AWGN or CW interferer, depending on the selected mode) is generated after the generator is activated.

"Additive Noise" The AWGN noise signal with selectable system bandwidth is added to the baseband signal.

"Noise Only" The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted.

"CW Interferer" A sine with a defined frequency offset is added to the baseband signal.
This mode is disabled in "System Configuration" with more than 4 input streams.

Remote command:
`[:SOURce<hw>]:AWGN:MODE` on page 668

System Bandwidth
For "Additive Noise" and "Noise Only" modes, sets the RF bandwidth to which the set carrier/noise ratio relates.

Within this frequency range, the signal is superimposed with a noise signal which level corresponds exactly to the set C/N or S/N ratio.

For more information, refer to the description of Figure 6-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth` on page 668

Minimum Noise/System Bandwidth Ratio
For "Additive Noise" and "Noise Only" modes, sets the ratio of minimum noise bandwidth to system bandwidth, as required by some standards.

"Noise Bandwidth" = "System BW" x "Minimum Noise/System BW Ratio"

The parameter Noise Bandwidth displays the resulting noise bandwidth. Because the noise power density is a constant value, increasing the noise/system bandwidth ratio increases the noise bandwidth.

The calculation of level from the selected C/N or S/N ratio in relation to system bandwidth is not influenced.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:RATio` on page 669

Bandwidth Coupling
Requires "Mode > Additive Noise/Noise Only". Activating bandwidth coupling requires an activated digital broadcast baseband signal, e.g. "Baseband > ATSC-M/H > ATSC-M/H > On".

Activates bandwidth coupling. If activated, the AWGN "System Bandwidth" couples to the digital broadcast baseband signal bandwidth. The baseband signal bandwidth is derived from the "Used Bandwidth" or "Symbol Rate" of the active coder of the digital broadcast standard.

Also the "Minimum Noise/System Bandwidth Ratio" is updated corresponding to the coupled "System Bandwidth".

"Bandwidth Coupling" is deactivated for "Audio AM", "Audio FM" and all other baseband signals, e.g. custom digital modulated signals.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe]` on page 669

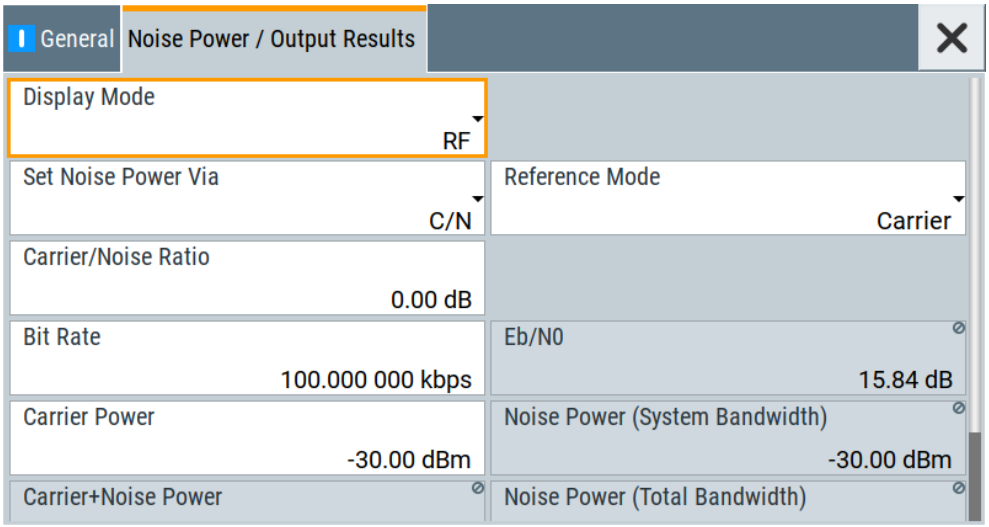
Target CW Frequency Offset
In "CW Interferer" mode, sets the desired frequency of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:TARGet` on page 673

6.1.4.2 Noise power/output results settings

Access:

► Select "AWGN > Noise Power/Output Results".



The available settings depend on the selected Mode.

Settings:

Show Powers For Output 291
Set Noise Power Via 291
Reference Mode 291
Bit Rate 291
Carrier/Noise Ratio, Signal/Noise Ratio 292
E_b/N_0 292
Carrier Power, Signal Power 292
Noise Power (System Bandwidth), Interferer Power 293
Noise Power (Total Bandwidth) 294

Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power 294
Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP 294
Noise Bandwidth 295
Resulting CW Frequency Offset 295

Show Powers For Output
Sets the output to which the displayed settings are related to.

This setting also influences:
- The way the interfering parameters are displayed, e.g. if the SNR value is defined as C/N or as S/N.
- The value units:
  – The values related to the RF outputs are displayed in dBm
  – The values related to the baseband outputs - in dB

Remote command:
`[:SOURce<hw>]:AWGN:DISP:MODE` on page 670

Set Noise Power Via
In "Additive Noise" mode, selects the way the noise power is determined.

The following correlation applies:

"C/N or S/N"= ("E_b/N_0")(f_{bit}/B_{sys})*, where:
- "C/N or S/N" is the carrier/noise ratio
- "E_b/N_0" is the ratio of bit energy to noise power density
- "Bit Rate" f_{bit}= "Symbol Rate" x Modulation Value
- B_{sys} is the system bandwidth.

See also Section 6.1.2, "About the AWGN generator", on page 283.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:MODE` on page 670

Reference Mode
Selects whether the carrier or the noise power is kept constant if the C/N or Eb/N0 ratio is changed.

In the common case, the instrument keeps the carrier power and adjusts the noise power accordingly. Some test cases however, for example the 3GPP base station tests (TS 25.141), specify explicitly the noise power. These test cases require that the noise power is permanently set as a function of the base station power class, whereas the carrier power is variable.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:RMODe` on page 670

Bit Rate
In "Additive Noise" mode, indicates the bit rate used for converting C/N or S/N to E_b/N_0.

Tip: For digitally modulated signals, select the bit rate before or after channel coding, as required.

See also Section 6.1.2, "About the AWGN generator", on page 283.

Remote command:
[:SOURce<hw>]:AWGN:BRATe on page 670

Carrier/Noise Ratio, Signal/Noise Ratio
In "Additive Noise" and "CW Interferer" mode, sets the carrier/noise, signal/noise or signal/interferer ratio.

Whether a configuration of C/N or S/N is enabled, depend on the selected output Show Powers For Output.

- In "Reference Mode > Carrier": sets the noise power. It does not affect the power of the useful signal, i.e. the carrier power remains constant.
  Thus the power of the carrier + noise signal or the *power of the output signal* changes.
- In "Reference Mode > Noise", sets the *power of the useful signal*, i.e. the carrier power.
  The power of the output signal remains constant.
- The power of the noise signal is derived from the entered C/N or S/N value and displayed with the parameter "Noise Power" in the units of the useful signal.
- The power of the useful signal is displayed with the parameter "Carrier Power" and can also be changed there. This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also Figure 6-3.

Remote command:
[:SOURce<hw>]:AWGN:CNRatio on page 671

E_b/N_0
In "Additive Noise" mode, sets the ratio of bit energy to noise power density.

- In "Reference Mode > Carrier": sets the *noise power* and hence the power of the output signal, i.e. the carrier + noise signal.
  It does not affect the power of the useful signal, i.e. the carrier power is kept constant.
- In "Reference Mode > Noise": sets the *power of the useful signal*, i.e. the carrier power.
  The noise power is kept constant.
- The power of the noise signal is derived from the selected E_b/N_0 and displayed with the parameter "Noise Power" in the units of the useful signal.
- The power of the useful signal is displayed with the parameter "Carrier Power". This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also Figure 6-3.

Remote command:
[:SOURce<hw>]:AWGN:ENRatio on page 671

Carrier Power, Signal Power
("Additive Noise" and "CW Interferer")

The name of this parameter depends on the selected output Show Powers For Output.

- In "Reference Mode > Carrier": sets the carrier power. This indication corresponds to the "Level" value in the "Status bar".
  The power of the noise signal is derived from the selected C/N or S/N value and displayed with the parameter "Noise Power" in the units of the useful signal.
- In "Reference Mode > Noise", indicates the carrier power as derived from the entered C/N or S/N value. This indication corresponds to the "Level" value in the "Status bar".
  The noise power can be set with the parameter "Noise Power".

Note: The peak envelope power (PEP) displayed in the "Status bar" corresponds to the PEP value of the carrier. The parameter "Carrier+Noise (PEP)" indicates the PEP value of the overall signal.

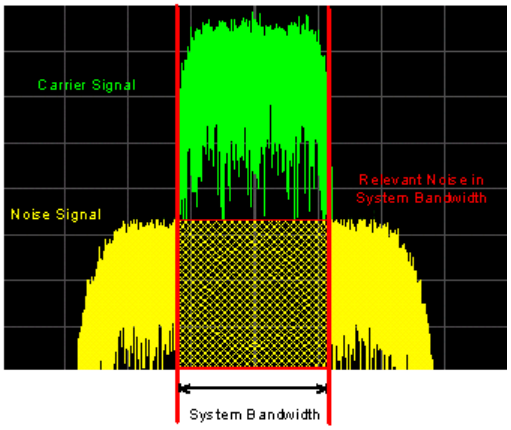
See also Figure 6-3.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:CARRier` on page 671

Noise Power (System Bandwidth), Interferer Power
Displays the power of the noise signal in the system respectively the total bandwidth in "Noise Only" and "Additive Noise" mode.

- "Noise Only" mode
  Sets the power of the noise signal. This indication corresponds to the "Level" value in the "Status bar".
- "Additive Noise" mode
  - "Reference Mode > Noise"
    Sets the power of the noise signal. The power of the carrier is derived from the entered C/N or S/N or Eb/N0 value.
  - "Reference Mode > Carrier"
    Displays the power of the noise signal in the system bandwidth. The power of the noise signal is derived from the entered C/N or S/N or Eb/N0 value.
    The carrier power is selected with "Carrier Power"; respectively the signal power is displayed by "Signal Power".
- "CW Interferer" mode
  - "Reference Mode > Noise"
    Sets the power of the interfering signal. The power of the carrier is derived from the entered C/I value.
  - "Reference Mode > Carrier"
    Displays the power of the interfering signal. The power of the interfering signal is derived from the entered C/N or S/N value. The carrier power is entered under "Carrier Power".

Note: The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. The occurrence means that the total measurable noise power usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.



See also Figure 6-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe on page 671

Noise Power (Total Bandwidth)
Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

See also Figure 6-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? on page 672

Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power
In "Additive Noise" and "CW Interferer" mode, displays the overall power of the noise/interferer signal plus useful signal.

The output selected with the parameter Show Powers For Output determines:
- The name of this parameter
- The units the overall power is measured in, dBm or dB (full-scale)

See also Figure 6-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:SUM? on page 672

Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP
In "Additive Noise" and "CW Interferer" mode, displays the peak envelope power (PEP) of the overall signal comprised of noise signal plus useful signal.

The output selected with the parameter Show Powers For Output determines:
- The name of this parameter
- The units the overall power is measured in, dBm or dB (full-scale)

Note: The peak envelope power ("PEP") displayed in the "Status bar" corresponds to the PEP value of the carrier.

Remote command:
[:SOURce<hw>]:AWGN:POWer:SUM:PEP? on page 672

Noise Bandwidth
For "Additive Noise" and "Noise Only" modes and with activated AWGN generator, indicates the real noise bandwidth.

See also Figure 6-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:NOISe?` on page 669

Resulting CW Frequency Offset
In "CW Interferer" mode, indicates the resulting frequency offset of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:RESult?` on page 673

6.1.5 How to configure the noise generator for receiver tests

This section shows you how to configure the noise generator for receiver tests, for example the tests specified in the 3GPP test specification TS 36.141, chapter 7.

For the following example, we assume that the R&S SMCV100B generates an uplink EUTRA/LTE signal with following characteristics:

- "EUTRA/LTE > Duplexing = FDD", "Link Direction = Uplink"
- "EUTRA/LTE > General Uplink Setting > Channel Bandwidth = 5 MHz" and "Occupied Bandwidth = 4.5 MHz"
- "EUTRA/LTE > Frame Configuration > UE1 > FRC > FRC State = On" and "FRC = TS 36.141: A2-3"
- "EUTRA/LTE > State = On"
- "Status bar > Frequency = 1.95 GHz" and "Level = -69.9 dBm"
- "RF State > On"

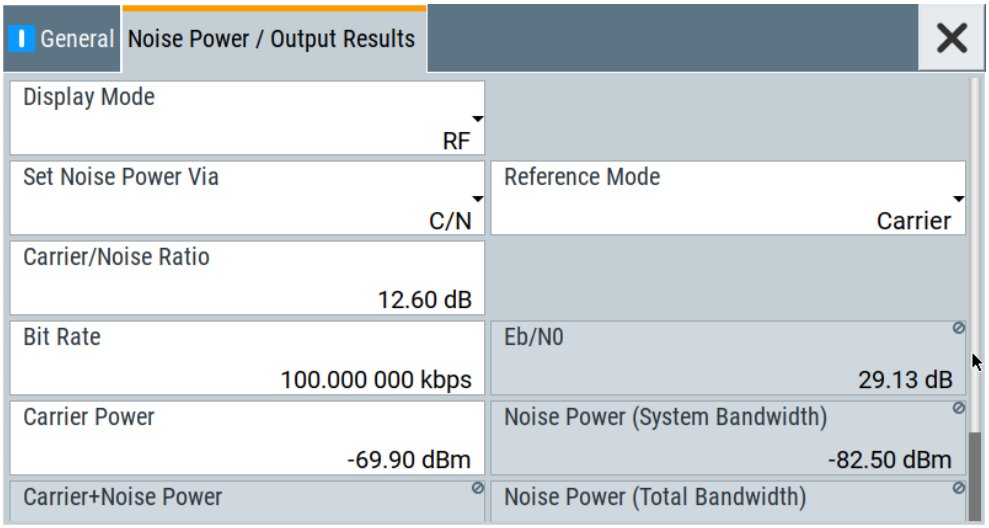
To configure the AWGN for receiver sensibility tests

We assume that an AWGN interfering signal with the following characteristics is required:

The mean power of the interfering signal is -82.5 dBm/BW and C/N = 12.6 dB.

1. Select "AWGN".
2. Set AWGN general settings:
   - "Mode > Additive Noise"
   - "System Bandwidth = 4.5 MHz"
     The definition of the interfering signal mean power is dBm/*BW*, where BW is the system bandwidth. The system bandwidth of the LTE signal is the occupied bandwidth.
     See also Figure 6-2.
   - "Min Noise/System Bandwidth Ratio = 1.5"
3. Select "Noise Power/Output Results".
4. Set AWGN noise power settings:

- "Set Noise Power Via = C/N"
- "Reference Mode = Carrier"
- "Carrier/Noise Ratio = 12.6 dB"



The dialog confirms the required mean power of the interfering signal "Noise Power (System Bandwidth) = -82.5 dBm".

5. Select "AWGN > General > State > On".

To generate a CW interfering signal

For the following example, we assume that two interfering signals are required, a 5 MHz uplink LTE signal and a CW signal. The signals are transmitted at -52 dBm; the LTE signal at 1.96 GHz and the CW signal 10 MHz below it. Signals with equal (or similar) RF levels and at frequencies spaced within the max. RF bandwidth can be generated by the same path.

To configure the instrument:

1. Enable the required LTE signal:
   a) Select "EUTRA/LTE > General Uplink Setting > Channel Bandwidth = 5 MHz" and "EUTRA/LTE > State = On"
   b) Select "Status bar > Frequency = 1.96 GHz" and "Level = -52 dBm"
2. Enable the required interfering signal:
   a) Select "AWGN > General > Mode > CW Interferer"
   b) Select "Target CW Frequency Offset = 10 MHz"
   c) Select "Noise Power/Output Results > Reference Mode = Noise"
   d) Select "Interferer Power = -52 dB"
   e) Select "AWGN > General > State > On".
3. Select "RF > State > On"

6.2 Impairing the signal

In the R&S SMCV100B, you can add digital linear impairments to the signal, for example an I/Q imbalance and a quadrature error.

6.2.1 Required options

The base unit is sufficient for impairing I/Q signals. Impairing these signals does not require additional options.

6.2.2 About the linear I/Q impairments

I/Q signal impairments are well-defined arithmetic modifications of the data. Every data sample is modified in the same way.

Adding linear impairments to the data stream is provided for the following purpose:

- To simulate frequent sources of distortions in a real signal processing chain as, it is required for tests with dirty transmitter conditions (receiver tests)

The R&S SMCV100B offers functions to impair an internal or external I/Q signal linearly.

Settings:

- Gain and gain imbalance 297
- I and Q offset 298
- Quadrature offset 299

6.2.2.1 Gain and gain imbalance

An I/Q gain is a multiplication of all I/Q amplitudes by a common factor. The effect is equivalent to two identical I and Q gain factors. The effect of an increased gain factor in the I/Q constellation diagram is shown on Figure 6-4.

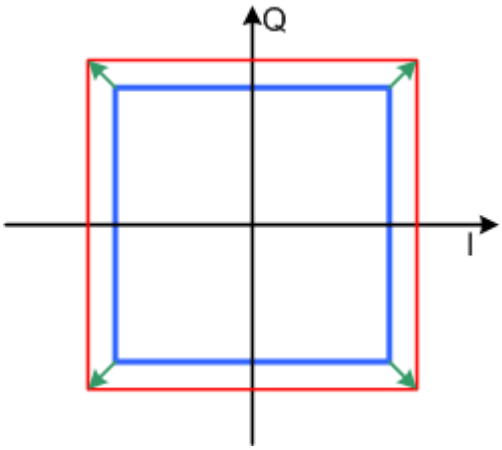


Figure 6-4: Effect of an increased amplitude in the I/Q constellation diagram

An I gain multiplies the I amplitudes by a factor, leaving the Q amplitudes unchanged. A Q gain has the opposite effect. Different I and Q gain factors result in an I/Q imbalance, which is due to different gains of the amplifiers in the I and Q channels of the I/Q modulator. The effect of a positive and negative gain imbalance is shown on Figure 6-5.

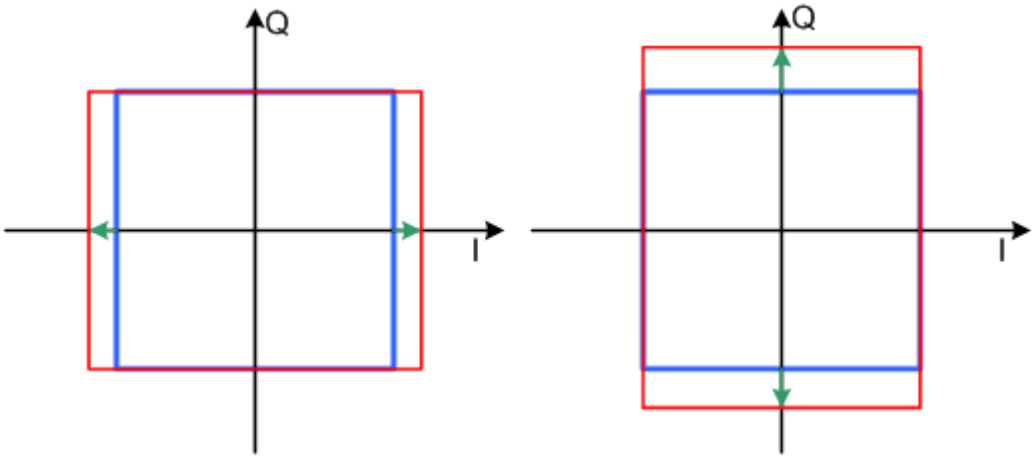


Figure 6-5: Negative gain imbalance (left) and positive gain imbalance (right) in the I/Q constellation diagram

6.2.2.2 I and Q offset

An I offset adds a constant value to all I amplitudes, leaving the Q amplitudes unchanged. A Q offset has the opposite effect. A combination of I and Q values results in an I/Q offset, which is due to carrier feedthrough in the I/Q modulator. Possible reasons are interfering signals at the RF carrier frequency, e.g. an unsuppressed RF carrier subchannel. The effect of a positive I and Q offset in the I/Q constellation diagram is shown on Figure 6-6.

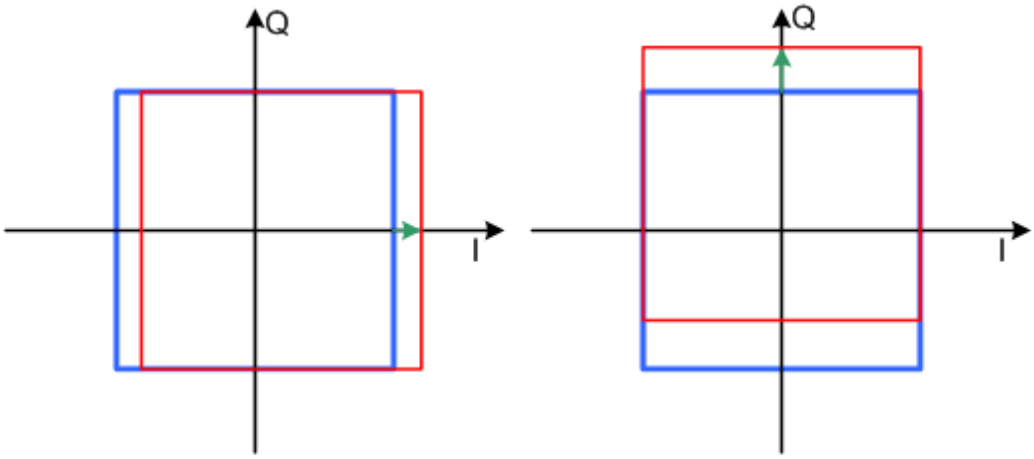


Figure 6-6: I offset (left) and Q offset (right) in the I/Q constellation diagram

6.2.2.3 Quadrature offset

Changes the phase angle between the I and the Q vectors from the ideal 90 degrees, while the amplitudes are maintained. A positive quadrature offset results in a phase angle greater than 90 degrees. The effect of a positive quadrature offset in the I/Q constellation diagram is shown on Figure 6-7.

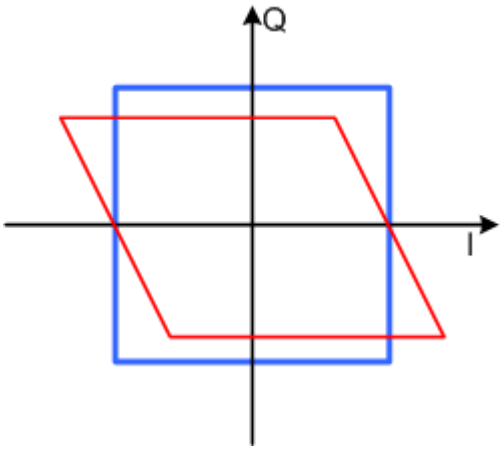


Figure 6-7: Positive quadrature offset in the I/Q constellation diagram

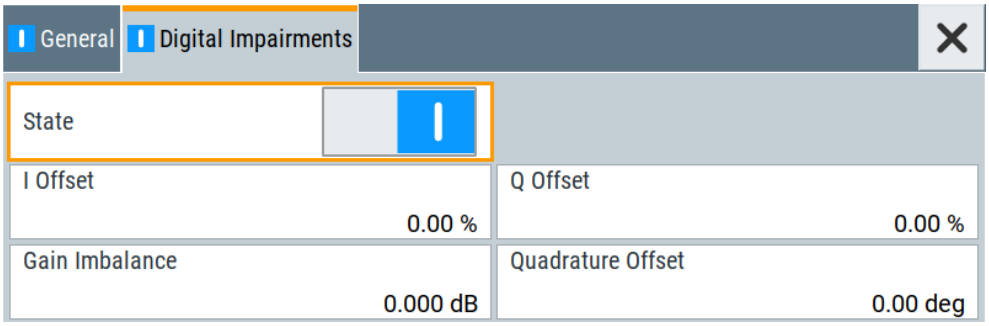
6.2.3 Digital impairments settings

You can add digital impairments to each internal generated I/Q stream.

See also Section 6.2.2, "About the linear I/Q impairments", on page 297.

Access:

► Select "I/Q Mod" > "I/Q Digital Impairments".



The dialog covers the settings for I/Q impairment, like leakage, imbalance and offset.

The remote commands required to define these settings are described in Section 14.16.4.5, "SOURce:BB:IMPairment subsystem", on page 762.

Settings:

State....300
I/Q Offset....300
Gain Imbalance....300
Quadrature Offset....301

State
Activates the impairment of the I/Q signal.

If activated, the settings for I/Q offset, I/Q imbalance, and quadrature offset become effective.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:STATe` on page 764

I/Q Offset
Sets a carrier offset (in percent) of the amplitudes (scaled to the peak envelope power (PEP)) for the I and/or Q signal component. An ideal I/Q modulator suppresses the carrier offset completely (offset = 0 percent).

For more information, see Section 6.2.2.2, "I and Q offset", on page 298.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:LEAKage:I` on page 763
`[:SOURce<hw>]:BB:IMPairment:LEAKage:Q` on page 763

Gain Imbalance
Sets the imbalance of the I and Q vector.

The entry is made in dB (default) or %, where 1 dB offset is roughly 12% according to the following:

Imbalance [dB] = 20log (| GainQ | / | GainI |)

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage. Negative values have the opposite effect.

For more information, see Section 6.2.2.1, "Gain and gain imbalance", on page 297.

Remote command:
[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] on page 763

Quadrature Offset
Sets the quadrature offset.

For more information, see Section 6.2.2.3, "Quadrature offset", on page 299.

Remote command:
[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] on page 763

7 Applying I/Q vector modulation

The R&S SMCV100B offers I/Q modulation with an external digital signals or an internally generated digital signal.

For a description on applying digital impairments and correcting the frequency response, see the following sections:

- Section 6.2, "Impairing the signal", on page 297
- Section 7.4, "Optimizing I/Q modulation performance", on page 305

- Required options....302
- About the I/Q modulator....302
- I/Q modulator settings....302
- Optimizing I/Q modulation performance....305

7.1 Required options

The equipment layout for I/Q modulation includes:

- Base unit
- One of the frequency options (R&S SMCVB-B103/-KB106)
  Sufficient for I/Q modulation with internal signal.

7.2 About the I/Q modulator

The R&S SMCV100B offers I/Q modulation with internally generated digital signals.

Defining the input signal of the I/Q modulator

The table Table 7-1 provides an overview of the possible input signals and input connectors. Any of the specified input signals is processed by the I/Q modulator and output at the RF output.

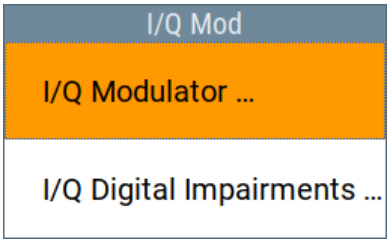
Table 7-1: Physical input signals of the I/Q modulator

Input signal	Input connector	GUI parameter
Internal digital baseband signal	-	"Baseband" > "On"
External digital signal	Dig. IQ HS 1	"BB Input" > "On"

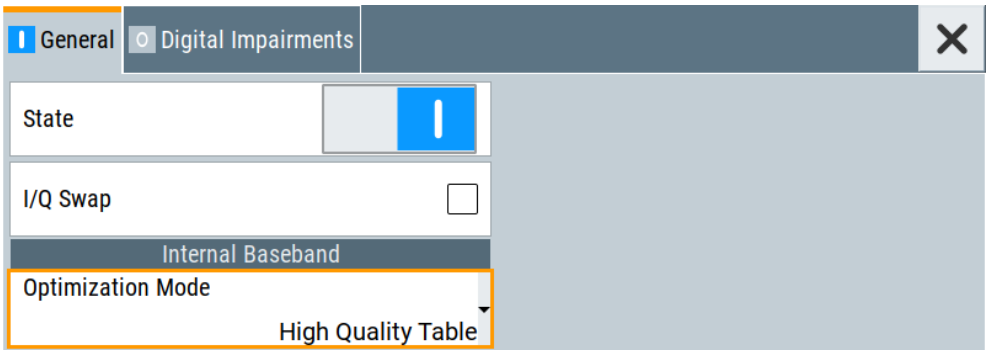
7.3 I/Q modulator settings

Access:

► Select "I/Q Mod" > "I/Q Mod" > "I/Q Modulator".



The "I/Q Modulator" dialog opens.



The dialog provides the I/Q modulator settings and settings for applying digital impairments.

The remote commands required to define these settings are described in Section 14.16.8, "SOURce:IQ subsystem", on page 782.

For a description on applying digital impairments and correcting the frequency response, see the following sections:

- Section 6.2, "Impairing the signal", on page 297
- Section 7.4, "Optimizing I/Q modulation performance", on page 305

Settings:

State....303
I/Q Swap....303
Optimization Mode....304

State
Activates/deactivates I/Q modulation.

Remote command:
`[:SOURce<hw>]:IQ:STATe` on page 782



I/Q Swap
Selects normal or swapped I/Q control for the generated signal.

The I/Q modulator defined in the IS2000 standard differs from the definition in this implementation. The definition on which the implementation is based is used by virtually all digital communication standards, except IS95 and IS2000.

In the final step, the filtered IQ signal is modulated to the desired RF in a different way in the I/Q modulator:

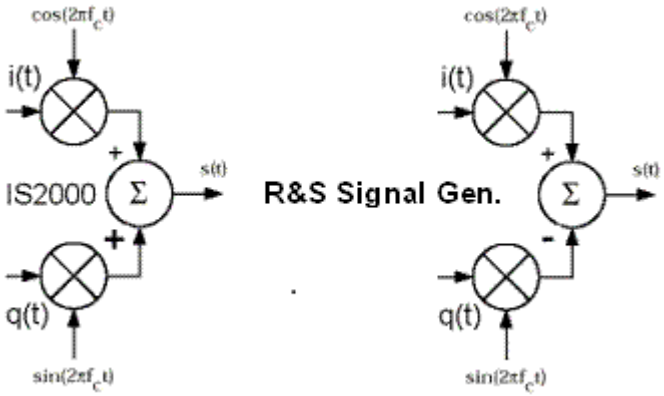


Figure 7-1: Definition of I/Q modulator in IS2000 and the R&S SMCV100B

IS2000 = The RF signal s(t) is derived from the baseband I/Q signal as $s(t)=i(t)\cos(2*pi*f_c t) + q(t)\sin(2*pi*f_c t)$

R&S SMCVB = The RF signal s(t) is based on the definition $s(t)=i(t)\cos(2*pi*f_c t) - q(t)\sin(2*pi*f_c t)$

"Off" I/Q control is normal.

"On" The modulation sidebands are inverted by swapping the I and Q signals (the Q-part of the signal is inverted).
The generated baseband signal is according to standards CDMA2000 and 1xEV-DO.
An I/Q modulator defined according to these standards can cope with the RF signal generated by the R&S SMCV100B.

Remote command:
`[:SOURce<hw>]:IQ:SWAP[:STATe]` on page 783

Optimization Mode
Selects the optimization mode for I/Q modulation of the internal baseband signal.

How to: Section 7.4, "Optimizing I/Q modulation performance", on page 305

For more information, refer to the specifications document.

"Fast" Fast optimization by compensating for I/Q skew. This mode is suitable in time sensitive environments and for narrowband signals.

"High Quality Table"
Requires R&S SMCVB-K547.
This mode further improves the frequency response while maintaining setting time. There is no signal interruption. Select this mode in set-ups to generate phase coherent signals with an RF modulation bandwidth of up to 240 MHz.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 764

7.4 Optimizing I/Q modulation performance

When using the default settings of the I/Q modulator, the R&S SMCV100B provides a vector-modulated RF signal. This signal is optimized for time sensitive measurements that require lower noise signals and narrowband signals.

For RF signals with larger I/Q modulation bandwidth, the R&S SMCV100B provides a predefined frequency response correction. This correction helps you to improve the signal flatness of the RF signal over the whole I/Q modulation bandwidth.

Predefined frequency response correction

Option: R&S SMCVB-K547

The R&S SMCV100B provides the optimization mode "High Quality Table" for I/Q modulation. To improve signal quality, this mode features the following:

- Frequency response correction for larger modulation bandwidth signals
- Correction of internally generated baseband signals by predefined correction values
- Absolute level correction at center frequency
- Correction in real time, no signal interruption

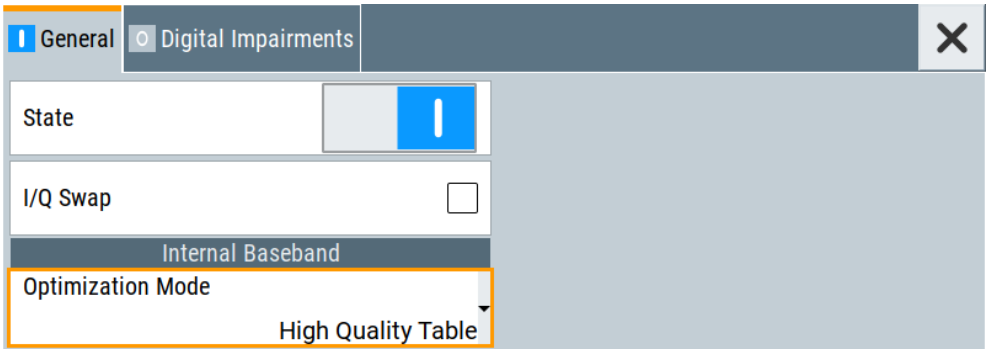
To improve RF signal flatness

In the following step-by-step instruction, we assume that:

- The R&S SMCV100B generates an RF signal. The I/Q modulator modulates a baseband signal onto the RF carrier.
- A spectrum analyzer is connected to the R&S SMCV100B. The analyzer is configured and measures the required signal characteristics.

In the following step-by-step instruction, we assume that you configured signal parameters of your baseband signal and RF signal. Also,

1. In the block diagram, enable baseband and RF signal generation:
   a) "Baseband" > "On".
   b) Select "RF" > "On"
2. Select "I/Q Mod" > "On".
   The I/Q modulator is enabled and modulates the internal baseband signal onto the RF carrier.
3. Select "I/Q Mod" > "I/Q Mod" > "I/Q Modulator".
   The general settings dialog of the I/Q modulator opens. By default, the R&S SMCV100B uses fast optimized I/Q modulation ("Optimization Mode" > "Fast") to compensate for I/Q skew.
4. Select "Optimization Mode" > "High Quality Table".



The R&S SMCV100B uses predefined values from the instrument calibration to correct the frequency response. This correction results in a flat signal over the whole I/Q modulation bandwidth.

5. On a connected signal analyzer, monitor the signal characteristics.

To correct systematic I/Q modulation errors

Adjust the I/Q modulator for a given carrier frequency to correct systematic errors, for example temperature fluctuations of several degrees. These corrections ensure precise and repeatable measurements.

► Select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "Adjust I/Q Modulator Current Frequency"

8 Configuring the RF signal

The vector signal generator R&S SMCV100B generates RF signals with outstanding spectral purity within the frequency range from 8 kHz up to 7.125 GHz and with adjustable signal level over a wide range.

In addition to these real-time CW signals, you can generate RF signals from predefined lists and sweep signals that vary according to the frequency or amplitude curves.

The variably adjustable output level due to the built-in attenuator, allows you to vary the RF signal level over the full level range. There are different methods to improve signal performance and to optimize the signal quality for the particular application, or to increase the accuracy and reliability of the generated RF signal.

The R&S SMCV100B supports R&S NRP power sensors, e.g. to monitor the output level of the generator and to determine the level correction values for user correction lists.

Signal modes and characteristics

The R&S SMCV100B generates unmodulated or modulated RF signals. You can output the signal in fixed mode or as a signal having periodically varying frequencies or amplitudes.

Signal modes for RF signal generation:

- Unmodulated signal
  Generates an unmodulated continuous wave (CW) of constant frequency and amplitude.

  For information on the signal frequency and level settings and example on how to configure a simple CW signal, see:
  - Section 8.5, "RF frequency settings", on page 311
  - Section 8.6, "RF level settings", on page 313
  - Section 3.3.1, "Generating an unmodulated carrier", on page 42
- Vector modulated signal
  Generates an I/Q vector modulated signal
  See Section 7, "Applying I/Q vector modulation", on page 302.

The R&S SMCV100B allows you to provide the RF signal with constant or varying frequencies and/or amplitudes at the output:

- Constant frequency and level (CW/Fixed mode)
  The RF output signal has the set frequency and level.
- Varying frequency and/or level
  - Sweep mode
    An RF or LF frequency and RF level sweep signal, processed continuously, step-by-step or individually and with selectable trigger modes. You can only run one sweep at a time.
  - List mode
    The RF signal is based on a list of predefined frequency and level values pairs and step widths.

See Section 8.9, "Varying the RF signal in list or sweep mode", on page 322.

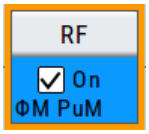
8.1 Required options

The equipment layout for generating the RF signal includes:

- Base unit
- Option frequency (R&S SMCVB-B103/-KB106)
- Optional, option extension from 60 MHz to 120 MHz RF bandwidth (R&S SMCVB-K521)
- Optional, option extension to 160 MHz RF bandwidth (R&S SMCVB-K522) (requires R&S SMCVB-K521)
- Optional, option extension to 240 MHz RF bandwidth (R&S SMCVB-K523) (requires R&S SMCVB-K522)

For more information, refer to the specifications document.

8.2 How to access the RF settings



Access:

1. In the block diagram, select the block "RF > RF".
2. Select the required function from the list.

   The RF block comprises all functions and settings concerning the RF signal. The settings include the RF frequency and level settings, enhanced functions for improving the signal characteristics, list and sweep mode settings and connector assignments and measurement functions of the RF signal.

8.3 How to activate the RF signal output

By default, the RF output signal is disabled. When you activate the RF output, the instrument restores the previously set signal configuration

To activate the RF output

1. Configure the RF signal as required.
   Set, for example, the frequency and level values.
2. Activate the RF output in one of the following ways:
   a) Select "Level > RF ON > On"

b) At the front panel, press the [RF On/Off] key.

The blue color of the "RF On" icon and the RF block indicate that the RF signal output is enabled.

RF State/RF ON....309
PEP....309
RF output impedance....309

RF State/RF ON
Activates or deactivates the RF output.

Acts as the [RF On/Off] key.

Remote command:
`:OUTPut<hw>[:STATe]` on page 629

PEP
Displays the PEP (Peak Envelope Power) in the status bar. This value corresponds to the level specification of a digital modulation or of a digital standard signal at the RF output.

Remote command:
`[:SOURce<hw>]:POWer:PEP?` on page 806

RF output impedance
You can query the impedance of the RF output.

Remote command:
`:OUTPut<hw>:IMPedance?` on page 630

8.4 How to set the frequency and level

The simplest form of the RF signal is a continuous wave (CW) of constant frequency and amplitude. The RF signal is defined by its frequency, level and phase.

► Use one of the following:

- "Status Bar > Frequency and Level"
- "RF > RF Frequency > Frequency > Frequency"
- "RF > RF Level > Level > Level"
- "RF > RF Frequency > Phase"

The frequency and level values are indicated on the "Status bar" so that you can see them at a glance. Values displayed in the status bar and in the "Frequency/Level" dialogs can deviate form each other.

See "RF frequency and level display with a downstream instrument" on page 310.

RF frequency and level display with a downstream instrument

If your test setup includes a downstream instrument, you can enter the parameter of the downstream instrument in the frequency or level settings dialog of the R&S SMCV100B. Examples of downstream instruments are mixers, frequency multipliers, amplifiers or attenuators and of their corresponding major parameters offset, multiplier, amplitude. The R&S SMCV100B generates the signal without the downstream parameters, but considers all additional parameters concerning the frequency and level.

Example parameters that affect the frequency and level:

- Frequency offset
- Multiplication factor
- User correction
- Digital attenuation

Any of these cases are indicated by a dedicated icon in the status bar, depending on the affected parameter.

Figure 8-1 illustrates the calculation of the "Frequency" and "Level" values, displayed in the status bar.

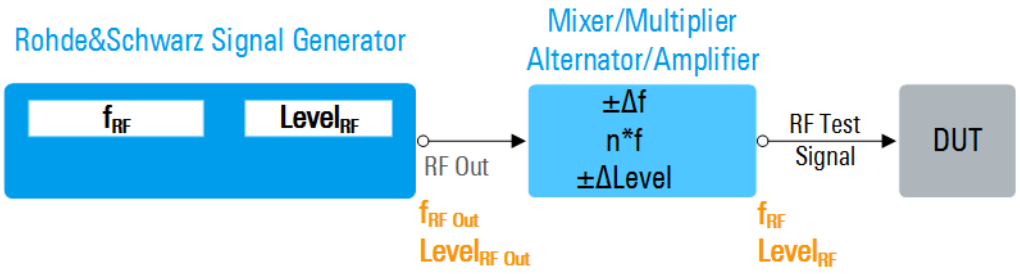


Figure 8-1: Frequency and Level display vs frequency and level at the RF output

f_{RF}, $Level_{RF}$ = Frequency and level ("Status bar > Frequency and Level") at the output of the downstream instrument, see also Calculation of f_{RF} and $Level_{RF}$)

$f_{RF\ Out}$, $Level_{RF\ Out}$ = Frequency and level at the output connector [RF 50 Ω] ("RF > RF Frequency > Frequency" and "RF > RF Level > Amplitude")

n*f = Multiplication factor ("RF > RF Frequency > Multiplier")

Δf = Frequency offset ("RF > RF Frequency > Offset")

ΔLevel = Power offset ("RF > RF Level > Offset")

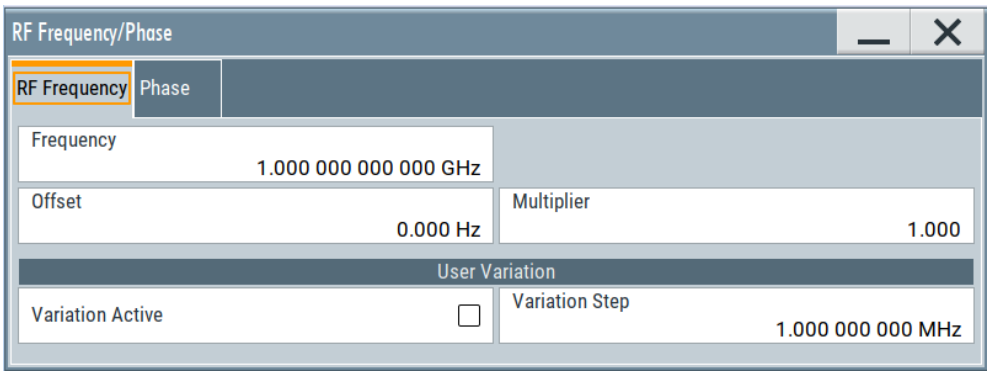
Calculation of f_{RF} and $Level_{RF}$

- $f_{RF} = n*f_{RF\ Out} + \Delta f$
- $Level_{RF} = Level_{RF\ Out} + \Delta Level + Level_{DigAtt}$
  ($Level_{DigAtt}$ for active internal I/Q modulation, "RF > RF Level > Digital Attenuation")

8.5 RF frequency settings

Access:

► Select "RF" > "RF Frequency" > "Frequency".



In the "RF Frequency" dialog, you can configure:

- RF frequency, incl. an offset or multiplication factor of a downstream instrument
- The step size for varying the frequency with the rotary knob.

The remote commands required to define the settings are described in Section 14.16.6, "SOURce:FREQuency subsystem", on page 776.

Settings

Frequency....311
Offset....312
Multiplier....312
User Variation....312
└ Variation Active....312
└ Variation Step....312

Frequency
Sets the RF frequency.

This frequency is output at the RF 50 Ω connector.

It does not consider any parameter that affect the frequency, as e.g., a frequency offset.

See "RF frequency and level display with a downstream instrument" on page 310.

Note: Suppressed values in the status bar

For security concerns or certain operating modes, you can hide the frequency and level display in the status bar.

- ******

  The display has been disabled for security reasons.
  See:
  – Annotation Frequency
  – Annotation Amplitude



The display is disabled when:

– List mode is running, see Section 8.9, "Varying the RF signal in list or sweep mode", on page 322.

Remote command:
[:SOURce<hw>]:FREQuency[:CW|FIXed] on page 777

Offset
Sets the frequency offset.

This value represents the frequency shift of a downstream instrument, like for example a mixer.

The "Frequency" value displayed in the status bar is the resulting frequency, as it is at the output of the downstream instrument. The frequency at the R&S SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 310.

Remote command:
[:SOURce<hw>]:FREQuency:OFFSet on page 779

Multiplier
Sets the multiplication factor for the RF frequency.

This value represents the multiplication factor of a downstream instrument, as for example a multiplier. You can also assign a negative multiplication factor, for example -1.0 to support frequency converters working in the reverse frequency position.

The "Frequency" value displayed in the status bar is the resulting frequency, as it is at the output of the downstream instrument. The frequency at the R&S SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 310.

Remote command:
[:SOURce<hw>]:FREQuency:MULTiplier on page 779

User Variation
Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

Variation Active ← User Variation
Activates the set user-defined step width.

Remote command:
[:SOURce<hw>]:FREQuency:STEP:MODE on page 781
[:SOURce<hw>]:POWer:STEP:MODE on page 810

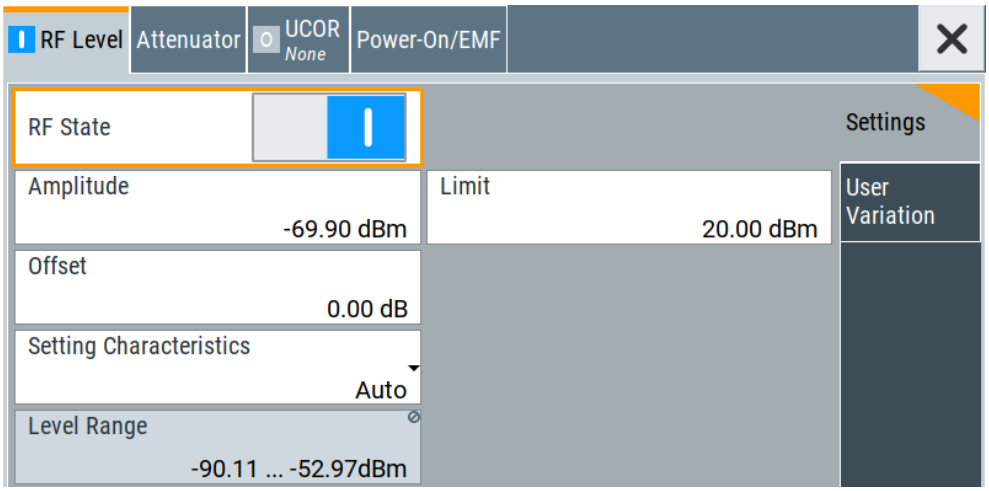
Variation Step ← User Variation
Sets the user-defined step width.

Remote command:
[:SOURce<hw>]:FREQuency:STEP[:INCRement] on page 781
[:SOURce<hw>]:POWer:STEP[:INCRement] on page 811

8.6 RF level settings

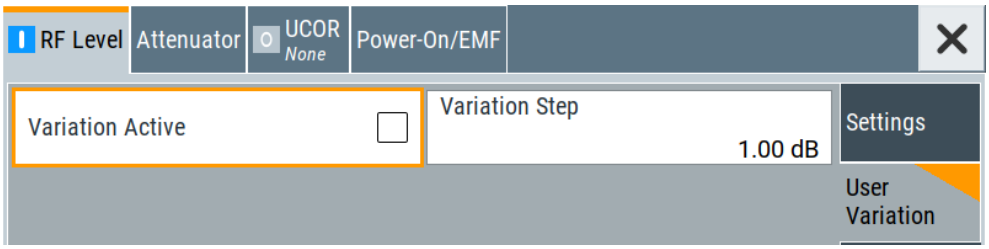
Access:

1. Select "RF" > "RF Level" > "Level".



In the "RF Level" dialog, you can configure the offset-free level, the level limit, and the step width for varying the level with the rotary knob.

2. Select "User Variation" to set the step width to be used when setting the RF level using the rotary knob.



The remote commands required to define the settings are described in Section 14.16.12, "SOURce:POWer subsystem", on page 802.

Settings

Amplitude 314
Limit 314
Offset 314
Setting Characteristics 315
Level Range 315

Readjust....315
User Variation....316
└ Variation Active....316
└ Variation Step....316

Amplitude
Sets the level of the RF signal.

The value is offset-free and corresponds to the level at the RF 50 Ω connector.

See "RF frequency and level display with a downstream instrument" on page 310.

Note: Suppressed values in the status bar

For security concerns or certain operating modes, you can hide the frequency and level display in the status bar.

- ******

  The display has been disabled for security reasons.
  See:
  – Annotation Frequency
  – Annotation Amplitude

  The display is disabled when:
  – List mode is running, see Section 8.9, "Varying the RF signal in list or sweep mode", on page 322.

Remote command:
`[:SOURce<hw>]:POWer:POWer` on page 807
Note: The SCPI command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display.
This means, the level containing offset.

Limit
Sets an upper limit for the output power.

Note: The parameter "RF level" > **"Limit"** and "NRP power control" > **"RF Amplitude Limit"** are identical.

You can use this value to protect your DUT from damage due to high input power. If you enter an RF level above this value, the instrument limits the output power to this specified value, and generates the warning message:

"Pep value greater than the defined limit." However, the level indication in the status bar is not affected.

The setting is not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
`[:SOURce<hw>]:POWer:LIMit[:AMPLitude]` on page 805

Offset
Sets a level offset.

This value represents the level shift of a downstream instrument, like, for example, an attenuator or an amplifier.

The "Level" value displayed in the status bar is the resulting level, as it is at the output of the downstream instrument. The level at the R&S SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 310.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet` on page 811

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Remote command:
`[:SOURce<hw>]:POWer:LBEHaviour` on page 805

Level Range
Shows the interruption-free range of the level that you can use in the currently selected mode.

Remote command:
`[:SOURce<hw>]:POWer:RANGe:LOWer?` on page 813
`[:SOURce<hw>]:POWer:RANGe:UPPer?` on page 813

Readjust
Recalculates and adjusts the internal switch positions of the RF chain according to the current level.

The R&S SMCV100B provides the "Readjust" function when you change one of the following parameters from the default setting:

- "RF Level" > Setting Characteristics
- "Attenuator" > Mode > FixedSetting Characteristics

Remote command:
`[:SOURce<hw>]:POWer:ALC:SONCe` on page 804

User Variation
Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

Variation Active ← User Variation
Activates the set user-defined step width.

Remote command:
`[:SOURce<hw>]:FREQuency:STEP:MODE` on page 781
`[:SOURce<hw>]:POWer:STEP:MODE` on page 810

Variation Step ← User Variation
Sets the user-defined step width.

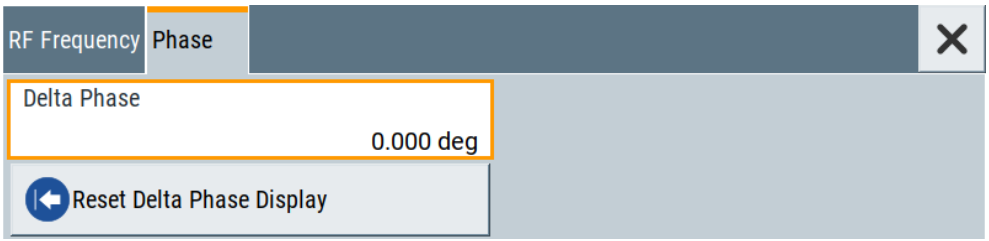
Remote command:
`[:SOURce<hw>]:FREQuency:STEP[:INCRement]` on page 781
`[:SOURce<hw>]:POWer:STEP[:INCRement]` on page 811

8.7 RF phase settings

The phase in sinusoidal signals defines the initial angle at its origin.

Access:

► Select "RF" > "RF Frequency" > "Phase".



In the "RF Phase" tab, you can determine the delta phase value and reset the phase to this reference.

The remote commands required to define the settings are described in Section 14.16.11, "SOURce:PHASe subsystem", on page 801.

Settings

Delta Phase....316
Reset Delta Phase Display....317

Delta Phase
Sets the phase of the RF signal.

The current phase of the signal is used as the reference.

Remote command:
[:SOURce<hw>]:PHASe on page 801

Reset Delta Phase Display
Adopts the selected "Delta Phase" value as the current value, and resets delta phase to 0 degrees.

Remote command:
[:SOURce<hw>]:PHASe:REFerence on page 802

8.8 Reference oscillator

The R&S SMCV100B is equipped with an internal reference oscillator that generates a reference frequency of 10 MHz. It is used as internal reference source for the synthesizer.

Alternatively, you can apply an external reference signal with reference frequency of 10 MHz or 13 MHz.

The reference oscillator settings are not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. They are reset only by factory preset.

8.8.1 Required options

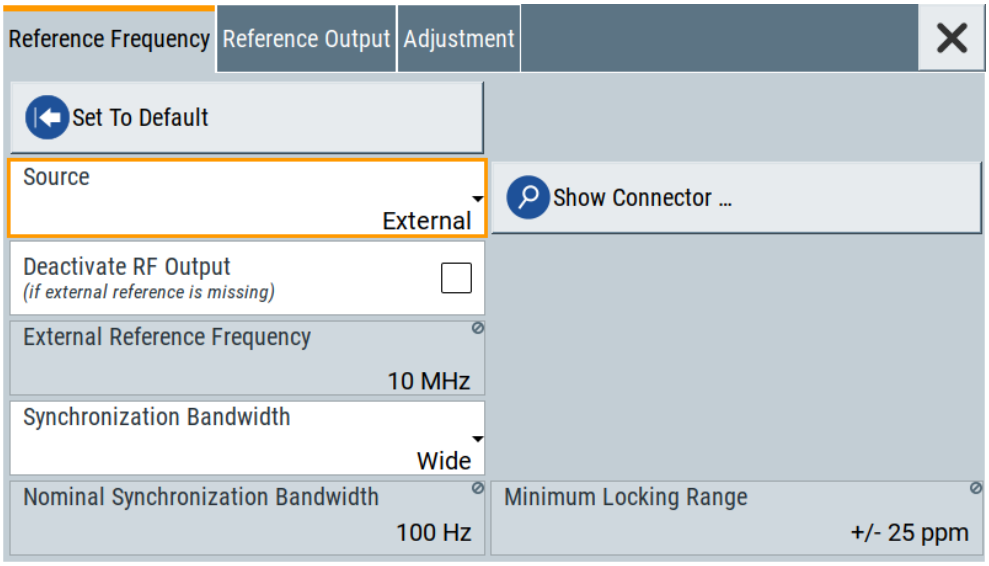
R&S SMCV100B base unit

For more information, refer to the specifications document.

8.8.2 Reference frequency settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".



In the "Reference Frequency" tab, you can select the reference frequency signal source and the frequency and synchronization bandwidth mode of an external reference signal.

2. Observe the information in the status bar of the block diagram.

   The status bar indicates the current oscillator configuration.



   The remote commands required to define these settings are described in Section 14.16.13, "SOURce:ROSCillator subsystem", on page 814.

Settings:

Set to Default 318
Source 318
Show Connector 319
Deactivate RF Output (if external reference is missing) 319
External Reference Frequency 319
Synchronization Bandwidth 319
Nominal Synchronization Bandwidth 320
Minimum Locking Range 320

Set to Default
Resets the reference oscillator settings to default.

Remote command:
`[:SOURce]:ROSCillator:PRESet` on page 814

Source
Selects the reference frequency source.

"Internal" Uses the internal reference oscillator, either with calibrated or a user-defined Adjustment Value.

Note: The internal reference frequency automatically uses Synchronization Bandwidth > Narrow. Thus, if you preset this parameter, or set the reference source from "External" to "Internal" manually, the R&S SMCV100B sets the bandwidth to "Narrow".

"External" Uses an external reference signal.

Note: If the external reference is missing, the R&S SMCV100B issues a warning message and indicates the icon (external reference missing).

To set the frequency of the external reference, see "External Reference Frequency".

Remote command:
`[:SOURce]:ROSCillator:SOURce` on page 815



Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

Deactivate RF Output (if external reference is missing)
Turns off the RF output when the external reference signal is selected, but no signal is supplied.

This function prevents that no improper RF signal due to the missing external reference signal is used for measurements. A message indicates that the RF output is deactivated.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe]` on page 815

External Reference Frequency
Selects the frequency of the external reference input signal.

"10 MHz" 10 MHz external reference frequency

"13 MHz" 13 MHz external reference frequency
If selected, you cannot select 10 MHz or 13 MHz as reference output frequency. See "Reference Output" on page 321.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:FREQuency` on page 815

Synchronization Bandwidth
Selects the synchronization bandwidth for an external reference signal, set with "Source > External".

The resulting bandwidth is indicated by the parameter Nominal Synchronization Bandwidth.

"Narrow" The internal reference oscillator is synchronized to the external signal with narrow bandwidth.
This setting is recommended if the phase noise of the external signal is worse than the phase noise of the internal OCXO.

"Wide" Synchronizes the internal oscillator to the external signal with the maximum possible bandwidth.
This mode is the recommended standard mode and for precise reference sources of high spectral purity.

Note: If the frequency of the external reference signal is outside the locking range of the internal reference oscillator, spurs due to the difference of the internal and external reference frequency are generated in the reference PLL.
The R&S SMCV100B issues an error message.

For more information, refer to the specifications document.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:SBANdwidth` on page 815

Nominal Synchronization Bandwidth
Indicates the nominal synchronization bandwidth for the selected external reference frequency and the synchronization bandwidth.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:NSBandwidth?` on page 816

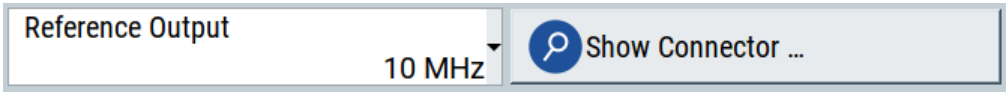
Minimum Locking Range
Indicates the minimum locking range for the selected external reference frequency and the synchronization bandwidth.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:MLRange?` on page 816

8.8.3 Reference output settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".
2. Select "Reference Output".



In the "Reference Output" tab, you can set the reference frequency value at the output connectors.
As a result of parameter dependencies, "Preset This Parameter" sometimes does not affect output dialogs.
The remote commands required to define these settings are described in Section 14.16.13, "SOURce:ROSCillator subsystem", on page 814.

Settings:

Reference Output....321
Show Connector....321

Reference Output
Selects the frequency of the reference output signal for downstream instruments.

"Off" Disables the reference signal output.

"10 MHz" Requires "Reference Frequency" > "External Reference Frequency" > "10 MHz".
Derives a signal with 10 MHz frequency from the internal reference oscillator and provides this signal at the output.

"Input Signal (loop through)"
Requires "Reference Frequency > Source > External".
Passes the external reference frequency to the output directly. You can pass through frequencies of 10 MHz or 13 MHz.

Remote command:
`[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE` on page 816

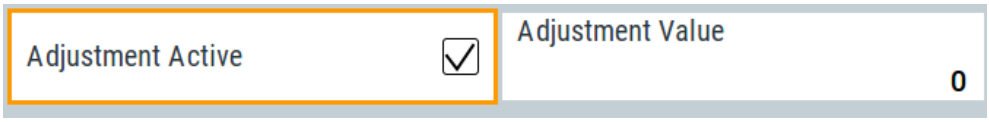
Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

8.8.4 Adjustment settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".
2. Select "Adjustment".



Settings:

Adjustment Active.... 321
Adjustment Value.... 322

Adjustment Active
Selects the adjustment mode.

"Off" Uses the calibrated internal reference frequency.

"On" Allows you to apply a deviation to the internal reference frequency, according to your requirements.
Enter the value in the Adjustment Value field.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]` on page 817

Adjustment Value
Sets a user-defined adjustment value for the internal reference frequency. This value takes effect when it is activated with Adjustment Active.

- "0" represents the calibrated state.
- The setting range depends on the reference oscillator type and its factory calibration value.

Note:
The setting is not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue` on page 817

8.9 Varying the RF signal in list or sweep mode

The operating modes "List" and "Sweep" allow you to generate an RF signal having periodically varying frequencies or amplitudes.

A signal generated with varying parameters scans a certain range of varying values of a parameter, with defined start and end points, and can be repeated cyclically.

The R&S SMCV100B supports two basic methods:

- **Sweep** mode
  The instrument generates an RF signal which varies its frequency or level values in discrete steps between the start and end values. The values change according to a specific shape like sawtooth or triangle. The spacing is linear or logarithmmic.

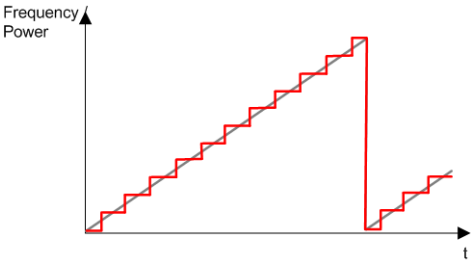


Figure 8-2: Schematic representation of a signal generated in sweep mode

  The main application field of the "Sweep" mode is to determine the frequency response a DUT.

- **List** mode
  The instrument generates a varying output signal, based on a previously saved list with frequency, amplitude and step width values. While in sweep mode the fre-

quency **or** the level values change, in list mode you can vary **both parameters simultaneously**. The frequency and level values do not need to have ascending or descending order, they can vary arbitrarily.
You can use a global dwell time, which means that the time interval is constant for all steps of the list, or different dwell times for each value pair.
Figure 8-3 represents the frequency and power value pairs, in this case with the dwell time set the same for all steps (global dwell time).

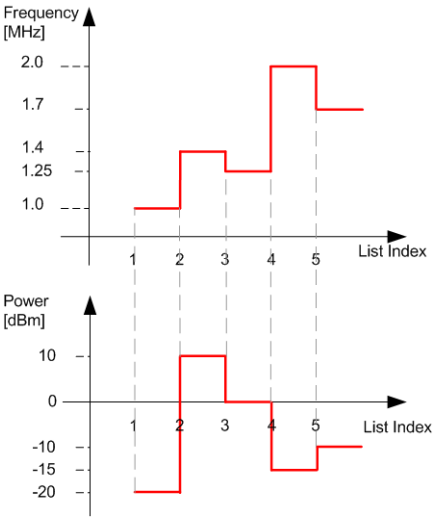


Figure 8-3: Schematic representation of a signal generated in list mode (global dwell time)

The list mode is especially useful in high-speed measurements with fast changing frequency and level settings.

Note that the shown diagrams represent the behaviour in theory. In real signal generation, the instruments usually have a blank time when the frequency or level changes.

Interactions and characteristics of list and sweep mode

- Activating the list mode automatically deactivates all RF and LF sweeps and vice versa.
- In list processing mode, the frequency and level display in the status bar is disabled.



- The sweep modes only work with a *global* dwell time, that means the time intervals are constant during signal generation.
- If you want to hold a running sweep at a specific frequency or level value, enter the value in the status bar. The sweep stops immediately.
- We recommend that you switch off the display update for optimum sweep performance, especially with short dwell times
  See Section 12.1.2, "Display update settings", on page 454.

8.9.1 Signal generation and triggering in the sweep and list modes

In both operating modes "List" and "Sweep", triggering and signal generation follow the same principle. The instrument generates the signal continuously (that means triggered automatically) or in individual steps (controlled manually by an internal or external trigger signal).

If the dwell time in sweep or list mode is too short or external trigger signals come too fast, the signal generation delays. As the delay increases, the R&S SMCV100B signals an overrun, or even stops sweep or list mode signal generation, if the delay gets too long.

The instrument diplays corresponding error messages.

The figures in this section give an overview on the signal generation in the sweep and list modes and the appropriate triggering. The figures show the signal state after activating the mode and the generation of the signal when a trigger event occurs. For each mode, the relevant parameters and settings are briefly explained.

Each "Sweep" and "List" mode dialog provides also a "Reset" function that sets the signal to the initial value or the beginning of the list. Depending on the selected trigger mode, the signal generation proceeds accordingly.

The naming of the selection parameters in manual control (GUI) sometimes deviates from the naming in the remote-control commands. In addition, the value names of the selection parameters used in the signal generator partly differ from the SCPI syntax. The instrument accepts all value names.

The correlation between the manual control and the corresponding remote control commands, including the SCPI conform syntax are explained for each mode (see the cross-reference tables).

See also the following programming examples on the sweep and list modes in remote control:

- Example "Setup an RF frequency or power sweep" on page 818
- Example "Create an RF list and activate the list mode" on page 788

Auto mode (Sweep/List)

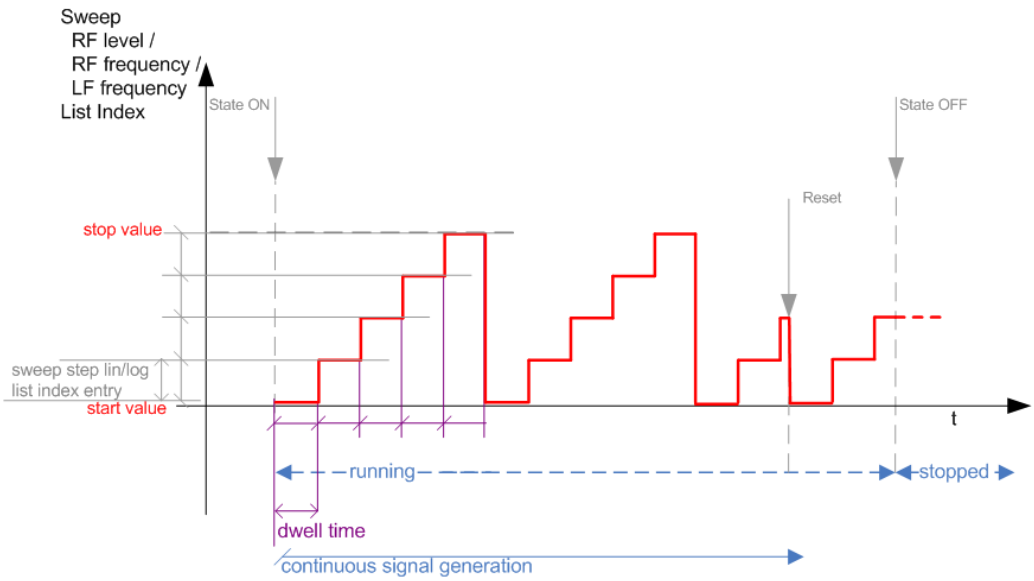


Figure 8-4: Auto mode (Sweep/List)

- The instrument generates the signal continuously.
- Trigger mode "Auto" is prerequisite (default). It causes the continuous generation of the sweep signal.
- Starts signal generation immediately with "State = On".
- Switches automatically to the next step when the Dwell time has elapsed.
- Stops signal generation with "State = Off".

Table 8-1: Cross-reference between manual and remote control in Auto mode (Sweep/List)

Manual control mode: "Auto"	**Remote commands** **Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce AUTO [IMMediate]` `:SOURce<hw>:SWEep:FREQuency:MODE AUTO`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce AUTO [IMMediate]` `:SOURce<hw>:SWEep:POWer:MODE AUTO`
List	`:SOURce<hw>:LIST:MODE AUTO` `:SOURce<hw>:LIST:TRIGger:SOURce AUTO`

Single / Extern Single mode (Sweep/List)

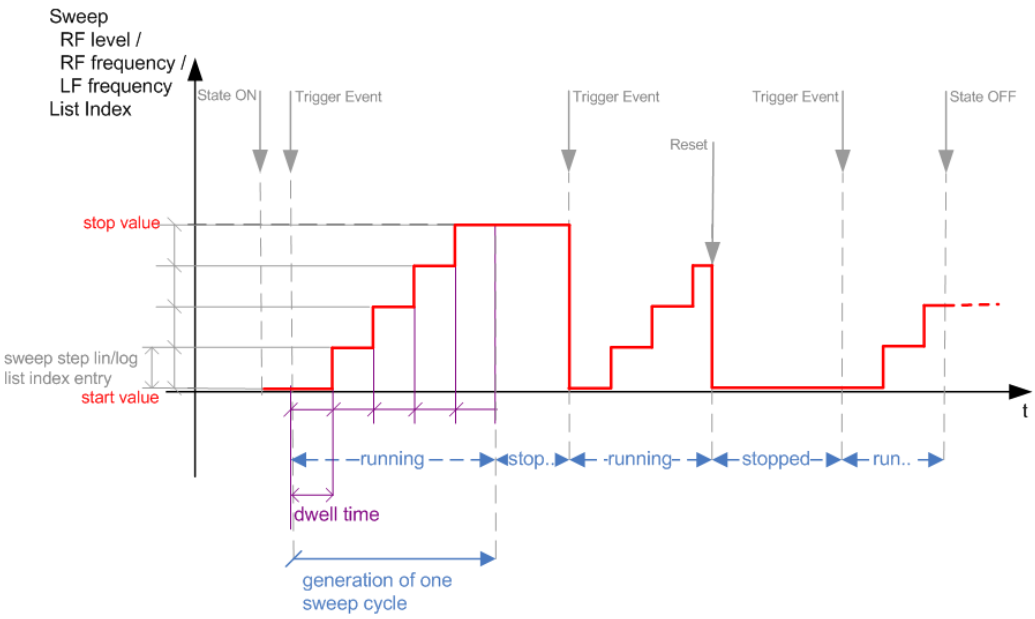


Figure 8-5: Single / Extern Single mode (sweep / list)

In single mode, you can specify, that the signal returns to the start value when a sweep cycle has been completed.

See "The Retrace function" on page 330 for details.

- The instrument generates a single sweep cycle.
- Trigger mode "Manual". A trigger event initiates one sweep from the start value to the end value.
- "State = On" sets the signal to the start value: the sweep start frequency, the sweep start power or the frequency-power value pair of the selected index in the list.
- Starts signal generation with a trigger event.
- Switches automatically to the next step when the Dwell time has elapsed.
- Stops signal generation at the set end value and waits for the subsequent trigger event.
- Trigger sources:
  - The "Execute Single Sweep" function.
  - The corresponding remote control command.
  - An externally applied trigger signal.
- "State = Off" stops the signal generation in sweep or list mode.

Table 8-2: Cross-reference between manual and remote control in Single / Extern Single modes (Sweep/List)

Manual control mode: **"Single / Extern Single"**	**Remote commands** **Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce SINGle [BUS]` "Single" **or** `:TRIGger<hw>:FSWeep:SOURce EXTernal [EXTernal]` "Extern Single" `:SOURce<hw>:SWEep:FREQuency:MODE AUTO`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce SINGle [BUS]` for "Single" **or** `:TRIGger<hw>:PSWeep:SOURce EXTernal [EXTernal]` for "Extern Single" `:SOURce<hw>:SWEep:POWer:MODE AUTO`
List	`:SOURce<hw>:LIST:TRIGger:SOURce SINGle` "Single" **or** `:SOURce<hw>:LIST:TRIGger:SOURce EXTernal` "Extern Single" `:SOURce<hw>:LIST:MODE AUTO`

Step / Extern Step mode (Sweep/List)

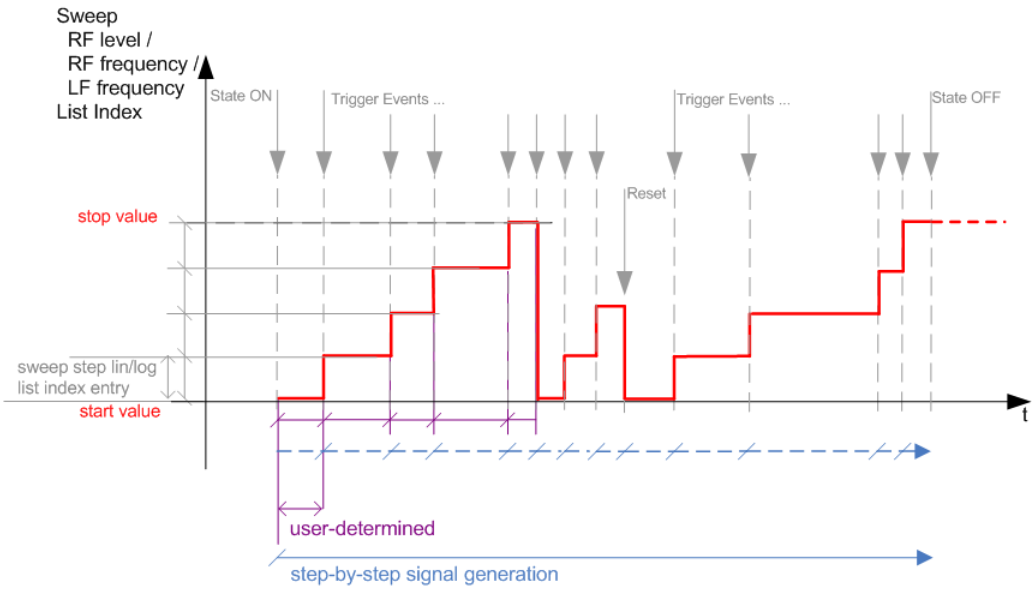


Figure 8-6: Step / Extern Step mode (sweep / list)

- The instrument generates the signal step-by-step.
- Starts signal generation with "State = On".
- Switches to the next step with a manual action.
  If the end value is reached, signal generation starts again from the beginning.
- Stops signal generation with "State = Off".
- Trigger sources:
  - The rotary knob at the front panel.
  - The corresponding remote control commands.
  - An externally applied trigger signal.

To step through the sweep frequencies or levels:

- In manual mode:
  - Set the Current Frequency or Current Level values
- In remote control mode:
  - Use the commands `[:SOURce<hw>]:FREQuency:MANual` or `[:SOURce<hw>]:POWer:MANual` with the `UP` or `DOWN` parameter

Steps that would exceed the sweep range are ignored.

Table 8-3: Cross-reference between manual and remote control in Step / Extern Step modes (Sweep/ List)

Manual control mode: **"Step / Extern Step"**	**Remote commands** **Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce SINGle [BUS]` "Step" **or** `:TRIGger<hw>:FSWeep:SOURce EXTernal [EXTernal]` for "Extern Step" `:SOURce<hw>:SWEep:FREQuency:MODE STEP`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce SINGle [BUS]` "Step" **or** `:TRIGger<hw>:PSWeep:SOURce EXTernal [EXTenal]` "Extern Step" `:SOURce<hw>:SWEep:POWer:MODE STEP`
List	`:SOURce<hw>:LIST:TRIGger:SOURce SINGle` "Step" **or** `:SOURce<hw>:LIST:TRIGger:SOURce EXTernal` "Extern Step" `:SOURce<hw>:LIST:MODE STEP`

Extern Start/Stop mode (sweep)

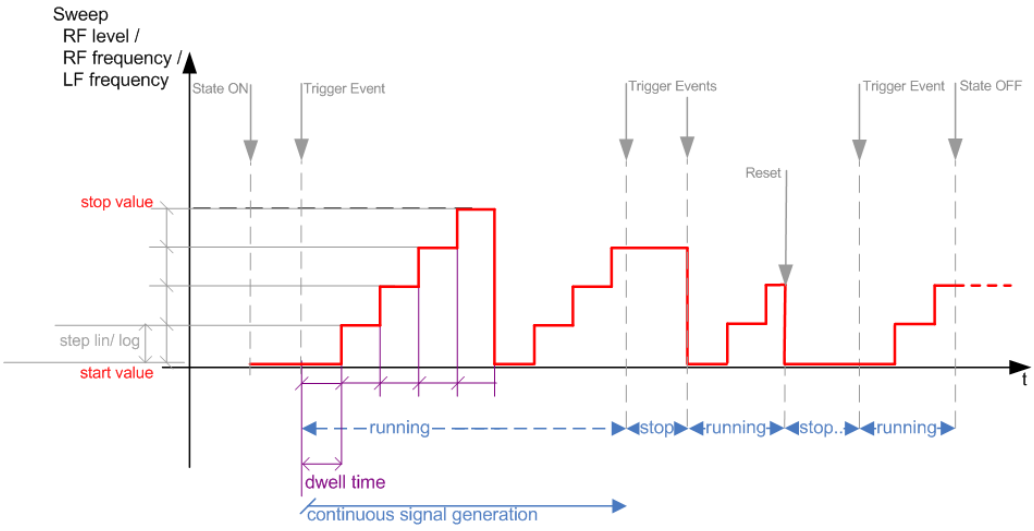


Figure 8-7: Extern Start/Stop mode (sweep)

- The instrument generates the signal continuously.

- Trigger mode "Auto" and "Sweep > State = On" are prerequisite.
- State "On" sets the signal to the start value, that is one of the following:
  - Sweep start frequency
  - Sweep start power
  - Frequency-power value pair of the selected index in the list
- Starts signal generation with a trigger event.
- Switches automatically to the next sweep step when the Dwell time has elapsed. If the end value is reached, signal generation continues with the next sweep cycle.
- Stops signal generation with the next external trigger event.
- Starts the signal generation again with the next trigger event, beginning at the start value.
- "State = Off" stops the signal generation in sweep or list mode.
- Trigger source: An externally applied trigger signal.

Table 8-4: Cross-reference between manual and remote control in Extern Start/Stop modes (sweep)

Manual control mode: "Extern Start/Stop"	**Remote commands** **Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce EAUTo [-]` `:SOURce<hw>:SWEep:FREQuency:MODE AUTO`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce EAUTo [-]` `:SOURce<hw>:SWEep:POWer:MODE AUTO`

Manual mode (Sweep/List)

The **manual** mode only applies to remote control. It is not visible in the graphical user interface of the instrument and is described here for completeness.

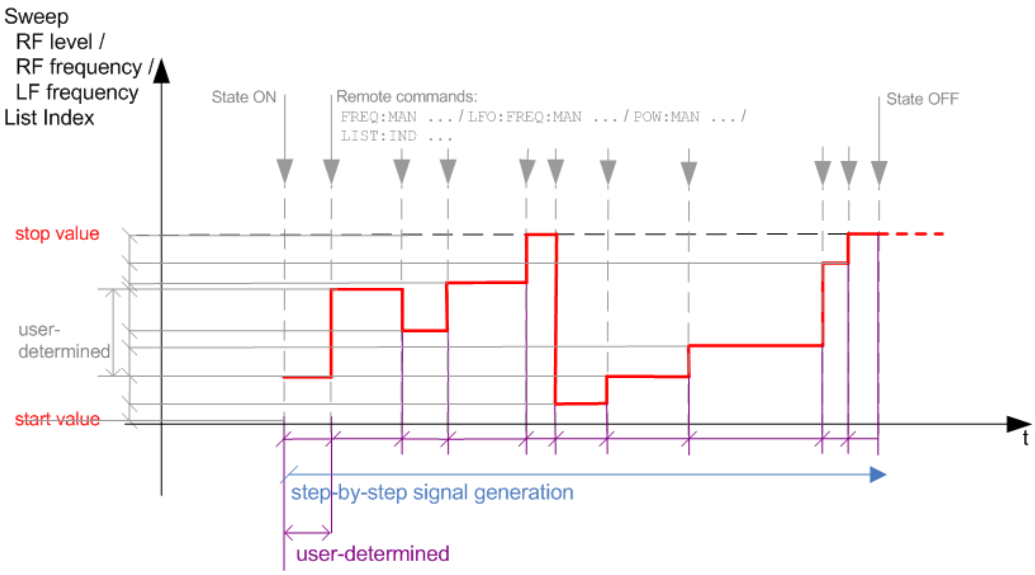


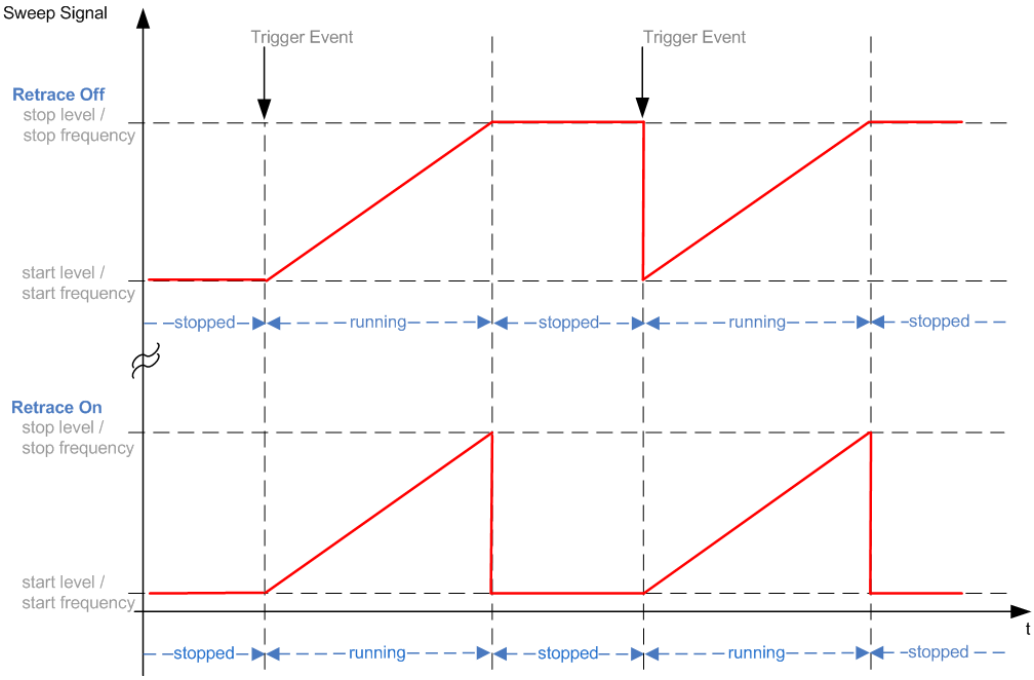
Figure 8-8: Manual mode in remote control (sweep / list)

- The instrument generates the signal in steps.
- Starts signal generation with "State = On".
- Switches to the next step with a user defined setting via remote control.
  You can arbitrarily select a value within the range of the start and stop values by setting the frequency, power or index using the corresponding remote control command. There is no ascending or descending order.
- Stops signal generation with "State = Off".

Table 8-5: Remote control commands in manual mode (Sweep/List)

Remote control mode: Manual	**Remote commands Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:SOURce<hw>:FREQuency:MANUal <Manual>`
RF level sweep	`:SOURce<hw>:POWer:MANual <Manual>`
List	`:SOURce<hw>:LIST:INDex <Index>`

The Retrace function



Retrace is a function especially designed for "Single" sweep modes, when the sweep signal follows a sawtooth shape. Working in this mode, the instrument performs a single sweep cycle when a trigger event occurs. The signal generation stops at the set end point (stop frequency or stop level), and waits for the next trigger event.

In this state, the upper value of the signal remains at the output until the next cycle starts. In particular, if you generate a level sweep signal, the high amplitude of the signal is output for a certain time. To protect the DUT from overload, the retrace function immediately resets the signal value to the start value at the end of a sweep cycle. It returns to the start level or start frequency until the next trigger is applied.

You can use the "Retrace" function if "Sweep > Mode = Single/External Single" and "Shape = Sawtooth", see:

- "Shape" on page 339
- "Mode" on page 339

8.9.2 About sweep mode

In sweep mode, the signal generator scans the sweep range gradually from one point to another, using a defined step size and following a triangle or sawtooth shape. This mode also enables you to change direction, that means, it is possible to step backwards.

See Section 8.9.2.2, "Sweep signal shapes", on page 333.

Configuration and operation of sweep mode signals

- The R&S SMCV100B generates a sweep signal by varying the following parameters: either the *RF frequency*, the *RF level* or both, the *RF frequency* and the *RF level* in combined RF sweep mode, or the *LF frequency*.
- In all sweep modes, you can perform a complete sweep cycle once, repeat the cycle continuously or step through it gradually.
- The instrument generates the sweep signal according to the sweep settings.
- The "Reset Sweep" function, provided in the sweep settings dialogs enables you to reset the sweep to its initial value and restart it.

Impact of changing the sweep mode during performance

If you change the sweep mode during the execution, the signal generator stops the sweep and starts with the next trigger event at the initial value.

Combined RF frequency / level sweep processing mode

The combined RF sweep functionality processes the signal similar to the Live list mode. The R&S SMCV100B sets the frequency and level values simultaneously in the hardware. The difference to the list mode is that the values are not taken from a previously created list, but are calculated using the selected frequency and level ranges, the dwell time and the number of steps.

8.9.2.1 Correlating parameters in sweep mode

A sweep signal is a periodic signal that changes its frequency or level, or both, from a starting value to an ending value in a defined time.

The R&S SMCV100B provides various possibilities to configure a sweep signal. For example, you can determine the sweep range by the start and end values, or based on the start value and span. In any case, related parameters are adjusted accordingly.

The formulas below show how the sweep parameters correlate and the corresponding calculation basis, by the frequency and offset settings. Apart from "Center Frequency", "Span" and "Step_lin", the values apply accordingly to the level settings.

Table 8-6: Variables that are used in the following formulas

Variable	Description
Sweep range	Defined frequency or level value range
f_{CENTer}	Defined center frequency
f_{SPAN}	Defined extend of the sweep range
f_{OFFSet}	Frequency offset
f_{STARt}	Start frequency of the sweep range
f_{STOP}	End frequency of the sweep range
f_1	Current sweep frequency
f_2	Next, subsequent sweep frequency
step_lin	Step size in linear scaling
step_log	Step size in logarithmic scaling
POINts	Number of steps within the sweep range

Sweep range

The sweep range is defined by a start and an end value. How the remaining parameters correlate is shown below.

Offset = 0

Sweep Range = f_{STARt} to f_{STOP}

$f_{CENTer} = (f_{STARt} + f_{STOP})/2$

$f_{SPAN} = (f_{STOP} - f_{STARt})$

Where:

$f_{STARt} = f_{CENTer} - (f_{SPAN}/2)$

$f_{STOP} = f_{CENTer} + (f_{SPAN}/2)$

Offset≠0

A defined offset also affects the sweep range and the center frequency. Therefore, the set frequencies are only absolute values, if the Offset = 0. Offset ≠ 0 shifts the frequencies with the offset value:

Sweep Range = $f_{STARt} + f_{OFFSet}$ to $f_{STOP} + f_{OFFSet}$

$f_{CENTer} = f_{CENTer} + f_{OFFSet}$

$f_{SPAN} = f_{SPAN} + f_{OFFSet}$

The value range of the instrument is calculated as follows:

$RF_{min} + f_{OFFSet}$ to $RF_{max} + f_{OFFSet}$

It is possible to set $f_{STARt} > f_{STOP}$ and $f_{STARt} < f_{STOP}$, so that even a negative value is permitted for the "Span".

If you change the start and/or stop frequency, the span and center frequency change accordingly, and vice versa.

Sweep steps

In the following, you see how the sweep steps are calculated depending on the defined spacing mode. The formulas show a frequency sweep, but apply to the level settings in the same way.

The step size is added to the current value, to get the subsequent sweep step.

With **linear** scaling, the next frequency is calculated according to:

$f_2 = f_1 + step_lin$

In the **logarithmic** scaling, the step size is determined in per cent, as a constant fraction of the current frequency.

Successive frequencies are calculated as follows:

- For $f_{STARt} < f_{STOP}$
  $f_2 = f_1*(1 + step_log/100)$
  If $f_2 > f_{STOP}$, then $f_2 = f_{STOP}$
- For $f_{STARt} > f_{STOP}$
  $f_2 = f_1/(1 + step_log/100)$
  If $f_2 < f_{STOP}$, then $f_2 = f_{STOP}$

With "Shape = Triangle", the frequency values on the slope from f_{STOP} to f_{STARt} are the same as on the slope from f_{STARt} to f_{STOP}.

If you specify the number of steps within the sweep range, the step size is adjusted according to the following correlation:

- For **linear** sweeps and $f_{STARt} < f_{STOP}$
  $POINTs_{frequency} = ((f_{STARt} - f_{STOP})/step_lin) +1 = (f_{SPAN}/step_lin) + 1$
- For **logarithmic** sweeps and $f_{STARt} < f_{STOP}$
  $POINTs_{frequency} = ((\log f_{STOP} - \log f_{STARt})/\log step_log) +1$

If step_log changes, the value of POINTs is adjusted. The f_{STARt} and f_{STOP} values are retained.

8.9.2.2 Sweep signal shapes

The R&S SMCV100B supports the following sweep shapes:

- Sawtooth
  The sweep sequence resembles a sawtooth. One sweep runs from start to stop frequency, or level value respectively. Each subsequent sweep starts again at the start value.

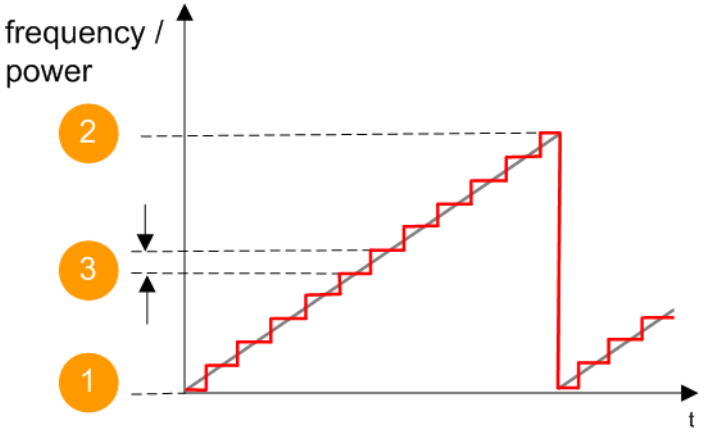


Figure 8-9: Sweep signal sawtooth shape

1 = Start value
2 = Stop value
3 = Step size

- Triangle
  The sweep sequence resembles a triangle. One sweep runs from start to stop value frequency and back. Each subsequent sweep starts at the start value.

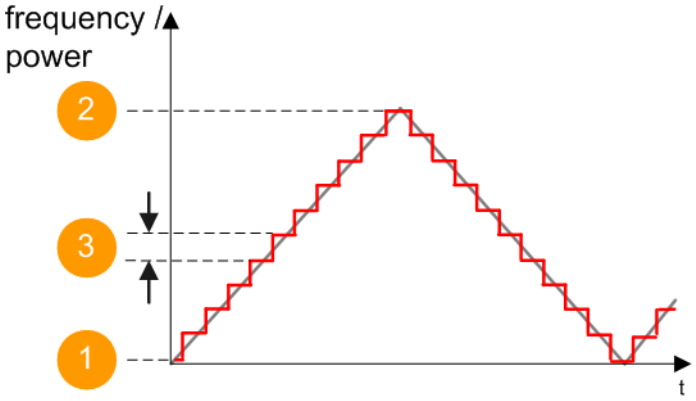


Figure 8-10: Sweep signal triangle shape

1 = Start value
2 = Stop value
3 = Step size

The current frequency or level of an RF frequency, level or LF frequency sweep is determined by the shape (e.g. sawtooth or triangle) and the spacing (linear or logarithmic), and the step size.

8.9.3 About list mode

The list mode is used to generate the RF signal based on a set of predefined frequency and amplitude value pairs, with individual step times. You can define the values arbitrarily, in any order and varying step sizes, within the entire configurable value range of the instrument.

Configuration and operation of list mode signals

The parameters configuring the RF signal are defined in a list (table) and stored in a file.

Creating and handling lists

List files can be created in the following ways:

- **Internally**
  Use the build-in table editor with columns for the frequency-level values pairs and the dwell time.
  Define the values manually (row by row) or automatically, based on value range and step size.
  See Section 8.9.7, "List editor", on page 352.
  Lists are saved as files with user-definable filename and the predefined file extension `*.lsw`. To load a saved file, use the "File Manager".
  See Section 11.9, "Using the file manager", on page 434.
- Lists can be exported, too. For example, to exchange configuration between instruments or to modify the file content with an external program and reload them again.
- **Externally**
  Create a list file as a CSV file with Microsoft Excel, with a Notepad or a similar tool and save it with the predefined extension. Transfer the file to and load it into the instrument.

Dwell time mode

You can choose whether you want to use different dwell times or a fixed value for all steps in the list mode:

- "From List"
  This mode uses the values from the data table.
  See Edit List Mode Data
- "Global"
  This mode processes the list with a fixed time interval you can set with Global Dwell Time.

List processing mode

8.9.4 Significant parameters and functions

This section provides some basic parameters, settings and functions that affect the operating modes CW, list and sweep, that means at all frequency and level transitions of the RF signal.

Dwell time

Dwell time is the length of time that elapses from the beginning until the end of a step in list or sweep mode.

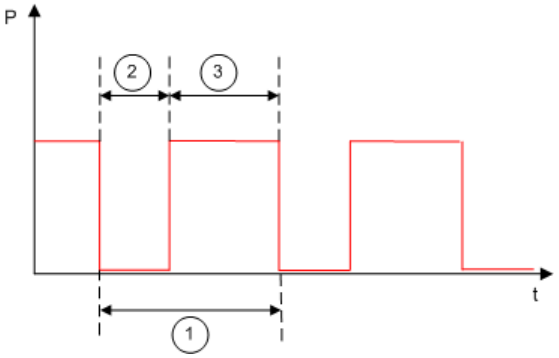


Figure 8-11: Dwell Time vs. settling time

1 = "Dwell Time" (as set with the parameter)
2 = Settling time
3 = Dwell time (effective)

However, the time the instrument requires for the signal to settle reduces the set dwell time:

$t_{dwell(effective)} = t_{dwell} - t_{setlting}$

If the dwell time in sweep or list mode is too short or external trigger signals come too fast, the signal generation delays. As the delay increases, the R&S SMCV100B signals an overrun, or even stops sweep or list mode signal generation, if the delay gets too long.

The instrument diplays corresponding error messages.

Hardware adjustments

The first time a list (new or modified) is processed, the instrument automatically calculates the necessary hardware settings. It can be performed during list processing, but delays the first cycle, especially with short dwell times.

With long dwell times, you can perform this calculation while the list is being processed; the entered dwell times are observed. With short dwell times, calculation of the hardware settings increases the dwell time for the initial processing cycle; the entered value is only observed from the second processing cycle onwards. In this case, a message indicates that there is a deviation between the current and set dwell times. After the first cycle, you do not need to perform additional calculations. The current dwell times do not deviate from the set dwell times.

Blanking

The instrument applies *blanking*, which temporarily turns off the RF signal when the frequency or level changes, until the signal has settled to a stable state.

Temporary blanking applies to all operating modes.

Live list processing mode

The R&S SMCV100B generates the signal directly from the value pairs in the database, and adjusts the hardware settings accordingly. The current instrument state and thus any change during the signal generation directly affects the RF signal. The temporary memory is not used.

You can conveniently modify parameters like modulation settings during run-time. Learning list mode data is not required. Impacts like temperature drift are also considered immediately.

This mode is optimized for **maximum signal quality**, and is useful if dwell times higher than 2 ms are sufficient.

8.9.5 Sweep mode settings

This section lists the settings of **all** available sweep modes.

Access:

1. Select "RF" > "Sweep / List" > "RF Frequency Sweep"
2. Select "RF" > "Sweep / List" > "RF Level Sweep"

   The sweep modes use the similar parameters to be configured. Thus, the description comprises the settings of the three dialogs, "RF Frequency Sweep", "RF Level Sweep" and "LF Frequency Sweep". If parameters relate to only particular modes, they are pointed out.

The remote commands required to define these settings are described in:

- Section 14.16.6, "SOURce:FREQuency subsystem", on page 776
- Section 14.16.12, "SOURce:POWer subsystem", on page 802
- Section 14.16.14, "SOURce:SWEep subsystem", on page 817

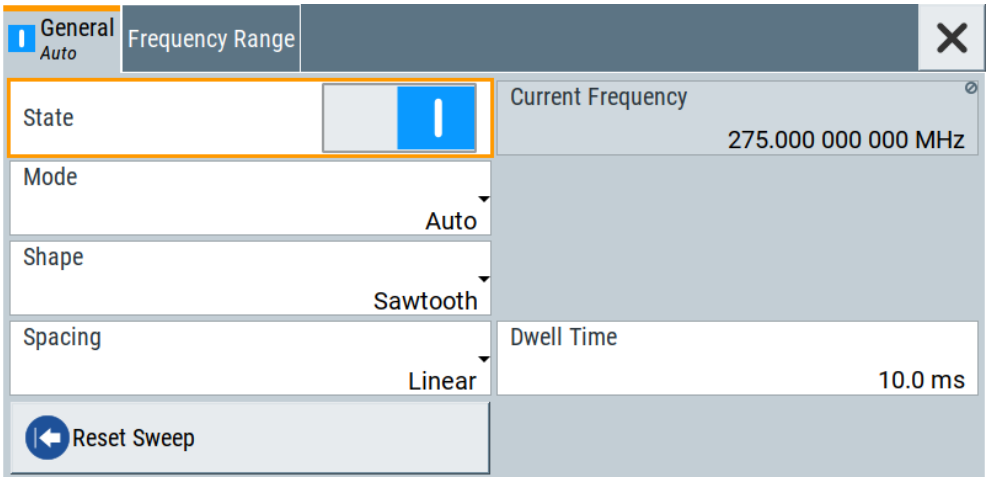
Settings

- General sweep settings....337
- Global connector settings....342
- Frequency range settings....342
- Level range settings....344

8.9.5.1 General sweep settings

Access:

► Select, for example, "RF" > "Sweep / List" > "RF Frequency Sweep".



Settings

State (RF frequency sweep)..... 338
State (RF level sweep)..... 338
Current Frequency..... 338
Current Level..... 339
Mode..... 339
Retrace..... 339
Shape..... 339
Spacing..... 341
Dwell Time..... 341
Trigger Slope..... 341
Execute Single Sweep..... 341
Reset Sweep..... 341

State (RF frequency sweep)
Activates RF frequency sweep signal generation.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
`[:SOURce<hw>]:FREQuency:MODE` on page 777

State (RF level sweep)
Activates RF level sweep signal generation.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
`[:SOURce<hw>]:POWer:MODE` on page 806

Current Frequency
Displays the current frequency sweep value for all sweep Modes, except of Mode > Step. In this mode, you can enter the next frequency setting manually.

Remote command:
`[:SOURce<hw>]:FREQuency:MANual` on page 778

Current Level
Displays the current level sweep value for all sweep Modes, except of Mode > Step. In this mode, you can enter the next level setting manually.

Remote command:
[:SOURce<hw>]:POWer:MANual on page 805

Mode
Selects the sweep mode.

See Section 8.9.1, "Signal generation and triggering in the sweep and list modes", on page 324.

"Auto" Generates a continuously repeating sweep signal directly after activating the sweep mode.
The sweep steps are performed automatically, controlled by the dwell time.

"Single / Extern Single"
Generates a single sweep cycle after a trigger event.
The sweep steps within the cycle are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event.

"Step / Extern Step"
Generates the sweep signal step-by-step, manually triggered.

"Extern Start/Stop"
Generates a continuously repeating sweep signal that is started, stopped, and restarted by subsequent external trigger events.
The sweep steps are performed automatically, controlled by the dwell time.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:MODE on page 822
:TRIGger<hw>:FSWeep:SOURce on page 861
RF level sweep:
[:SOURce<hw>]:SWEep:POWer:MODE on page 820
:TRIGger<hw>:PSWeep:SOURce on page 861

Retrace
For "Shape = Sawtooth" and "Mode = Single/External Single", enables changing the signal to the start value while it is waiting for the next trigger event. It returns to the start level or start frequency until the next trigger is applied.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace on page 824
RF level sweep:
[:SOURce<hw>]:SWEep:POWer:RETRace on page 824

Shape
Selects the waveform shape of the sweep signal.

"Sawtooth" The sweep runs from start to stop frequency. The subsequent sweep starts at the start value, i.e. the shape of the sweep sequence resembles a sawtooth.

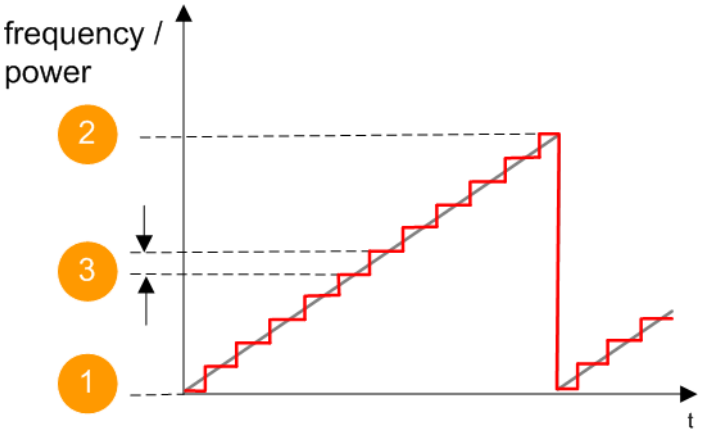


Figure 8-12: Sweep signal sawtooth shape

1 = Start value
2 = Stop value
3 = Step width

"Triangle" The sweep runs from start to stop value and back, i.e. the shape of the sweep resembles a triangle. Each subsequent sweep starts at the start frequency.

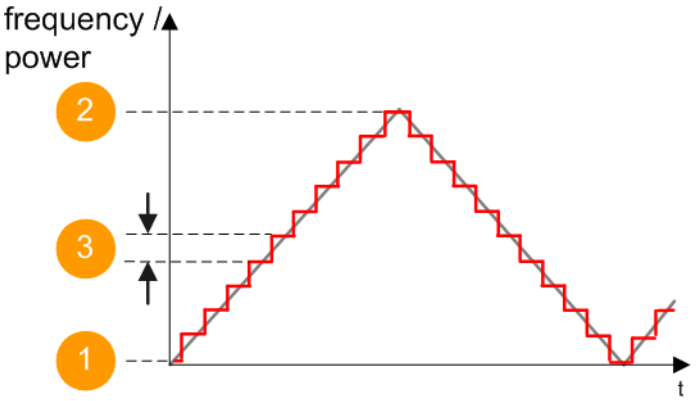


Figure 8-13: Sweep signal triangle shape

1 = Start value
2 = Stop value
3 = Step width

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe` on page 823
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:SHAPe` on page 823

Spacing
Selects the mode for calculating the frequency interval, which increases or decreases the current frequency at each step.

To determine the step size, select the parameter Step Linear/Step Logarithmic.

"Linear" Takes the frequency value entered as absolute value in Hz.

"Logarithmic" Takes the value entered as a logarithmic value, i.e. as a constant fraction of the current frequency in %.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:SPACing` on page 822

Dwell Time
Defines the duration of the individual sweep steps.

Note: In case of considerable overrun conditions, the R&S SMCV100B turns off the sweep mode.

See also Section 8.9.4, "Significant parameters and functions", on page 335.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:DWELl` on page 821
`[:SOURce<hw>]:SWEep:POWer:DWELl` on page 820

Trigger Slope
For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at one of the User x connectors.

See also Section 12.2, "Configuring global connectors", on page 456.

"Positive" The rising edge of the trigger signal triggers the instrument.

"Negative" The falling edge of the trigger signal triggers the instrument.

Remote command:
`[:SOURce]:INPut:TRIGger:SLOPe` on page 782

Execute Single Sweep
In "Mode = Single", starts a sweep manually.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:EXECute` on page 823
`:TRIGger<hw>:FSWeep[:IMMediate]` on page 862
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:EXECute` on page 823
`:TRIGger<hw>:PSWeep[:IMMediate]` on page 862
General:
`:TRIGger<hw>[:SWEep][:IMMediate]` on page 862

Reset Sweep
Resets a sweep.

With the next trigger event, the sweep starts at the initial value.

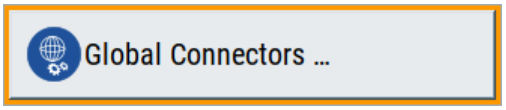
Remote command:
[:SOURce<hw>]:SWEep:RESet[:ALL] on page 825

8.9.5.2 Global connector settings

Opens a dialog to configure global connectors.

The button is available in the following dialogs or tabs:

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

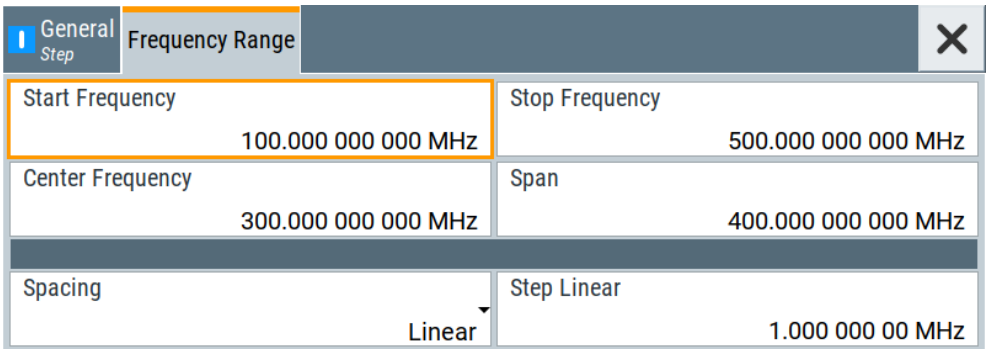


See also Section 12.2, "Configuring global connectors", on page 456.

8.9.5.3 Frequency range settings

Access:

1. Select for example "RF" > "Sweep / List" > "RF Frequency Sweep"
2. Select "Frequency Range".



Settings

Start Frequency/Stop Frequency 343
Center Frequency 343
Span 343
Spacing 343
Step Linear/Step Logarithmic 343

Start Frequency/Stop Frequency
Defines the frequency sweep range by setting the start and end values.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:FREQuency:STARt` on page 780
`[:SOURce<hw>]:FREQuency:STOP` on page 781

Center Frequency
In "RF Frequency Sweep" mode, sets the RF center frequency.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Remote command:
`[:SOURce<hw>]:FREQuency:CENTer` on page 780

Span
In "RF Frequency Sweep" mode, sets the span of the frequency sweep range.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Remote command:
`[:SOURce<hw>]:FREQuency:SPAN` on page 780

Spacing
Selects the mode for calculating the frequency interval, which increases or decreases the current frequency at each step.

To determine the step size, select the parameter Step Linear/Step Logarithmic.

"Linear" Takes the frequency value entered as absolute value in Hz.

"Logarithmic" Takes the value entered as a logarithmic value, i.e. as a constant fraction of the current frequency in %.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:SPACing` on page 822

Step Linear/Step Logarithmic
Sets the step width for individual frequency sweep steps. The value is added at each sweep step to the current frequency.

Depending on the current Spacing, you can enter either an absolute or logarithmic step width.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

"Step Linear" The step width is a constant value in Hz.

"Step Logarithmic"

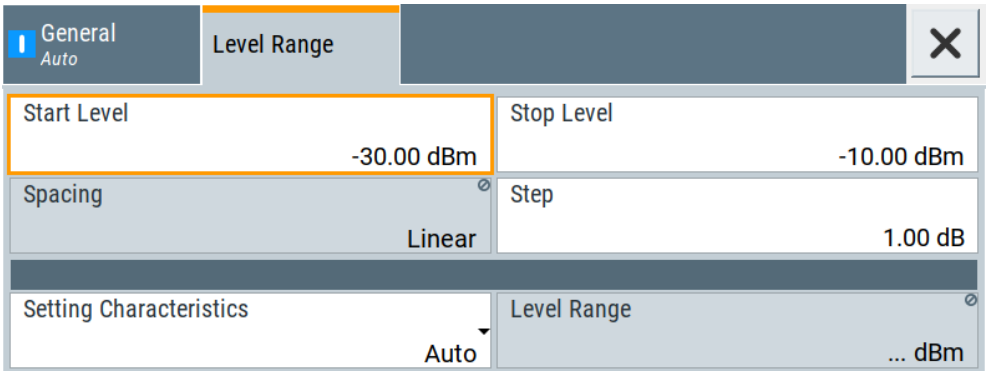
The step width is determined logarithmically in %, i.e. as a constant fraction of the current frequency.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]`
on page 824
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic`
on page 824

8.9.5.4 Level range settings

Access:

1. Select "RF" > "Sweep / List" > "RF Level Sweep"
2. Select "Level Range".



Settings

Start Level / Stop Level 344
Spacing 344
Step 345
Setting Characteristics 345
Level Range 345

Start Level / Stop Level
Defines the RF level sweep range by setting the start and end values.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Remote command:
RF level sweep:
`[:SOURce<hw>]:POWer:STARt` on page 807
`[:SOURce<hw>]:POWer:STOP` on page 807

Spacing
Indicates that the instrument distributes the level steps linearly (straight proportional), i.e. the level steps have the same size.

To determine the step size, use the parameter Step.

Remote command:
n.a.

Step
Sets the step width for the RF level sweep in dB.

The "RF level sweep" mode increases or decreases the level value linearly by the set value.

Remote command:
`[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic]` on page 821

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Remote command:
`[:SOURce<hw>]:POWer:LBEHaviour` on page 805

Level Range
Shows the interruption-free range of the level that you can use in the currently selected mode.

Remote command:
`[:SOURce<hw>]:POWer:RANGe:LOWer?` on page 813
`[:SOURce<hw>]:POWer:RANGe:UPPer?` on page 813

8.9.6 List mode settings

The "List Mode" dialog contains all the functions and settings for creating and handling lists with RF frequency/level pairs for generating the RF signal based on these values.

Access:

► Select "RF" > "Sweep / List" > "List mode".

The dialog contains parameters for configuring the list mode processing, entering list mode data and transferring data files from or to the instrument.

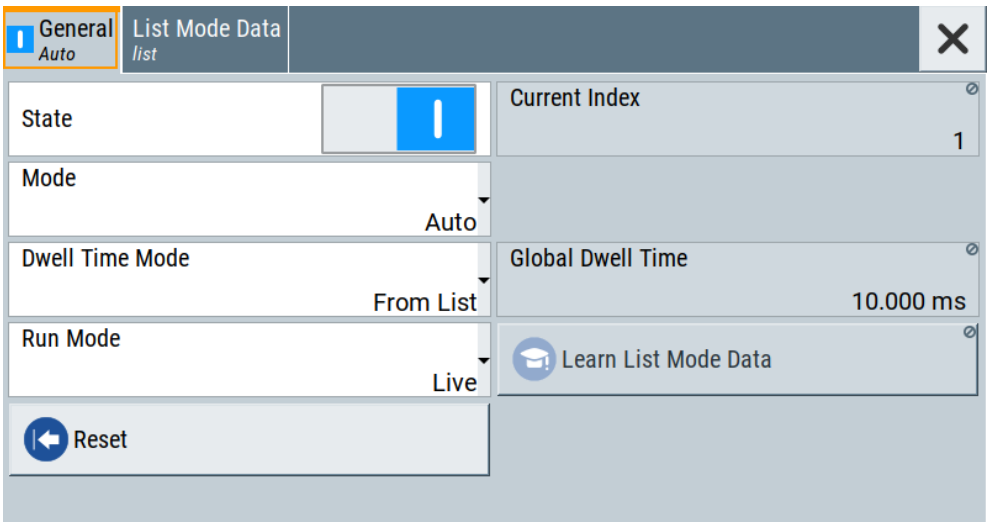
The remote commands required to define these settings are described in Section 14.16.10, "SOURce:LIST subsystem", on page 788.

- General settings....346
- List mode data settings....349
- Import/export settings....350

8.9.6.1 General settings

Access:

► Select "RF" > "Sweep / List" > "List mode > General".



In the "General" tab, you can configure the trigger and dwell time modes for list processing and activate signal generation.

Settings

State....346
Current Index....347
Mode....347
Dwell Time Mode....347
Global Dwell Time....347
Run Mode....348
Learn List Mode Data....348
Trigger Slope....348
Show Connector....348
Reset....348
Execute Single....348

State
Activates the list mode and processes the currently selected list.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
[:SOURce<hw>]:FREQuency:MODE on page 777

Current Index
Sets the list index for list processing in "Step" mode. In the other modes, the index indicates the current step.

Remote command:
[:SOURce<hw>]:LIST:INDex on page 793

Mode
Selects the mode for list processing.

See Section 8.9.1, "Signal generation and triggering in the sweep and list modes", on page 324.

"Auto" Generates the signal by processing the frequency/level value pairs of the list from the beginning to the end.
The list steps are performed automatically, controlled by the dwell time. If you switch from any mode to "Auto", signal generation always starts at the top of the list.

"Single / Extern Single"
Generates the signal by processing the frequency/level value pairs of the list once from the beginning to the end after a trigger event.
The list steps are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event.

"Step / Extern Step"
Generates the signal by processing the frequency/level value pairs of the list step-by-step, manually triggered.

Remote command:
[:SOURce<hw>]:LIST:TRIGger:SOURce on page 795
[:SOURce<hw>]:LIST:MODE on page 794

Dwell Time Mode
Selects either variable dwell times or a fixed dwell time to perform signal generation in list mode.

"Global" Uses the same dwell time for all lists steps, set with Global Dwell Time.

"From List" Uses the dwell times from the list.
You can define the dwell time for each frequency/level value pair individually, see Section 8.9.7, "List editor", on page 352.

Remote command:
[:SOURce<hw>]:LIST:DWELl:MODE on page 792

Global Dwell Time
Sets the dwell time for Dwell Time Mode > "Global".

Note: In case of considerable overrun conditions, the R&S SMCV100B turns off the list mode.

See also "Dwell time" on page 335.

Remote command:
[:SOURce<hw>]:LIST:DWELl on page 791

Run Mode
Selects whether the instrument generates the signal by processing the list directly, or by learning and replaying the data.

"Learned (Frozen RF Settings)"
The R&S SMCV100B does not support the learn list mode function.

"Live" Generates the signal directly from the database.
The instrument reads the pairs of values from the list, calculates the hardware settings and generates the signal immediately.
See "Live list processing mode" on page 337.

Remote command:
[:SOURce<hw>]:LIST:RMODe on page 794

Learn List Mode Data
The R&S SMCV100B does not support the learn list mode function.

Remote command:
n.a.

Trigger Slope
For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at one of the User x connectors.

See also Section 12.2, "Configuring global connectors", on page 456.

"Positive" The rising edge of the trigger signal triggers the instrument.

"Negative" The falling edge of the trigger signal triggers the instrument.

Remote command:
[:SOURce]:INPut:TRIGger:SLOPe on page 782

Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

Reset
Resets the list to the starting point.

Remote command:
[:SOURce<hw>]:LIST:RESet on page 798

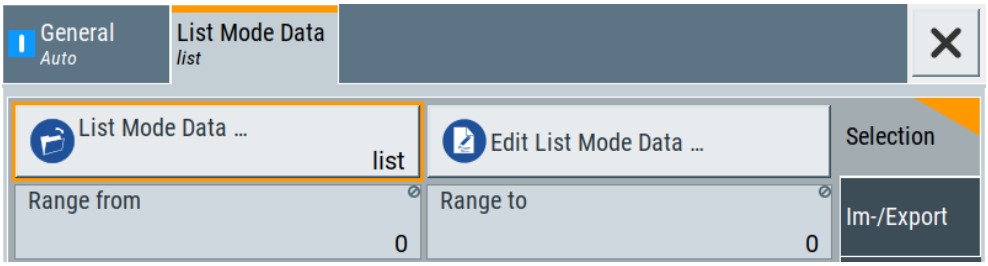
Execute Single
Manually starts list processing in "Single" mode.

Remote command:
[:SOURce<hw>]:LIST:TRIGger:EXECute on page 795

8.9.6.2 List mode data settings

Access:

1. Select "RF" > "Sweep / List" > "List mode".
2. Select "List Mode Data".



This dialog contains the parameters required for creating and editing lists, activating the learning function and selecting the list processing mode.

Settings

List Mode Data....349
Edit List Mode Data....349
List Range from/to....349

List Mode Data
Accesses the standard "Select List" dialog for selecting, creating and editing a list file. The currently loaded file is indicated.

You can create data lists with the internal editor or import externally created files, see "Creating and handling lists" on page 335.

Remote command:
[:SOURce<hw>]:LIST:CATalog? on page 797
[:SOURce<hw>]:LIST:SELect on page 798
[:SOURce<hw>]:LIST:DELete on page 797
[:SOURce<hw>]:LIST:DELete:ALL on page 797

Edit List Mode Data
Opens the editor to insert and save data lists with RF frequency, power and dwell time values, see Section 8.9.7, "List editor", on page 352.

You find this function also in standard file select dialog, accessed via List Mode Data.

List Range from/to
Defines an index range in the current list by setting the start and stop index.

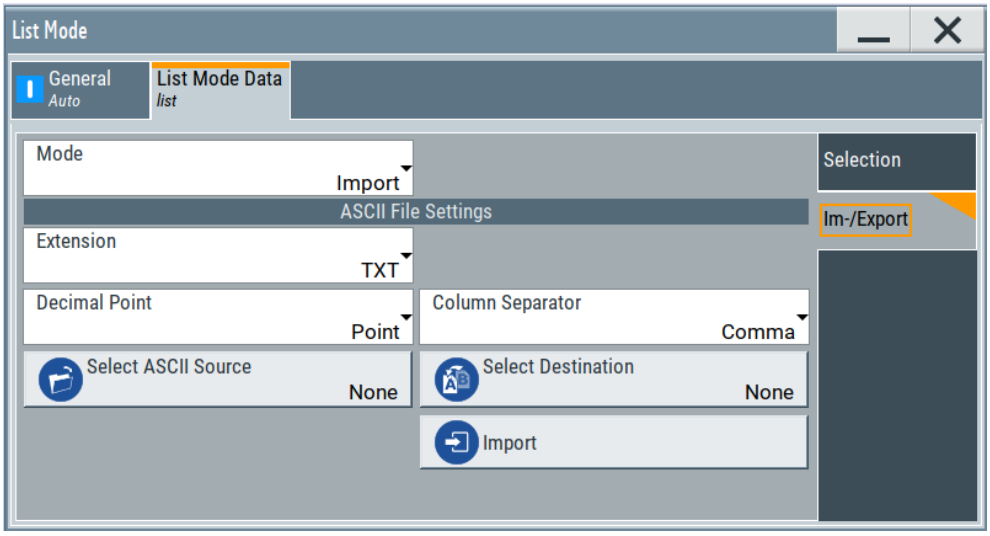
The instrument generates the signal with the values of the selected index range and ignores all other list entries.

Remote command:
[:SOURce<hw>]:LIST:INDex:STARt on page 794
[:SOURce<hw>]:LIST:INDex:STOP on page 794

8.9.6.3 Import/export settings

Access:

1. Select "RF" > "Sweep / List" > "List Mode".
2. Select "List Mode Data" > "Im-/Export".



The "Im-/Export" dialog provides the parameters for importing or exporting files with user data in standard ASCII `*.txt` or `*.csv` file format.
The table separators and the decimal floating point numbers are customizable.

Settings

Mode....350
ASCII File Settings....350
Select (ASCII) Source/Select (ASCII) Destination....351
Select Source/Select ASCII Destination....351
Import / Export....351

Mode
Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:
[:SOURce<hw>]:LIST:DEXChange:MODE on page 801
[:SOURce<hw>]:CORRection:DEXChange:MODE on page 775

ASCII File Settings
Defines the format and the separators of the associated data file.

"Extension" Selects `*.csv` or `*.txt` format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator"
Sets the separator between the columns in an ASCII table. Available are: "Tab", "Semicolon", "Comma" or "Space".

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension` on page 800
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal` on page 800
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn` on page 800
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension` on page 774
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal` on page 775
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn` on page 775

Select (ASCII) Source/Select (ASCII) Destination
In "Mode > Import", access the file select dialog that provides standard file handling functions.

Where:
- "Select ASCII Source": defines the file to be loaded (imported)
- "Select ASCII Destination": selects the filename under that the loaded file is saved

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?` on page 799
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect` on page 800
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?` on page 774
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect` on page 774

Select Source/Select ASCII Destination
In "Mode > Export", access the file select dialog that provides standard file handling functions.

Where:
- "Select Source": selects the file to be exported
- "Select ASCII Destination": defines the filename and the file path for the exported file

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:SELect` on page 801
`[:SOURce<hw>]:CORRection:DEXChange:SELect` on page 776

Import / Export
Imports or exports the selected data list file, depending on the current mode.

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:EXECute` on page 799
`[:SOURce<hw>]:CORRection:DEXChange:EXECute` on page 775

8.9.7 List editor

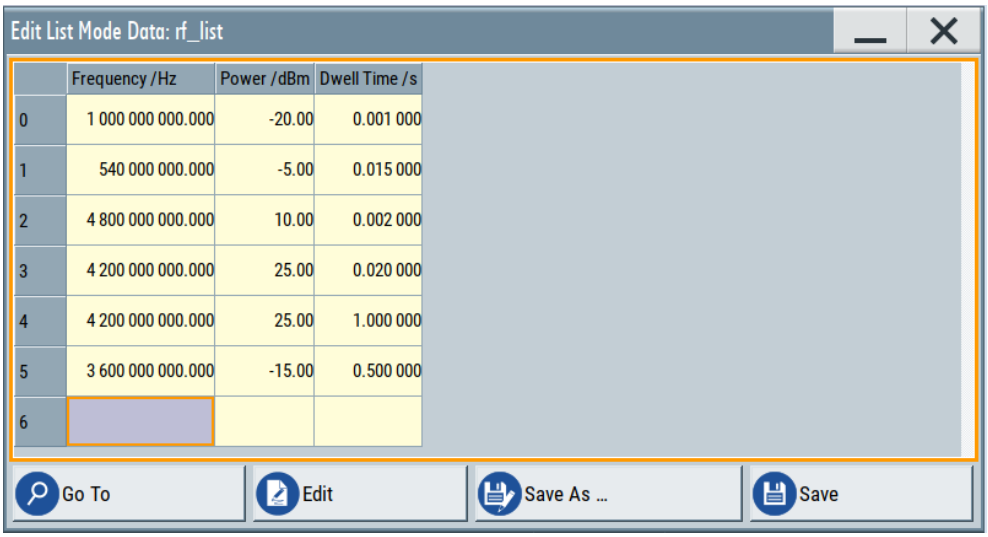
The "User Correction" and "List Mode" dialogs provide a build-in list editor for defining the corresponding value pairs.

The table and navigation functions of the UCOR and list mode editors have the same structure and are therefore summarized below. The access is specified for both modes, the fields and functions are explained using the example of the list mode.

Access to "Edit List Mode Data":

► "RF" > "Sweep / List" > "List Mode" > "List Mode Data" > "Edit List Mode Data"

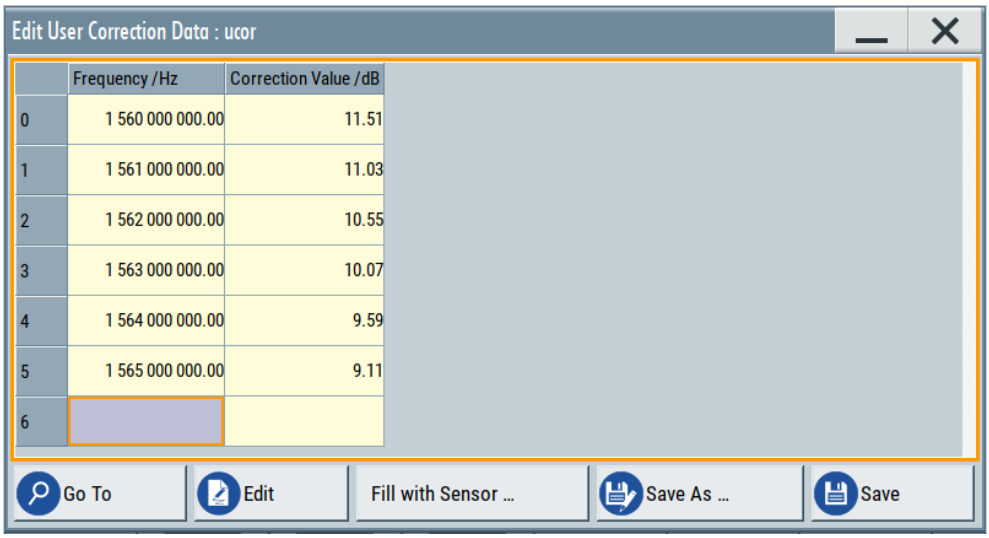
The editor for list mode provides a table with RF frequency and power values, an extra column for defining variable dwell times, and standard navigation functions.



The remote commands required to define the list mode data are described in Section 14.16.10, "SOURce:LIST subsystem", on page 788.

Access to "Edit User Correction Data":

► "RF" > "RF Level" > "User Correction" > "Edit User Cor. Data"



The editor for user correction data provides a table with RF frequency and power values and standard navigation functions.
The remote commands required to define the user correction data are described in Section 14.16.5, "SOURce:CORRection subsystem", on page 768.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

If you use **global dwell time in list mode**, consider also that the instrument uses the value set with Global Dwell Time for all list steps and not the values from the list.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview, shown by the example of the "Edit List Mode Data" dialog. If a function relates to a particular dialog, it is explicitly stated.

Settings

Edit List Mode Data....353
Data handling keys....354
└ Go To....354
└ Edit....354
└ Fill with Sensor....354
└ Save As/Save....354
Fill....354

Edit List Mode Data
Table with values for list or user correction processing.

Note: Once you enter a value, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows are lost when saving. You can simply override these values.

"Frequency (Hz)"
Sets the frequency values.

Remote command:
[:SOURce<hw>]:LIST:FREQuency on page 793
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency on page 771

"Power (dBm)" (list mode data table)
Sets the level values.

Remote command:
[:SOURce<hw>]:LIST:POWer on page 795

"Correction Value (dBm)" (user correction data table)
Sets the level values.

Remote command:
[:SOURce<hw>]:CORRection:CSET:DATA:POWer on page 771

"Dwell /s"
In list mode, sets the dwell time values.

Remote command:
[:SOURce<hw>]:LIST:DWELl:LIST on page 792

Data handling keys
Standard functions for file and data handling.



Go To ← Data handling keys
Selects a row for editing.

Edit ← Data handling keys
Enables you to insert, or delete a row or ranges within the table, and provides access to a dialog for automatic filling, see "Fill..." on page 354.

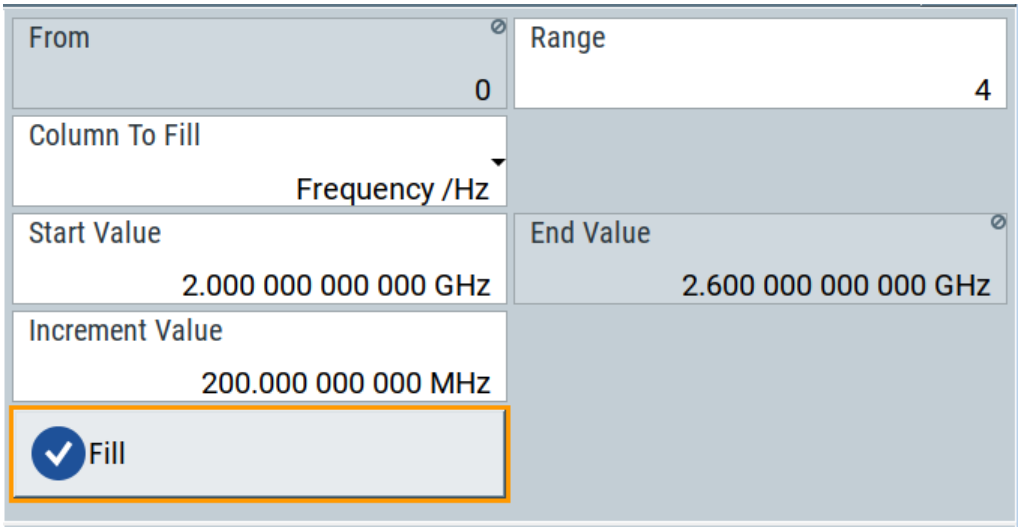
Fill with Sensor ← Data handling keys
Opens a dialog to configure the automatic filling of user correction data with an R&S NRP power sensor.

Available in UCOR mode only.

See Section 8.10.2.3, "Fill with sensor", on page 368

Save As/Save ← Data handling keys
Saves the table in a file with user-defined name and predefined file extension. To save a copy or create a file, use the "Save as" function.

Fill...
Provides parameters for filling a table automatically with user-defined values.



To fill the table, select "Fill".

Note: Once you enter a value or fill a column, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows will be lost when saving. You can simply override these values.

"From / Range"
Defines the start line and number of lines to be filled.

"Column To Fill"
Selects, if the column is filled up with frequencies in Hz, levels in dBm or dwell times in s.

"Start Value / End Value"
Sets the start value for frequency, level or dwell time. The end value is read only and depends on the increment value and the range.

"Increment Value"
Determines the step size.

"Fill" Fills the column specified in "Column To fill".

8.9.8 How to generate a signal in list or sweep mode

This section shows you how to configure a varying RF output signal for both, the list and sweep modes.

To configure the frequency sweep signal

1. In the status bar, enter "Freq = 6 GHz" and "Lev = -25 dBm".
2. Select "RF" > "Sweep / List" > "RF Frequency Sweep"
3. Select "Mode > Auto".
4. Select "Spacing > Linear".
5. Set "Dwell Time > 15.0 ms".

6. In the "Frequency Range" tab, set "Start Freq > 200 MHz" and "Stop Freq > 600 MHz".
   (Alternatively you can set "Center Freq > 400 MHz" and "Span > 400 MHz".)
7. Set the step width "Step Lin > 10 MHz" and "Dwell Time > 10.0 ms".
8. In the "Advanced" tab, trigger the sweep "Auto".
9. In the "General" tab, select "State > On".

Example: Fast changing frequency and level settings in list mode

The following example shows you how to generate an amplitude modulated RF signal based on list mode data.

General workflow

Since any change of the hardware settings or list entries can affect the RF signal characteristics directly, we recommend that you proceed as follows:

1. Configure the modulation settings.
   Activate the RF signal.
2. Wait until the hardware settings have settled.
3. Create a list file.
4. Configure the list mode.
5. Activate list mode.

To create list mode data

1. Select "RF" > "Sweep / List" > "List Mode".
2. In the "List Mode Data" tab, select "List Mode Data > New"
3. Enter the filename `ListMode_Test` for the data list and confirm with "Ok".
   The instrument creates a file and stores it in the `/var/user/` directory.
4. Select "Edit List Mode Data".
5. Enter the first values "Frequency > 2", "Power > 0" and "Dwell > 2".
6. Enter further frequency, power and dwell time values in the same way.
7. Select "Save" and close the dialog.

To configure the list mode and start signal generation

1. In the "General" tab, select "List Mode > Auto".
2. Select "Dwell Time Mode > From List".
3. Switch state to "On".

4. Select "General > State > On".

   The instrument continuously generates an amplitude-modulated RF signal whose frequency and level values change according to the dwell times, as defined in the list.

   With active list mode, the generator displays no frequency and level values in the status bar, but you can check the following parameters.
   - In the list mode dialog, the current index indicates the steps of the signal generation.
   - In remote control mode, you can query:
     – The current state with `[:SOURce<hw>]:LIST:RUNNing?`

8.10 Improving level performance

To adjust the RF output signal to specific needs in your application optimally, the R&S SMCV100B provides different functions:

- **Attenuator**
  The R&S SMCV100B is equipped with a step attenuator that enables you to vary the amplitude of the RF signal in a wide range. It is characterized by low VSWR (voltage standing wave ratio) over the full level and frequency range, and provides highest level accuracy and noise suppression.
  See Section 8.10.1, "Attenuator", on page 358.
- **User correction (UCOR)**
  The user correction function allows you to compensate frequency responses of external setups (e.g. losses of cables) and achieve a stable input signal over frequency directly at the DUT.
  See Section 8.10.2, "User correction", on page 360.
- **Power sensors**
  The R&S NRP power sensors support RF signal level optimization by determining the attenuation characteristics of downstream devices or cables, or by monitoring the RF signal level at the output directly. The R&S SMCV100B uses the readings of a sensor for compensation of losses and thus improving the accuracy of the RF signal level.
  You can configure the measurement parameters of a power sensor directly in the R&S SMCV100B and monitor its readings, including calibration.

  See:
  – Section 8.10.3, "Using power sensors", on page 372
  – Section 8.10.4, "Improving the RF signal performance", on page 388
  – Section 8.10.3.2, "NRP power viewer", on page 374
  – Section 8.10.3.3, "NRP power control", on page 376
  – Section 8.10.3.4, "NRP sensor configuration", on page 381
  – Section 8.10.3.5, "NRP sensor mapping", on page 385

8.10.1 Attenuator

About the attenuator

According to the requirements of your application, you can select different attenuator characteristics.

The following are examples of test requirements and the corresponding configuration:

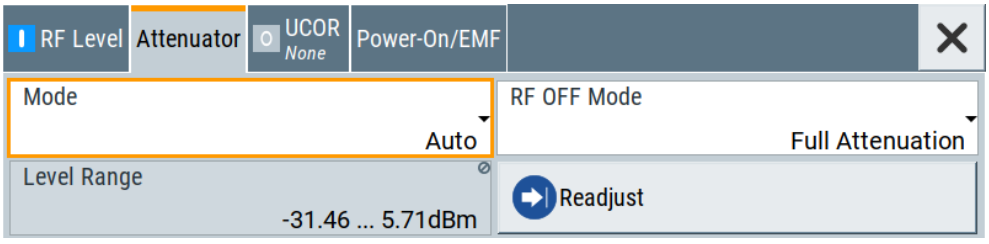
- Automatic configuration
  Select standard operation mode ("Auto"), in which the generator adjusts the attenuation of the RF output signal automatically.
- DUT tests under low signal to noise conditions
  Low output power is suitable to test the behavior of a DUT under low signal to noise conditions.
- Uninterrupted level settings with constant VSWR
  A fix attenuation value is required for obtaining uninterrupted level settings with constant VSWR.
  The configuration "RF Off Mode > Unchanged" ensures that constant VSWR is maintained if you turn the signal off and on again.
- Noise sensitive applications
  The parameter "RF OFF Mode > Full Attenuation" sets maximum attenuation and thus suppresses noise when you turn off the RF signal.

8.10.1.1 Attenuator settings

Access:

► Select "RF" > "RF Level" > "Level > Attenuator".

In the "Attenuator" dialog, you can select the operating mode of the step attenuator, the instrument is equipped with.



The remote commands required to define these settings are described in Section 14.13, "OUTPut subsystem", on page 629 and Section 14.16.12, "SOURce:POWer subsystem", on page 802.

Settings

Mode 359
Level Range 359
RF OFF Mode 359

Mode
Determines the operating mode of the step attenuator.

"Auto" Adjusts the attenuator settings automatically.

"Fixed" Fixes the attenuator and amplifier paths for the current RF level and provides signal output with constant output VSWR. The resulting level range is indicated under "Level Range" on page 359.

Remote command:
:OUTPut<hw>:AMODe on page 630

Level Range
Shows the interruption-free range of the level that you can use in the selected mode.

Remote command:
:OUTPut<hw>:AFIXed:RANGe:LOWer? on page 631
:OUTPut<hw>:AFIXed:RANGe:UPPer? on page 631

RF OFF Mode
Determines the state of the step attenuator, when the RF signal is switched off.

The setting is not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. It is reset only by factory preset.

"Unchanged" Freezes the setting of the step attenuator.
Use this mode if a constant VSWR (Voltage Standing Wave Ratio) is required.

"Full Attenuation"
Switches to the maximum attenuation.
Use this mode for applications that require a high level of noise suppression.

Remote command:
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE on page 804

8.10.1.2 Reverse power protection

The instrument is equipped with a reverse power protection circuit.

The reverse power protection is tripped when the power of signals reflected from the load or external signals applied to the RF output get too high. A relay opens and interrupts the internal connection to the RF output. This condition is indicated in the status bar by the "Overload" status message.

Overload
If an "Overload" status message is indicated in the status bar, perform the following:
- Remove the cause for the overload
- Press the [RF On/Off] key to reset the overload protection

The RF input is activated when the overload protection is reset.

Remote command:
:OUTPut<hw>:PROTection:TRIPped? on page 631
:OUTPut<hw>:PROTection:CLEar on page 631

8.10.2 User correction

The R&S SMCV100B supports a correction function to compensate external losses, caused, for example, by the RF cable, to achieve a precise target input level at the DUT.

The signal at the RF outputs of the R&S SMCV100B is flat. However, the DUT is usually not connected directly to the outputs of the instrument but rather via connecting cables. Components like cables, power combiners, switches or mixers can affect the signal flatness at the DUT input.

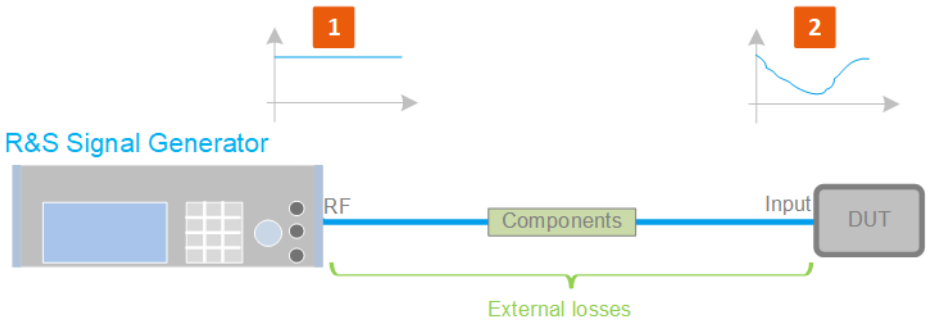


Figure 8-14: Effect of external losses on the signal flatness at the DUT input

DUT = Device under test
Components = Designation of all components between the measurement equipment and the DUT, e.g. cables
1 = Flat signal at the outputs of the R&S SMCV100B
2 = Signal received at the DUT, incl. the external losses

About UCOR

User correction (UCOR) is a method that determines the external level loss of the RF output signal over a frequency range in advance, see Figure 8-15.

User correction relates to the RF center frequency only. It does not affect the baseband bandwidth.

The difference between the generator output level and the level at the DUT determines the correction value at the respective frequency. Alternatively, the attenuation characteristics over a certain frequency range of, for example, RF cables are also specified in the associated specifications document.

For more information, refer to the specifications document.

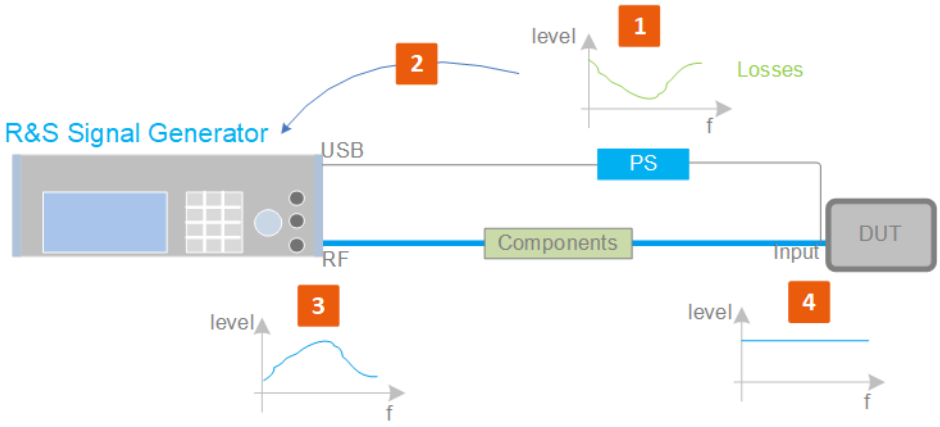


Figure 8-15: Understanding the principle of user correction

DUT = Device under test
Components = Designation of all components between the measurement equipment and the DUT, e.g. cables
PS = Power sensor, e.g. R&S NRP, connected at the DUT's input and the USB connector of the R&S SMCV100B
1 = Power sensor measures the level over a frequency range, where the collected values correspond to the losses caused by the components between the R&S SMCV100B and the DUT
2 = Obtain the correction data by inverting the collected data; load the correction parameters in the R&S SMCV100B
3 = In the R&S SMCV100B, the RF signal is pre-processed with the correction values so that the signal at the outputs is the inverted version of the external losses
4 = Received at the DUT input, the pre-processed signal if flat

With active **UCOR**, the generator adds the correction value internally and thus increases the output level by exactly the amount of the loss between its output and the DUT. For frequencies which are not contained in the list, the level correction is calculated by interpolation of the closest correction values.

Possible ways for configuring the user correction values

You can configure correction values in the following ways:

- **Internally**
  - Use the built-in table editor in the "UCOR > Edit User Correction Data" dialog. Once defined, user correction values can be saved in a file.
    Files with correction data can be exported, for example, to exchange configuration between instruments or to modify the file content with an external program and reload them again.
  - Using the corresponding remote-control commands.
    Note that you have to create a user correction file first.
- **Externally**
  Create a file with correction values as a CSV file with Microsoft Excel, with a Notepad or a similar tool and save it with the predefined extension. Transfer the file to and load it into the instrument.

UCOR file format

Files containing correction data are simple files in text or comma-separated value (CSV) file format. The filename is user-definable; the file extension is `*.ucor`.

The file contains a list of correction values, one row per frequency and correction value pair; a new line indicator separates the correction values.

For file handling, use the standard functions in the "File Manager", see Section 11.9, "Using the file manager", on page 434.

Collecting correction data

To fill the frequency and power values in the correction table, use one of the following options:

- **Manually**, row by row.
- Fill the table **automatically** with linearly interpolated values, calculated from value range and step size.
- Acquire the real frequency response characteristics of the used component with the **R&S NRP power sensor**, see Understanding the principle of user correction.

Using a power sensor for frequency response measurements

Consider the following when using R&S NRP power sensors to measure the correction values:

- Measure the level directly at the input of the DUT.
- Use the internal correction functions of an R&S NRP power sensor to increase the measurement accuracy.
- Use S-parameter to consider the impact of any two-port device like an adapter between the signal generator and the sensor input.

For information on the various possibilities of interoperability between Rohde & Schwarz power sensors and Rohde & Schwarz signal generators, see the application note 1GP141.



Interactions and characteristics

You can enable user correction in all operating modes.

The RF output level ($Level_{RF}$) is the sum of the level value and the correction for the particular frequency:

$Level_{RF}$ = "Status bar > Level" + "UCOR"

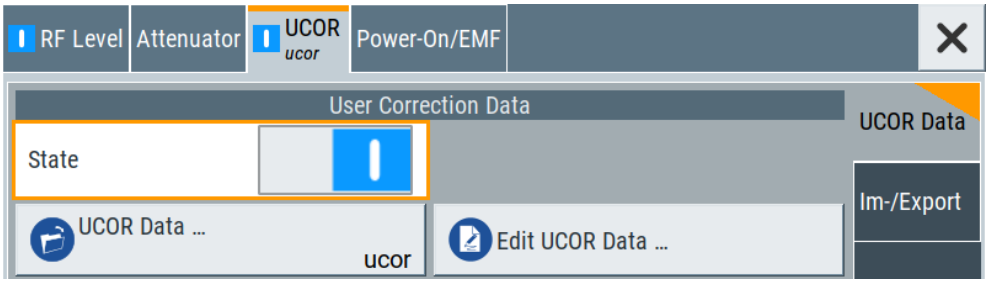
If enabled, the R&S SMCV100B indicates user correction by the "Lev Ucor" icon in the status bar.

8.10.2.1 User correction settings

Access:

1. Select "RF" > "RF Level" > "User Correction".

2. If you already have created a file with user correction data:
   a) Select "UCOR Data" > navigate to the file "*.uco" > "Select".
   b) Proceed with step 4.
3. If you need to create a file:
   a) Select "UCOR Data" > "New".
   b) Enter the filename `UCOR_Data` and confirm with "Ok".
   c) Choose the file and confirm with "Select".
   d) Select "Edit UCOR Data".
   e) To fill the user correction data table, proceed as described in Section 8.9.7, "List editor", on page 352.
4. Select "UCOR" > "State" > "On".
5. Select block diagram > RF > "On".



The "UCOR" dialog contains all settings for creating and handling files with user-defined level correction values.

The remote commands required to define these settings are described in Section 14.16.5, "SOURce:CORRection subsystem", on page 768.

Settings

State....363
User Correction....363
UCOR Data....364
Edit UCOR Data....364
UCOR Info 364

State
Activates user correction.

Remote command:
`[:SOURce<hw>]:CORRection[:STATe]` on page 773

User Correction
Indicates the corrected level value for a specific frequency point.

Remote command:
`[:SOURce<hw>]:CORRection:VALue?` on page 772

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

Files with user correction values are files with predefined file extension `*.uco`. When a file is selected, the dialog indicates the filename.

You can create the file internally in the table editor or externally.
- To select an existing file, select "Select List > navigate to the file *.uco > Select"
- Use the general editor function to create a file or to edit an existing one.
- Use the standard file manager function to load externally created files to the instrument.

Remote command:
`[:SOURce]:CORRection:CSET:CATalog?` on page 773
`[:SOURce<hw>]:CORRection:CSET[:SELect]` on page 772
`[:SOURce]:CORRection:CSET:DELete` on page 774

Edit UCOR Data
Opens the build-in table editor to define a new correction table or edit an existing one.

See also:
- Section 8.9.7, "List editor", on page 352
- "Fill..." on page 354
- Section 8.10.2.3, "Fill with sensor", on page 368

UCOR Info ...
Opens a window with information on the user correction file.

The window shows the metadata of the file and the output level parameters that are relevant for user correction.

Remote command:
n.a.

8.10.2.2 List editor

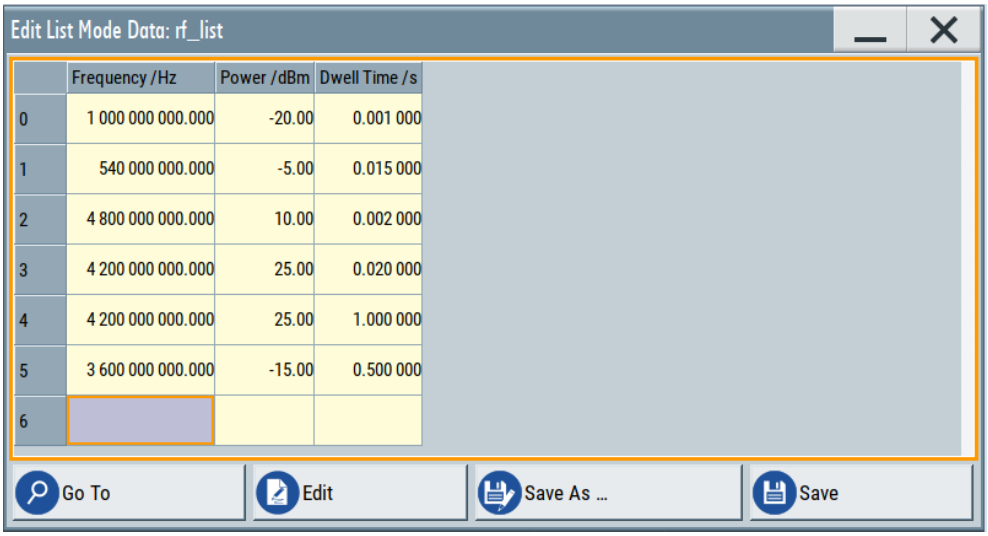
The "User Correction" and "List Mode" dialogs provide a build-in list editor for defining the corresponding value pairs.

The table and navigation functions of the UCOR and list mode editors have the same structure and are therefore summarized below. The access is specified for both modes, the fields and functions are explained using the example of the list mode.

Access to "Edit List Mode Data":

► "RF" > "Sweep / List" > "List Mode" > "List Mode Data" > "Edit List Mode Data"

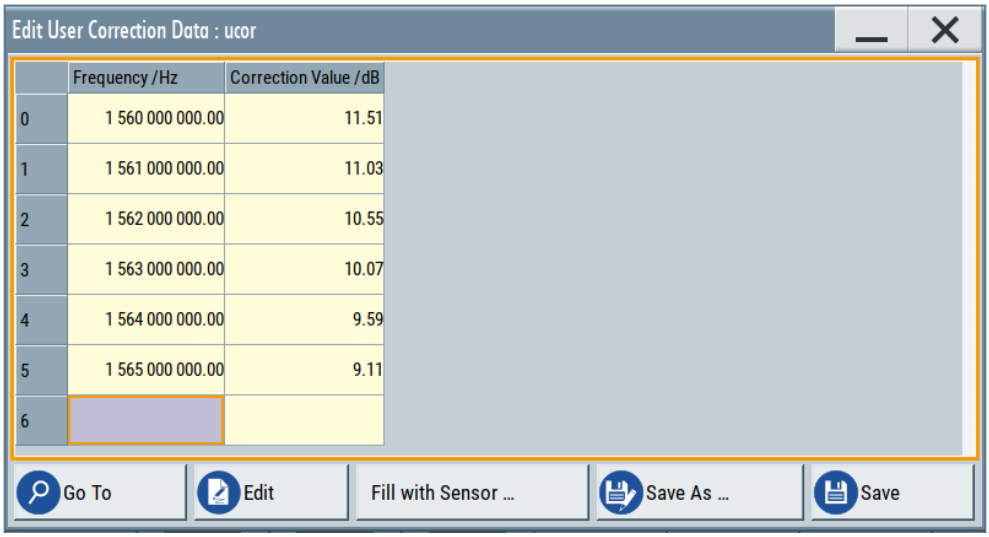
The editor for list mode provides a table with RF frequency and power values, an extra column for defining variable dwell times, and standard navigation functions.



The remote commands required to define the list mode data are described in Section 14.16.10, "SOURce:LIST subsystem", on page 788.

Access to "Edit User Correction Data":

► "RF" > "RF Level" > "User Correction" > "Edit User Cor. Data"



The editor for user correction data provides a table with RF frequency and power values and standard navigation functions.
The remote commands required to define the user correction data are described in Section 14.16.5, "SOURce:CORRection subsystem", on page 768.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

If you use **global dwell time in list mode**, consider also that the instrument uses the value set with Global Dwell Time for all list steps and not the values from the list.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview, shown by the example of the "Edit List Mode Data" dialog. If a function relates to a particular dialog, it is explicitly stated.

Settings

Edit List Mode Data....366
Data handling keys....366
└ Go To....366
└ Edit....367
└ Fill with Sensor....367
└ Save As/Save....367
Fill....367

Edit List Mode Data
Table with values for list or user correction processing.

Note: Once you enter a value, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows are lost when saving. You can simply override these values.

"Frequency (Hz)"
Sets the frequency values.

Remote command:
`[:SOURce<hw>]:LIST:FREQuency` on page 793
`[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency` on page 771

"Power (dBm)" (list mode data table)
Sets the level values.

Remote command:
`[:SOURce<hw>]:LIST:POWer` on page 795

"Correction Value (dBm)" (user correction data table)
Sets the level values.

Remote command:
`[:SOURce<hw>]:CORRection:CSET:DATA:POWer` on page 771

"Dwell /s"
In list mode, sets the dwell time values.

Remote command:
`[:SOURce<hw>]:LIST:DWELl:LIST` on page 792

Data handling keys
Standard functions for file and data handling.



Go To ← Data handling keys
Selects a row for editing.

Edit ← Data handling keys
Enables you to insert, or delete a row or ranges within the table, and provides access to a dialog for automatic filling, see "Fill..." on page 354.

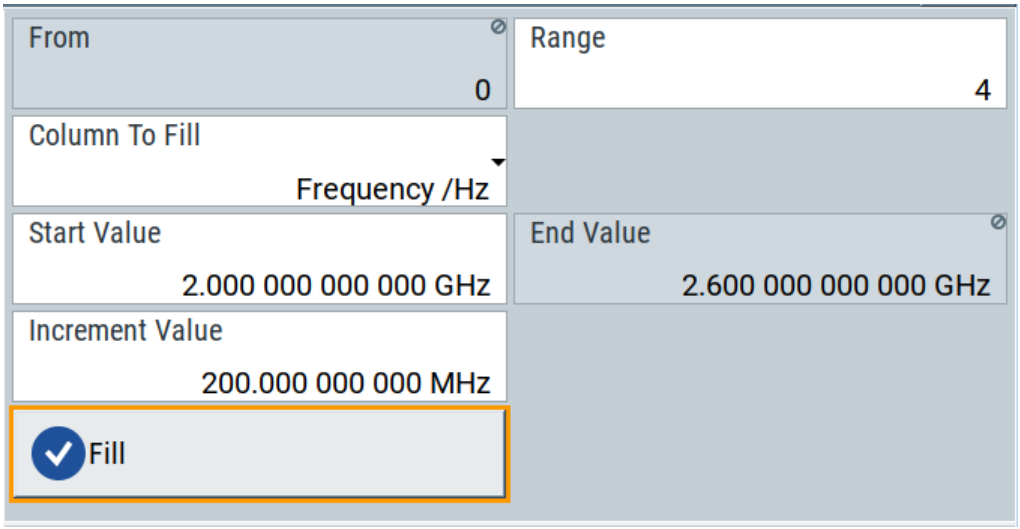
Fill with Sensor ← Data handling keys
Opens a dialog to configure the automatic filling of user correction data with an R&S NRP power sensor.

Available in UCOR mode only.

See Section 8.10.2.3, "Fill with sensor", on page 368

Save As/Save ← Data handling keys
Saves the table in a file with user-defined name and predefined file extension. To save a copy or create a file, use the "Save as" function.

Fill...
Provides parameters for filling a table automatically with user-defined values.



To fill the table, select "Fill".

Note: Once you enter a value or fill a column, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows will be lost when saving. You can simply override these values.

"From / Range"
Defines the start line and number of lines to be filled.

"Column To Fill"
Selects, if the column is filled up with frequencies in Hz, levels in dBm or dwell times in s.

"Start Value / End Value"
Sets the start value for frequency, level or dwell time. The end value is read only and depends on the increment value and the range.

"Increment Value"
Determines the step size.

"Fill" Fills the column specified in "Column To fill".

8.10.2.3 Fill with sensor

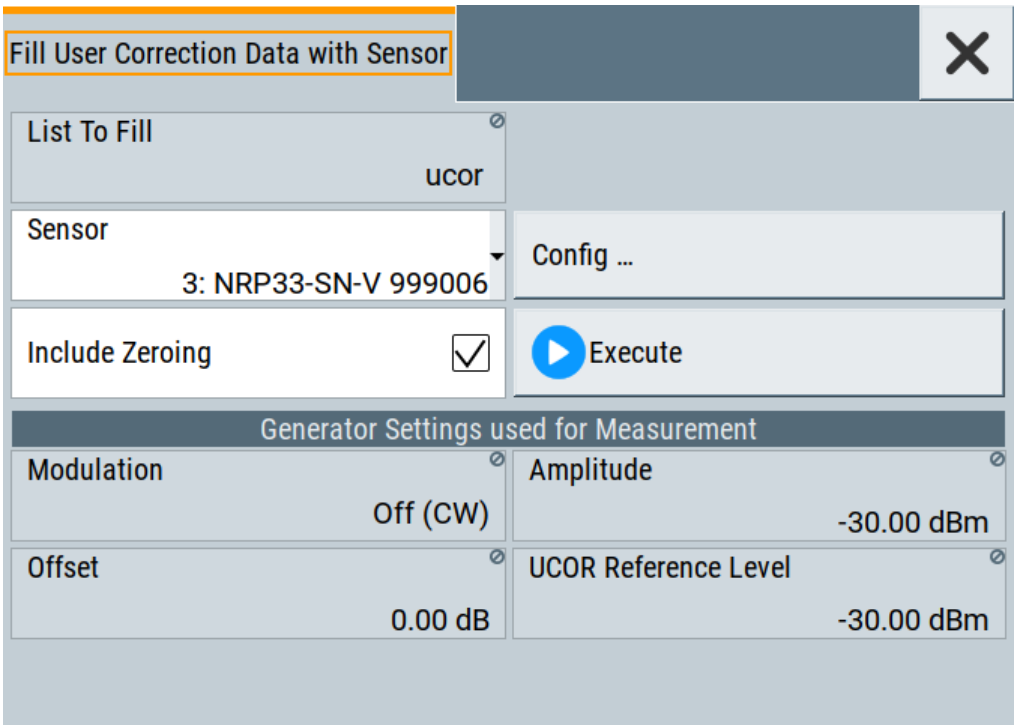
The fill with sensor function requires that you have connected a power sensor and also selected a file for user correction data before.

See:

- Section 8.10.3, "Using power sensors", on page 372
- "To create user correction data with an R&S NRP and the R&S SMCV100B" on page 389

Access:

1. Select "RF" > "RF Level" > "User Correction".
2. Select "UCOR Data > navigate to the file *.ucor > Select".
3. Select "Edit UCOR Data > Fill With Sensor...".



This dialog contains parameters for filling a table automatically with sensor readings.

To fill the table, select "Execute".

For information on power sensors and how to use them, see Section 8.10.4, "Improving the RF signal performance", on page 388.

Settings:

Fill User Correction Data with Sensor 369
Generator Settings used for Measurement 369

Fill User Correction Data with Sensor
The "Execute" button is only enabled if a sensor is detected and the user correction list contains at least one frequency value.

"Sensor" Displays connected sensors for selection.

"List To Fill" Indicates the used list.

"Config" Opens the sensor configuration dialog to set the parameters for the selected power sensor.

"Include Zeroing"
Performs a zeroing procedure before acquiring the user correction data to improve precision.
No signal is applied to the sensor during zeroing. RF output is temporarily switched off during that time.
When unchecked, the zeroing procedure is skipped. However, the RF signal level can be blanked shortly. This setting is useful if blanking of RF is undesirable or the absence of power at the sensor cannot be guaranteed.

Remote command:
`[:SOURce<hw>]:CORRection:ZERoing:STATe` on page 772

"Execute" Triggers the sensor to measure and to return the data for user correction.
The "Execute" button is only enabled if a sensor is detected and the user correction list contains at least one frequency value.

Remote command:
`[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe` on page 772

Generator Settings used for Measurement
Displays the settings relevant for the measurement.

"Modulation" Indicates that modulation is off.
The R&S SMCV100B disables modulation for the "Fill with sensor" process, even if you have enabled a modulation and if you have started "Fill with sensor".

"Amplitude" Displays the currently set level.

Remote command:
`[:SOURce<hw>]:POWer:POWer` on page 807

"Offset" Displays the level offset, set with "Offset" on page 314.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet` on page 811

"UCOR Reference Level"

Displays the reference value for user correction.
The user correction reference level is the set Amplitude plus the set Offset.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel`
on page 813

8.10.2.4 Import/export list files

Access:

1. Select one of the following:
   - "RF" > "Sweep / List" > "List mode".
   - "RF" > "RF Level" > "User Correction".
2. Select "Import/Export".

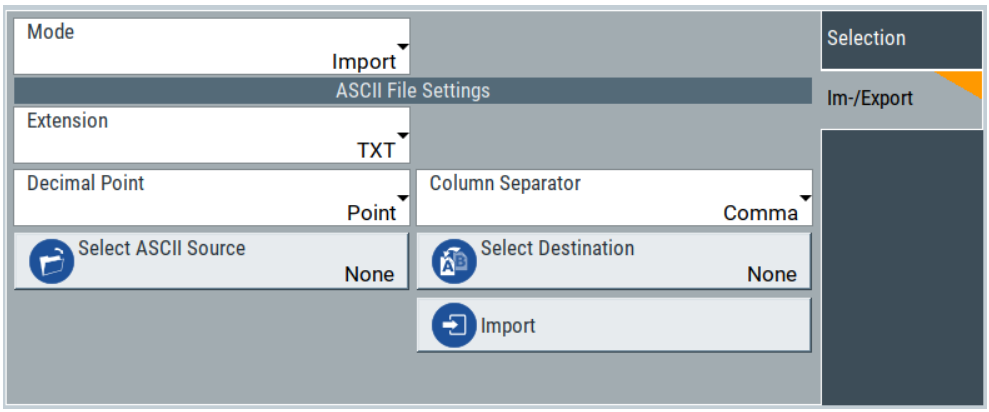


Figure 8-16: Im-/Export dialog (example with UCOR settings)

The "Import/Export" dialog contains all functions and settings to import externally created list data or to export it accordingly. You can process and store a list in the formats `*.txt` (ASCII), or `*.csv` (plain text with identical sequence of fields). The table separators and the decimal floating point numbers are customizable.

Settings

Mode 370
ASCII File Settings 371
Select (ASCII) Source/Select (ASCII) Destination 371
Select Source/Select ASCII Destination 371
Import / Export 371

Mode
Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:
[:SOURce<hw>]:LIST:DEXChange:MODE on page 801
[:SOURce<hw>]:CORRection:DEXChange:MODE on page 775

ASCII File Settings
Defines the format and the separators of the associated data file.

"Extension" Selects *.csv or *.txt format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator"
Sets the separator between the columns in an ASCII table. Available are: "Tab", "Semicolon", "Comma" or "Space".

Remote command:
[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension on page 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal on page 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn on page 800
[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension on page 774
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal on page 775
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn on page 775

Select (ASCII) Source/Select (ASCII) Destination
In "Mode > Import", access the file select dialog that provides standard file handling functions.

Where:
- "Select ASCII Source": defines the file to be loaded (imported)
- "Select ASCII Destination": selects the filename under that the loaded file is saved

Remote command:
[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog? on page 799
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect on page 800
[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog? on page 774
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect on page 774

Select Source/Select ASCII Destination
In "Mode > Export", access the file select dialog that provides standard file handling functions.

Where:
- "Select Source": selects the file to be exported
- "Select ASCII Destination": defines the filename and the file path for the exported file

Remote command:
[:SOURce<hw>]:LIST:DEXChange:SELect on page 801
[:SOURce<hw>]:CORRection:DEXChange:SELect on page 776

Import / Export
Imports or exports the selected data list file, depending on the current mode.

Remote command:
[:SOURce<hw>]:LIST:DEXChange:EXECute on page 799
[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 775

8.10.3 Using power sensors

The R&S SMCV100B works with any of the R&S NRP power sensors and thus supports various application tasks. Using power sensors, you can for example determine attenuation characteristics of downstream equipment or cables. You can use the measured values to compensate the losses with internal control functions or with an external control circuit in real time.

For information on the various possibilities of interoperability between Rohde & Schwarz power sensors and Rohde & Schwarz signal generators, see the application note 1GP141.

R&S NRP power sensors are highly accurate standalone measuring devices, suitable for a wide range of applications. The power sensors communicate directly with the signal generator, calculate the average or peak power internally, include S-parameter correction and return the measurement results to the generator.

The R&S SMCV100B supports up to four power sensors, allowing up to four power measurements simultaneously.

Check the firmware version of the R&S NRP sensors regularly. Update the firmware, if necessary.

For updates, see the Rohde & Schwarz website www.rohde-schwarz.com in section "Power Meters & Voltmeters".

For more information on working with power sensors, see the following topics:

- Section 8.10.3.1, "Connecting R&S NRP power sensors to the R&S SMCV100B", on page 373
  Overview on the supported connectors, connection options and the required accessories.
- Section 8.10.3.2, "NRP power viewer", on page 374
  A function for measuring and monitoring the RF output power or a user-defined signal source.
- Section 8.10.3.3, "NRP power control", on page 376
  Controls a downstream closed loop power control circuit, to compensate frequency response characteristics.
- Section 8.10.3.4, "NRP sensor configuration", on page 381
  Parameter settings of the specific R&S NRP power sensor.
- Section 8.10.3.5, "NRP sensor mapping", on page 385
  Shows all R&S NRP sensors connected to the instrument, or in the LAN.

8.10.3.1 Connecting R&S NRP power sensors to the R&S SMCV100B

Connection	Sensor type (incl. USB hub)	Cables/Acessories	Characteristics
USB type A	R&S NRPxx	R&S NRP-ZKU	USB interface cable
	R&S NRP-Zxx	R&S NRP-Z3 R&S NRP-Z4	USB adapter cables
	R&S NRP-Z5 USB sensor hub (high-speed USB 2.0)	Standard USB cable (USB type A to USB type B)	This connection does not support external triggering.
	Standard USB hub with external power supply unit R&S NRPxx	R&S NRP-ZKU	USB interface cable
	Standard USB hub with external power supply unit R&S NRP-Zxx	R&S NRP-Z3 R&S NRP-Z4	USB adapter cables
LAN	R&S NRPxxxSN/xxxTN/ xxxAN	• A PoE Ethernet switch, e.g. R&S NRP-ZAP1 and an RJ-45 Ethernet cable. • A PoE injector and an RJ-45 Ethernet cable.	Using the Ethernet interface requires PoE (Power over Ethernet) to provide the electrical power.

For details, see the description R&S®NRP Power Sensors getting started.

Detection and mapping

The R&S SMCV100B either detects a R&S NRP power sensor automatically or you can scan for available power sensors manually. The "NRP Sensor Mapping" dialog lists all detected R&S NRP power sensors, see Section 8.10.3.5, "NRP sensor mapping", on page 385. The dialog enables you to add, remove and map the sensors manually.

Depending on the connection interface, the R&S SMCV100B detects and maps connected R&S NRP power sensors differently:

- USB interface
  Detects a sensor automatically and maps it with index "1" to index "4" according to the sequence of connection.
- LAN interface
  To detect sensors that are connected in the LAN, the instrument provides a scan function. When you start the function, scan searches in the LAN for available R&S NRP power sensors and adds all detected sensors to list. Assigning a mapping index activates the sensor for the measurement.



On connection, the R&S SMCV100B immediately starts the measurement of the R&S NRP power sensor. If you preset the instrument ([Preset] key or `*RST`), the R&S SMCV100B stops the measurement. The connection and the mapping of the power sensors remain.

8.10.3.2 NRP power viewer

The R&S SMCV100B features the power viewer function for measuring or monitoring signals with R&S NRP power sensors.

About

The R&S SMCV100B can perform up to four power measurements simultaneously.

Depending on the signal characteristic (CW, AM, pulsed, etc.) or the parameter to be measured (average, peak, etc.) a suitable R&S power sensor must be used.

About the measuring principle, averaging filter, filter length, and achieving stable results

A sensor measures the average or peak RF power of the source continuously. The measurement results are displayed in the "NRP Power Viewer" dialog.

The power viewer function uses **averaging filters** for getting a stable readout.

Measurement results could be interfered, for instance, by too much noise in your setup, by a bad suppression of harmonics or non-harmonics or when you reach the sensitivity level of your power sensor.

Measurements are continuously repeated in a predefined time window. The measurement result is obtained by averaging the measured values for the last 2N time windows. This approach is referred as a **two-step averaging process**.

The factor of 2 in the formula arises because the output signals from the microwave detector are chopped at the same rate as the time windows to suppress low-frequency noise. An independent measured value can only be obtained from two consecutive values.

The variable N in the formula indicates the **filter length**. The filter length then directly influences the measurement time. The filter length can be selected automatically or it can be manually set to a fixed value.

Follow the following general recommendation to find out the **optimum filter length**:

- Always start a measurement in auto mode ("Filter > Auto").
  Check if the measurement results are sufficient.
- If the power is not constant, select the filter length manually ("Filter > User").
  Trigger the "Auto Once" function to search for the optimum filter length for the current measurement conditions.
  The estimated value is indicated as filter length.
- If the target measurement accuracy value is known, select "Filter > Fixed Noise".
  The averaging factor is selected automatically and so that the sensor's intrinsic noise (two standard deviations) does not exceed the specified noise content.
- Depending on the R&S NRP power sensor type, the manual setting of the filter length varies in resolution.
- Different sensor types achieve the same filtering result with different filter and time window lengths.
  For most sensors, the time window length is fixed to 20 ms, whereas, e.g., for the R&S NRP-Z81 sensor, the time window length is 10 µs.

For more information, refer to the specifications document.

About zeroing

Activates the auto zero function.

Zeroing calibrates the external power sensor by adjusting its reading at zero signal power. For this purpose, the RF power source must be switched off or disconnected from the sensor. If a Rohde & Schwarz power sensor receives an input power during the zeroing process, it aborts zeroing and generates an error message. Zeroing takes a few seconds, depending on the sensor model. Refer to the documentation of your power sensor for more information.

Tips for zeroing

When to perform zeroing:

- During warm up after switching on or connecting the instrument
- After a substantial change of the ambient temperature
- After fastening the power sensor module to an RF connector at high temperature
- After several hours of operation
- When low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.
- Switch off the RF power source for zeroing, but do not disconnect it from the power sensor. This proceeding keeps the thermal equilibrium, and the zeroing process also compensates the noise that superimposes the measured signal (e.g. from a broadband amplifier).

Related settings and functions

- Measurements-related settings, like results, filter, filter length:
  Section 8.10.3.4, "NRP sensor configuration", on page 381
- Closed loop power control of the output level:
  Section 8.10.3.3, "NRP power control", on page 376.
- Software version of the connected power sensor:
  `:SENSe<ch>[:POWer]:TYPE?` on page 646
- Acquisition of level correction data:

Additional information

See the Rohde & Schwarz website www.rohde-schwarz.com, section "Power Meters & Voltmeters" for:

- R&S NRP power sensor manual.
- Information on the R&S NRP-Z5 sensor hub and the available accessories.
- Sensor software updates.

NRP power viewer settings

Access:

► Select "RF" > "RF Measurement" > "NRP Power Viewer".



The "Power Viewer" tab lists the mapped R&S NRP power sensors with the measured parameter mode and the current readings. The "Config" button leads you to the configuration dialog to set the parameters for each sensor.

Config.....376

Config
Opens the "Sensor Configuration" dialog.

See also Section 8.10.3.4, "NRP sensor configuration", on page 381.

8.10.3.3 NRP power control

The NRP power control function enables you to apply stable and accurate RF power to the DUT. For example, you can set up a downstream closed loop power control circuit to compensate spurious effects or losses caused by power amplifiers or cables.

Example: How to set up a closed loop power control

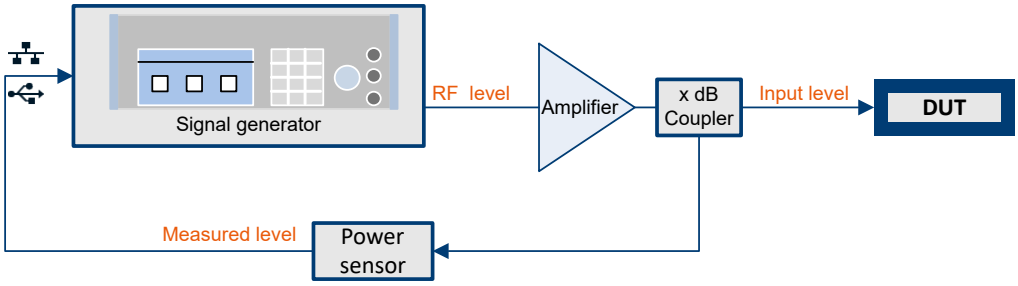


Figure 8-17: Example of a test setup with NRP power control

The signal generator applies the RF output signal to an amplifier and to the DUT. An intermediately connected coupler derivates the output power from the output signal and forwards it to the power sensor. Thus, the power sensor measures a proportional power in defined time intervals, and returns the results to the signal generator. If supported, the power sensor also includes given S-parameters. The signal generator compares the measured power with the set level value and adjusts the level of the output signal accordingly.

This closed loop power control enables you to control the external signal level continuously and reliably achieve a constant input power at the DUT in real time.

Impact of NRP power control and operating modes

Since the frequency and level of the RF output signal are continuously adjusted during "NRP Power Control", this operating mode interferes signal generation modes with varying frequency and level values. In addition, the setting time increases. The reason is the interaction between the signal generator and the R&S NRP power sensor in the control loop.

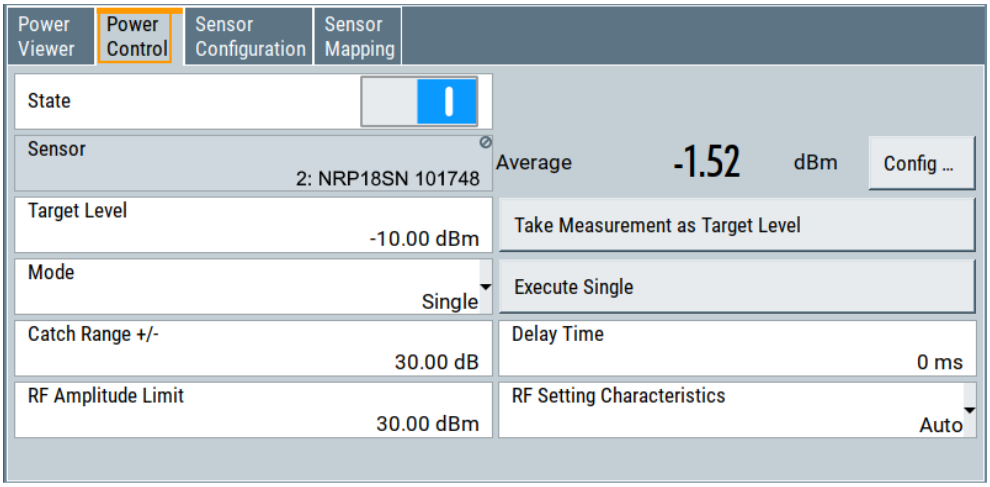
The operating modes impact each other as follows:

- Enabling the RF frequency sweep, RF level sweep or the list mode disables a running "NRP Power Control".
- A running list or RF sweep mode blocks "NRP Power Control".
- Modulated signals can deviate from the CW signal in mean power and peak power, and thus affect the "NRP Power Control".

NRP power control settings

Access:

► Select "RF" > "RF Measurement" > "NRP Power Control".



In this dialog you can configure the parameters of the power control setup for the selected power sensor.
The remote commands required to define these settings are described in Section 14.16.12, "SOURce:POWer subsystem", on page 802.

Settings

State....378
Sensor....378
Measured Level....379
Target Level....379
Take Measurement as Target Level....379
Mode....379
Execute Single....379
Catch Range +/-....379
Delay Time....380
Limit....380
Setting Characteristics....380

State
Enables power control with the selected sensor.

The control loop periodically adjusts the generator output. After switching off, the running loop is completed.

Note: If you want to use another sensor, you must disable power control before. It is not possible to switch between sensors when power control is active.

Remote command:
`[:SOURce<hw>]:POWer:SPC:STATe` on page 809

Sensor
Indicates the R&S NRP power sensor that is selected for power control.

To configure the power sensor parameters, see Section 8.10.3.4, "NRP sensor configuration", on page 381.

Remote command:
`[:SOURce<hw>]:POWer:SPC:SELect` on page 809

Measured Level
Indicates the current reading of the selected power sensor.

Remote command:
:READ<ch>[:POWer]? on page 638
:SENSe<ch>:UNIT[:POWer] on page 639

Target Level
Specifies the nominal level expected at the input of the sensor. The signal generator adjusts the output power accordingly, to meet the target value at the sensor input, and thus the power required at the DUT.

Remote command:
[:SOURce<hw>]:POWer:SPC:TARGet on page 810

Take Measurement as Target Level
Uses the currently measured level as reference and applies the value as target level, see "Target Level" on page 379.

This feature simplifies setting up the control loop after manual adjustment of the measurement configuration. To assign the measured level as reference level, you must switch off "NRP Power Control". It is not possible when the control loop is running.

Remote command:
[:SOURce<hw>]:POWer:SPC:MEASure on page 808

Mode
Selects the measurement mode for acquiring the power values measured by the sensor.

"Auto"	Immediately starts and measures the power continuously.
"Single"	Starts when you manually select Execute Single, and executes one power measurement cycle. Note, that you can achieve the expected target power level at the DUT only with linear test setups. Non-linear test setups, for example, setups including an amplifier do not work.

Remote command:
[:SOURce<hw>]:POWer:SPC:MODE on page 808

Execute Single
In mode "Single", starts one measurement cycle manually.

Remote command:
[:SOURce<hw>]:POWer:SPC:SINGle on page 809

Catch Range +/-
Sets the capture range of the control system.

Within the range:

Target Level +/- Catch Range

the power control locks and tries to achieve the target level. Readings outside the range are not considered.

Remote command:
[:SOURce<hw>]:POWer:SPC:CRANge on page 808

Delay Time
Sets a waiting period between the level adjustment of the generator and the next measurement of the power sensor.

With this parameter, you can bypass idle times in the controlled system.

Remote command:
[:SOURce<hw>]:POWer:SPC:DELay on page 808

Limit
Sets an upper limit for the output power.

Note: The parameter "RF level" > **"Limit"** and "NRP power control" > **"RF Amplitude Limit"** are identical.

You can use this value to protect your DUT from damage due to high input power. If you enter an RF level above this value, the instrument limits the output power to this specified value, and generates the warning message:

"Pep value greater than the defined limit." However, the level indication in the status bar is not affected.

The setting is not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] on page 805

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

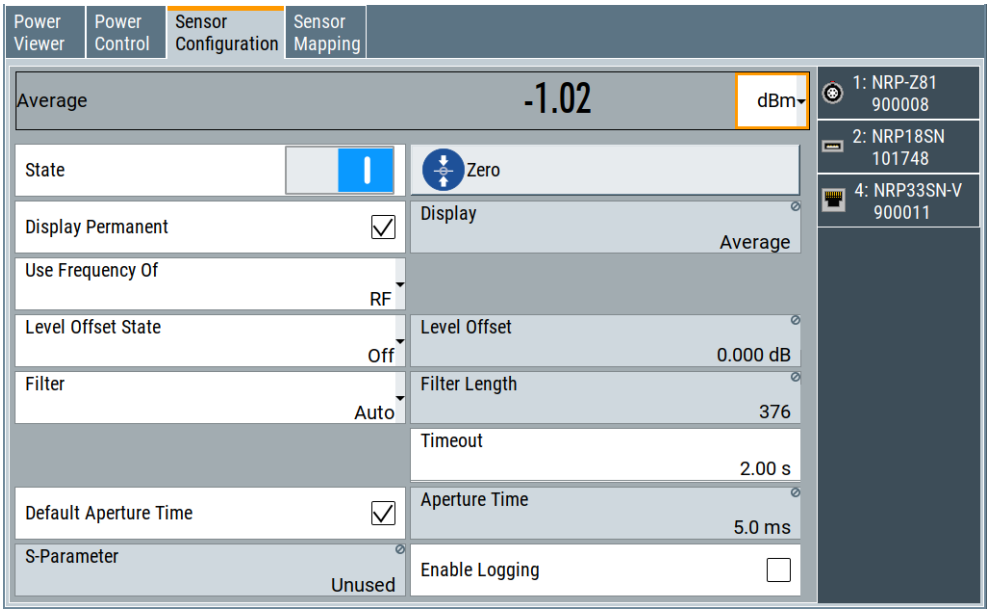
"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Remote command:
[:SOURce<hw>]:POWer:LBEHaviour on page 805

8.10.3.4 NRP sensor configuration

Access:

► Select "RF" > "RF Measurement" > "NRP Sensor Configuration".



In this dialog you can configure the parameters for each mapped R&S NRP power sensor in separate tabs.

The remote commands required to define these settings are described in Section 14.14, "SENSe, READ, INITiate and SLISt subsystems", on page 632, including the triggering of the measurement and the retrieval of measurement results.

Settings:

Sensor type and serial number 382
Level (Peak) / Level (Average) 382
State 382
Zero 382
Display 382
Display Permanent 382
Use Frequency Of 383
Frequency 383
Level Offset State,Level Offset 383
Filter 383
Filter Length 384
Auto Once 384
Noise/Signal Ratio 384
Timeout 384
Default Aperture Time 384

Aperture Time....384
S-Parameter....385
Enable Logging....385

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 646
`:SENSe<ch>[:POWer]:SNUMber?` on page 645

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 638
`:SENSe<ch>:UNIT[:POWer]` on page 639

State
Enables level measurement of the R&S NRP power sensor.

Remote command:
`:INITiate<hw>[:POWer]:CONTinuous` on page 637
To query the availability of a sensor at a given connector, use the command `:SENSe<ch>[:POWer]:STATus[:DEVice]?` on page 645.

Zero
Activates the auto zeroing.

For details, see "About zeroing" on page 375.

Remote command:
`:SENSe<ch>[:POWer]:ZERO` on page 646

Display
Sets the display of results on mean or peak power.

Remote command:
`:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority` on page 640

Display Permanent
Enables the display of the power sensor with the currently measured value in the task bar.

The task bar label shows the measurement result, the channel, the sensor is mapped to and its serial number.

You can activate the permanent display for several sensors.

Remote command:
`:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe` on page 641

Use Frequency Of
Selects the source for measurement.

"RF" The R&S SMCV100B transfers the RF frequency and level settings to the R&S power sensor automatically. Thus you achieve power readings of high accuracy, irrespective from the connected sensor type.

"User" Sets a user defined frequency.

Example:

If you have a frequency converting device between the generator and the DUT. If the frequency converter doubles the frequency, you can set twice the frequency in the R&S SMCV100B. The R&S power sensor considers this RF frequency setting.

Set the parameter Frequency to the measurement's frequency.

Remote command:
`:SENSe<ch>[:POWer]:SOURce` on page 645

Frequency
Defines the frequency value if "Source > User" is used.

Remote command:
`:SENSe<ch>[:POWer]:FREQuency` on page 643

Level Offset State,Level Offset
Activates and defines a level offset which is considered in the power measurement result. The level offset value is always expressed in dB, irrespective of the display of the measurement result.

This function allows you to consider, for example, an attenuator in the signal path.

Remote command:
`:SENSe<ch>[:POWer]:OFFSet` on page 644
`:SENSe<ch>[:POWer]:OFFSet:STATe` on page 644

Filter
Selects the way the length of the used filter is defined.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 374.

"Auto" Selects the filter length automatically and adjusts it to the measured value. The value is indicated with the parameter Filter Length.
When high output power is applied, the filter length and therefore the measurement time can be short.
When low output power is applied, the filter length and therefore the measurement time is increased which reduces the considered noise content in your measurement.

"User" The filter length is defined manually, with the parameter Filter Length.
As the filter length works as a multiplier for the time window, constant filter length results in a constant measurement time.
Values 1 and 2N are allowed.

"Fixed Noise" The averaging factor is taken automatically in accordance to the value Noise/Signal Ratio. Thus, the sensor's intrinsic noise (2 standard deviations) does not exceed the specified noise content.
To avoid long measurement times when the power is too low, set a Timeout.
Timeout is the maximum acceptable measurement time which limits the averaging factor and therefore leads to a more unstable readout.

Remote command:
:SENSe<ch>[:POWer]:FILTer:TYPE on page 643

Filter Length
Sets or indicates the filter length, depending on the selected filter mode.
- "Filter > Auto" indicates the automatically adjusted filter length.
- "Filter > User" enables you to set the filter length manually.
- "Filter > Fixed Noise" hides the setting parameter.

Remote command:
:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO? on page 641
:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] on page 641

Auto Once
Searches the optimum filter length for the current measurement conditions. The result is indicated with the parameter Filter Length.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 374.

Remote command:
:SENSe<ch>[:POWer]:FILTer:SONCe on page 642

Noise/Signal Ratio
For Filter > Fixed Noise, sets the noise content.

Remote command:
:SENSe<ch>[:POWer]:FILTer:NSRatio on page 642

Timeout
Sets a time limit for the averaging process.

The setting is bound to the timeout of the connected sensor.

Remote command:
:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe on page 642

Default Aperture Time
The sensor default setting is sufficient. Disable this parameter to specify a user-defined aperture time per sensor, if, for example, the readings vary.

To obtain stable readings, set the Aperture Time exactly to one modulation period.

Remote command:
:SENSe<ch>[:POWer]:APERture:DEFault:STATe on page 639

Aperture Time
If "Use Default Aperture Time > Off", defines the acquisition time per sensor.

For example, to obtain a sufficient low average value, set the aperture time exactly to one modulation period.

Remote command:
:SENSe<ch>[:POWer]:APERture:TIMe on page 639

S-Parameter
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 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST? on page 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect on page 640

Enable Logging
Activates recording of R&S NRP power sensor readings in a log file.

There is 1 log file per sensor. The log files are created automatically and filled in continuously. They are text files with predefined filename `SensLog<n>.txt`, where `<n>` indicates the connected sensor. Log files are stored on the internal memory, in the directory `/var/user/SensorLogging`.

Each log file contains the measured value (2 readings when you work with peak sensors), the sensor type, and the measurement time (timestamp). Logged data is not overwritten. When a new measurement is started, the collected logging data is appended in the log file.

Check the used disc space regularly and remove log files to maintain storage capacity.

Note: The logging function is intended for measurements with long time intervals. It is suitable source for data reconstructions if the connection to the sensor was interrupted.

Remote command:
:SENSe<ch>[:POWer]:LOGGing:STATe on page 644

8.10.3.5 NRP sensor mapping

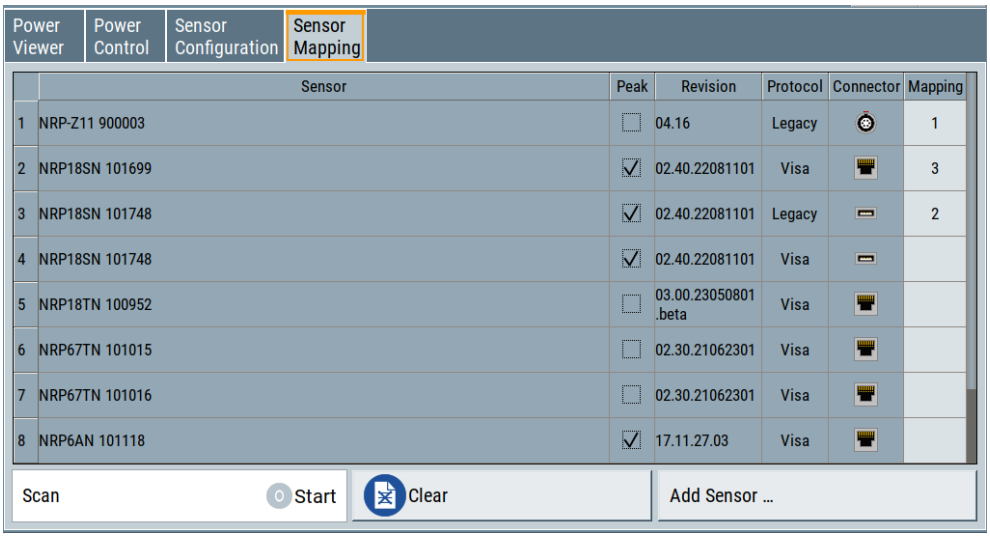
The "NRP Sensor Mapping" lists the sensors detected by the instrument.

Any R&S NRP sensor that supports the USB legacy protocol and is connected to one of the USB interfaces, is detected automatically and added to the list. When you disconnect a power sensor, the R&S SMCV100B removes it from the list accordingly.

R&S NRP power sensors that are connected in the LAN or use the USBTMC protocol are only detected by the scan search function.

Access:

► Select "RF" > "RF Measurement" > "NRP Sensor Mapping".



The dialog lists all detected R&S NRP sensors for selection and mapping. You can also browse the network for sensors.
The list informs on the sensor type with serial number, specific features and the revision of the sensor firmware.
For each sensor, you find the used protocol and the connector icon of the interface.
In the "Mapping" column, you can assign a mapping index to enable the sensor for use. The list can contain several entries but the R&S SMCV100B can only use up to four sensors simultaneously.
The remote commands required to define these settings are described in Section 14.14, "SENSe, READ, INITiate and SLISt subsystems", on page 632.

Settings

Sensor Mapping List 386
Scan 387
Clear 387
Add Sensor 387
Add LAN Sensor 387
Add USBTMC Sensor 387

Sensor Mapping List

Shows the sensors that are connected to the R&S SMCV100B.

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 635
`:SLISt:ELEMent<ch>:MAPPing` on page 637
`:SLISt:SENSor:MAP` on page 637

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.

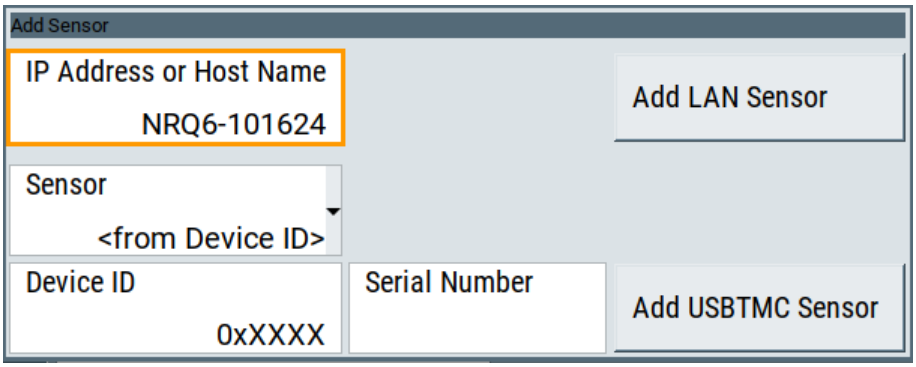
The instrument detects sensors communicating over the USB legacy protocol automatically.

Remote command:
`:SLISt:SCAN[:STATe]` on page 635

Clear
Removes the selected sensor from the sensor mapping list.

Remote command:
`:SLISt:CLEar:LAN` on page 636
`:SLISt:CLEar:USB` on page 636
`:SLISt:CLEar[:ALL]` on page 637

Add Sensor
Shows or hides the "Add Sensor" dialog to configure power sensors connected to the R&S SMCV100B over USB or LAN.



Add LAN Sensor
Configures settings to add sensors connected to the R&S SMCV100B 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 SMCV100B does not detect a connected R&S NRP sensor, you can assign the address information manually.

"Add LAN Sensor"
Adds a detected R&S NRP sensor connected in the LAN to the list of sensors, including its device ID or name and its serial number.

Remote command:
`:SLISt:SCAN:LSENsor` on page 635

Add USBTMC Sensor
Configures settings to add sensors connected to the R&S SMCV100B over USB.

If the R&S SMCV100B does not detect a connected R&S NRP sensor, you can assign the device ID manually.

"Sensor"
Selects the name of the R&S NRP power sensor.
If the R&S SMCV100B does not contain the R&S NRP power sensor you use, select "<from Device ID". The "Device ID" entry field switches in edit mode where you can enter the ID of your product manually.

"Device ID"
Displays the device identifier of a selected R&S NRP power sensor.
If you want to assign the device ID manually, get the information in the user documentation of your power sensor.

"Serial Number"
Displays the serial number of the R&S NRP power sensor.
If the R&S SMCV100B does not detect a connected R&S NRP sensor, you can assign the serial number manually.

"Add USBTMC Sensor"
Adds a detected R&S NRP sensor connected at the USB interface to the list of sensors, including its device ID or name and its serial number.

Remote command:
`:SLISt:SCAN:USENsor` on page 636

8.10.4 Improving the RF signal performance

To achieve an accurate input level at the DUT, you can compensate losses, e.g. caused by cables between the RF output and the DUT over a frequency range.

Using the user correction function and e.g., a R&S NRP power sensor, the R&S SMCV100B utilizes the readings of the power sensor and creates a correction value table for controlling the output level during operation.

To connect the R&S NRP to the R&S SMCV100B

1. Connect the power sensor.
   See Section 8.10.3.1, "Connecting R&S NRP power sensors to the R&S SMCV100B", on page 373.
2. Select "RF" > "RF Measurement" > "NRP Sensor Mapping".
3. If the sensor is not detected automatically, select "Scan > Start".

   The instrument scans the network and the USB connections for connected sensors and lists all detected R&S NRP sensors in the mapping table.
4. In the "Mapping" column, assign the sensor to a sensor channel, see Section 8.10.3.5, "NRP sensor mapping", on page 385.
5. Close the dialog.

To configure and calibrate the R&S NRP in the R&S SMCV100B

Provided the power sensor is connected to the R&S SMCV100B and is assigned to a sensor channel, we recommend that you calibrate and configure the power sensor.

1. In the block diagram > RF, turn off the RF output signal.
2. Select "RF" > "RF Measurement" > "NRP Power Viewer".



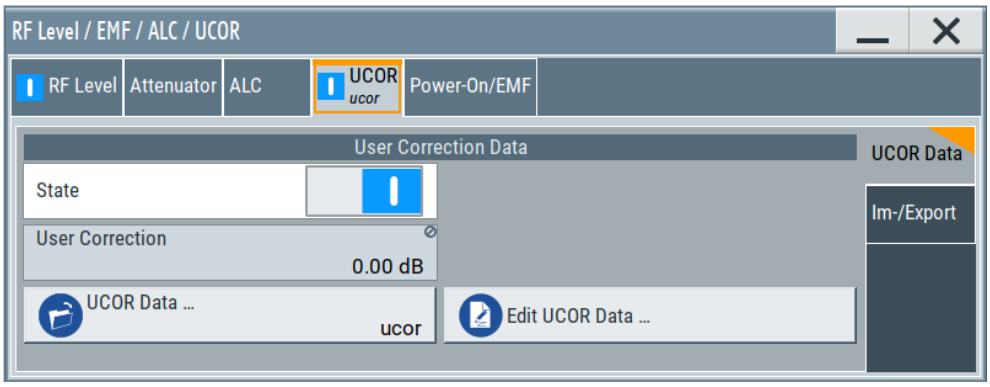
3. To configure a sensor, select "Config".
4. Select "Zero" to start zeroing of the sensor.
   Note: Always turn the RF power off or disconnect the sensor from RF before zeroing, since the function calibrates the power sensor at zero signal power.

   The zeroing process takes a few seconds, depending on the power sensor type.
5. Configure additional parameters for the selected sensor as required.
6. Select "State > On".
7. Close the dialog.

To create user correction data with an R&S NRP and the R&S SMCV100B

We assume, that the power sensor is connected, assigned and ready for operation.

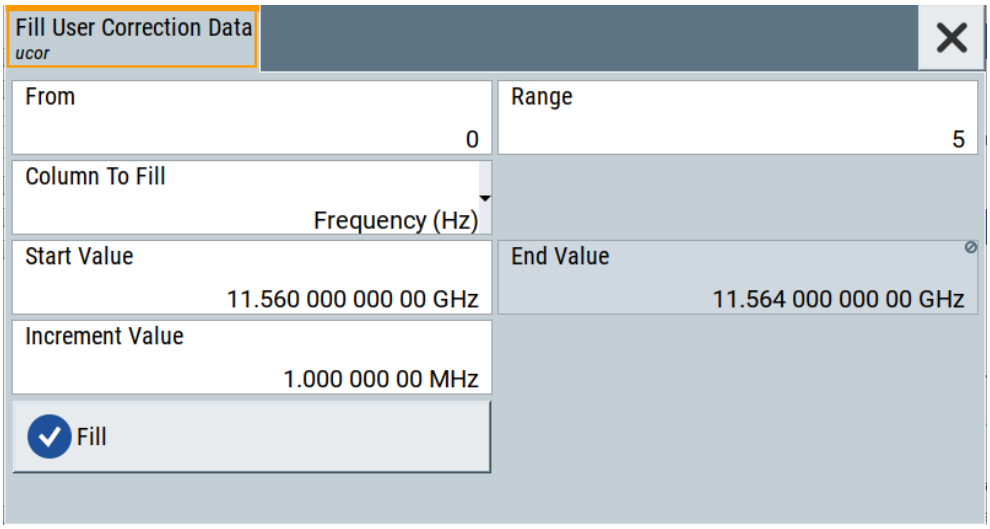
1. Select "RF" > "RF Level" > "User Correction".



2. Select "UCOR Data" > "UCOR Data...."
3. Create a file: "New" > Filename and confirm with "OK".
4. Select the new file with "Select".

5. Select "Edit UCOR Data...".
6. Select "Edit" > "Fill".

   The "Fill Table" dialog enables you to fill in the values of the columns automatically.
7. To fill in the frequency column:

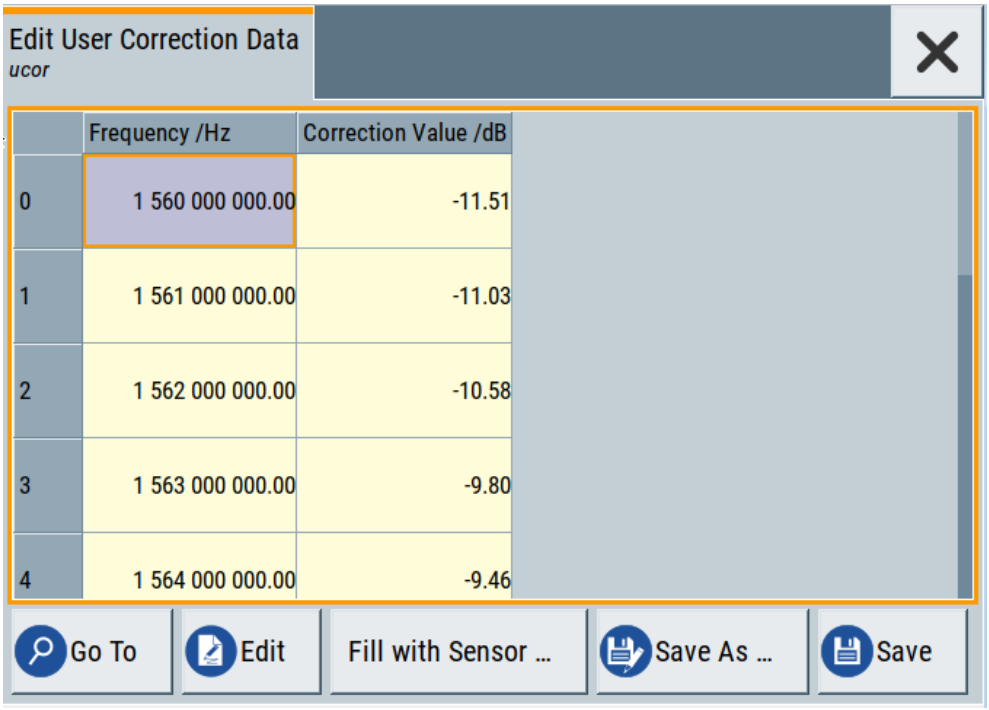


   a) Select "Select Column To Fill > Frequency / Hz".
   b) Select "Range > e.g. 15" to determine the number of values.
   c) Select "Start Value > e.g. 1.56 GHz".
   d) Select "Increment Value > e.g. 1 MHz", to determine the frequency steps.
   e) Select "Fill", to insert the frequency values.

   The "Fill" function also fills the column of the "Correction Value / dB" values with a predefined value, since empty cells lead to the data loss of the entire line. If you need different values, you can change them manually, or you can use the automatic function "Fill with Sensor" as described in the next steps.
8. Select "Fill with Sensor".

   The "Fill User Correction Data With Sensor" dialog provides an overview of the sensor configuration.
9. Select "Execute".

   The R&S SMCV100B successively sets each frequency point, reads the measured power of the sensor and fills in the value in the correction table.



10. Select "Save" to save the data in the file.
11. Close the dialog.

To perform power leveling calibration with user correction data

We assume that a user correction file is available in the user directory of the R&S SMCV100B or on a memory stick or in a shared directory.

If you have created and saved the file immediately before this step, the file is loaded in the "User Correction" dialog automatically. Otherwise you can load a previously saved file.

1. Select "RF" > "RF Level" > "User Correction".
2. Select "UCOR Data" > "UCOR Data...", if there is no file loaded already.
3. Select the directory and file you want to use.
4. Load the file with "Select".
5. To view the file content, select "Edit UCOR Data...".
6. Select "UCOR Data" > "State" > "On" to apply the user correction values.

   When you activate the RF output, the R&S SMCV100B considers the user correction data and adjusts the signal level accordingly to compensate external frequency responses.

9 Monitoring baseband signal characteristics

Instead of analyzing the baseband signal characteristics with an external instrument, the R&S SMCV100B can also visualize a subset of these signal characteristics with the built-in graphical signal display function. Also, this function evaluates signal measurement quantities and displays signal characteristics graphically in real-time.

9.1 Required options

The minimum equipment layout for using this function includes the base unit.

9.2 About the graphical signal display

To ease the setting and routing of baseband signals, R&S SMCV100B is able to capture these signals and display them graphically in different ways: as I/Q, vector, eye or constellation diagram, as power spectrum or as statistical evaluations.

In the digital domain, the measurements are based on recorded I/Q samples. The sources of these samples are selectable points (acquisition points) in the signal flow. You can configure and display the signal characteristics simultaneously in up to dia-grams.

9.2.1 Available diagrams

This section focuses on graphical signal displays, their content and application. See Table 9-1 for an overview of the signal characteristics that you can monitor.

Table 9-1: Graphics modes overview

Graphics modes	Domain	Measurement instrument
I/Q diagram	Time	Oscilloscope (standard mode)
Vector diagram	Time	Oscilloscope (XY mode)
Constellation diagram	Time	Oscilloscope (XY mode)
Eye diagram	Time	Oscilloscope (triggered to symbol clock and showing repetitive traces)
CCDF display	Statistical representation of peaks	Peak power analyzer
Power spectrum	Frequency	Spectrum analyzer

9.2.1.1 I/Q diagram

The I/Q diagram displays the in-phase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time.

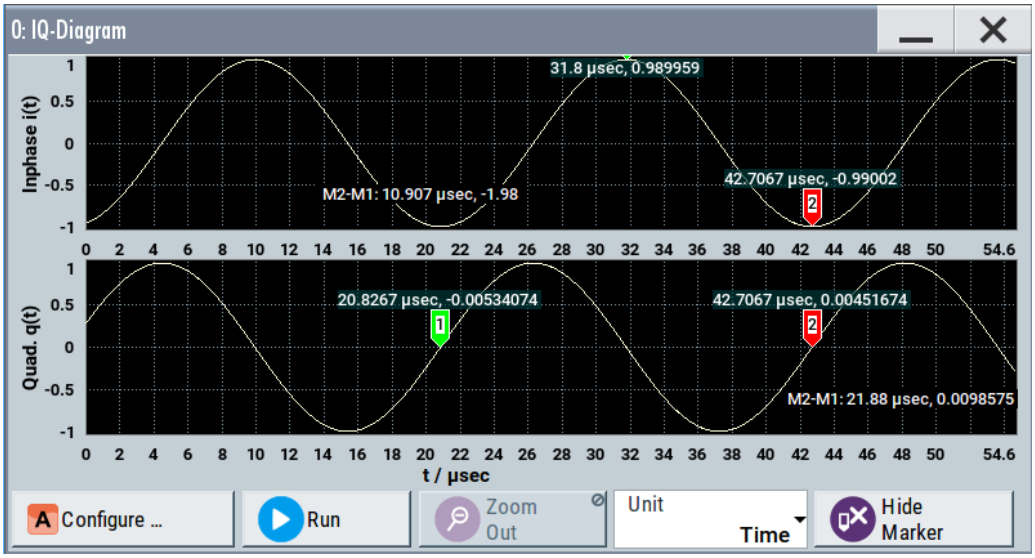


Figure 9-1: I/Q diagram with markers

= window with two separate coordinate systems with identical x-axis and y-axis
x-axis = time in units number of symbols, chips, samples or seconds depending on the signal
y-axis = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To analyze impairments, added noise and signals (e.g. from external baseband input) in the time domain. This mode shows the signal like an oscilloscope.

Signal acquisition points: See Table 9-2.

9.2.1.2 Vector diagram

The vector diagram displays the Q component over the I component. All points in the complex domain are connected by lines.

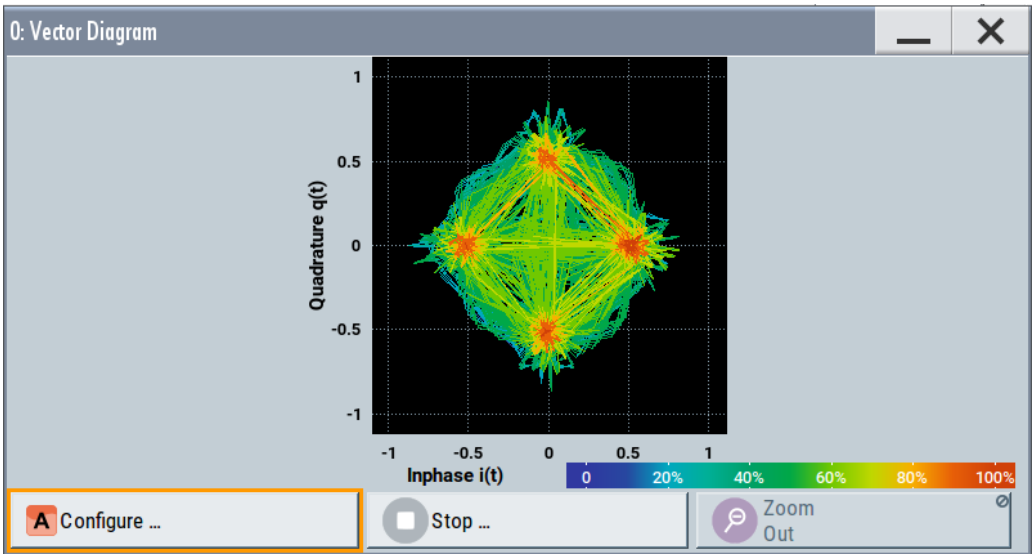


Figure 9-2: Vector diagram (64QAM)

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To analyze the transition between the various states of modulation mapping, especially with linear modulations like MSK, QPSK or QAM. This mode shows the signal like an oscilloscope (X/Y-mode).

Signal acquisition points: See Table 9-2.

9.2.1.3 Constellation diagram

Constellation diagrams display the modulation symbols as discrete points in the I/Q plane. Unlike the vector diagram, the constellation diagram displays only one sample per symbol. This sample represents the symbol.

Constellation diagrams are helpful when generating signals using the "Custom Digital Modulation" settings. Compare the displayed constellation diagram with the diagram displayed in the "Custom Digital Modulation > Modulation" dialog.

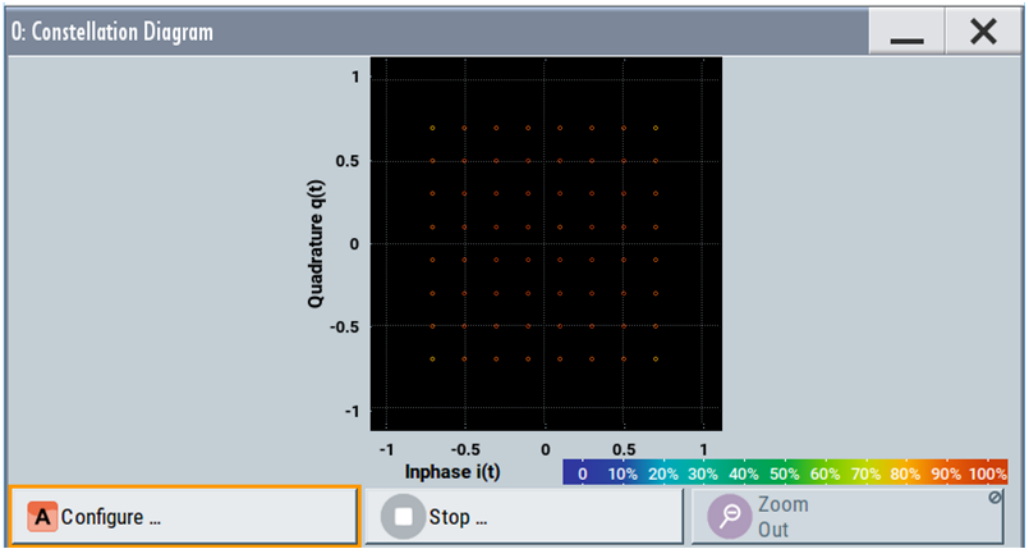


Figure 9-3: Constellation diagram (64QAM)

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To classify modulation.

Signal acquisition points: See Table 9-2.

9.2.1.4 Eye diagram

The eye diagram displays synchronized and superimposed sections of either the in-phase or the quadrature components of the signal.

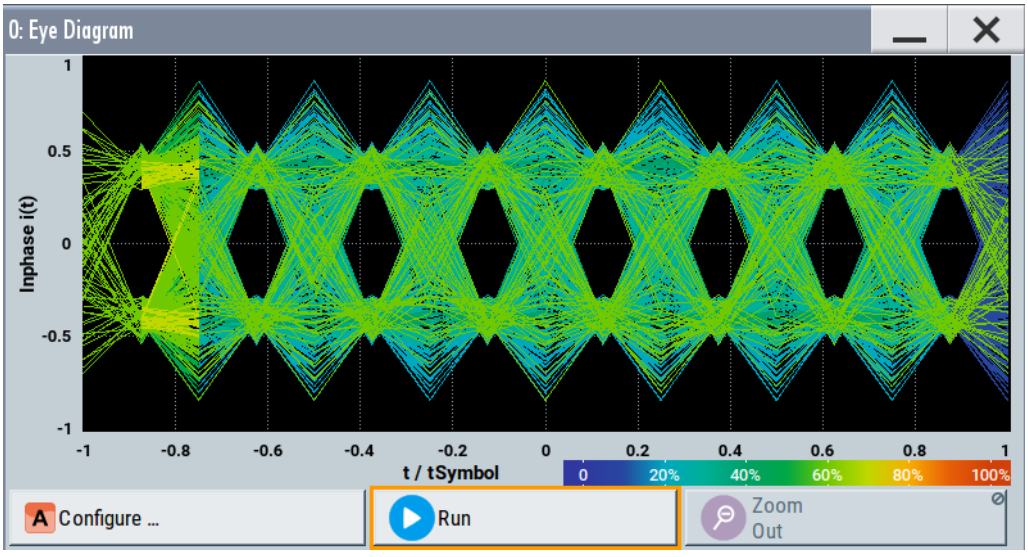


Figure 9-4: Eye diagram with partially closed eye (QPSK)

X-axis = time in the range of -/+ 1 symbol
Y-axis = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

The display width is normalized for 2 symbols. It uses one-symbol "eye opening" in the center of the display and 1/2-symbols to the left and right of the center eye for capturing time transitions. Several hundred curve segments are superimposed. The beginning of the recording is synchronous to the symbol and chip clock pulse.

Application: To analyze amplitude and time distortion elements (e.g. jitter) at high-speed digital data systems. A high quality, unimpaired signal shows a clearly open eye (horizontally and vertically).

Signal acquisition points: See Table 9-2.

9.2.1.5 CCDF display

The complementary cumulative distribution function (CCDF) displays the probability with which the output signal exceeds the average power.

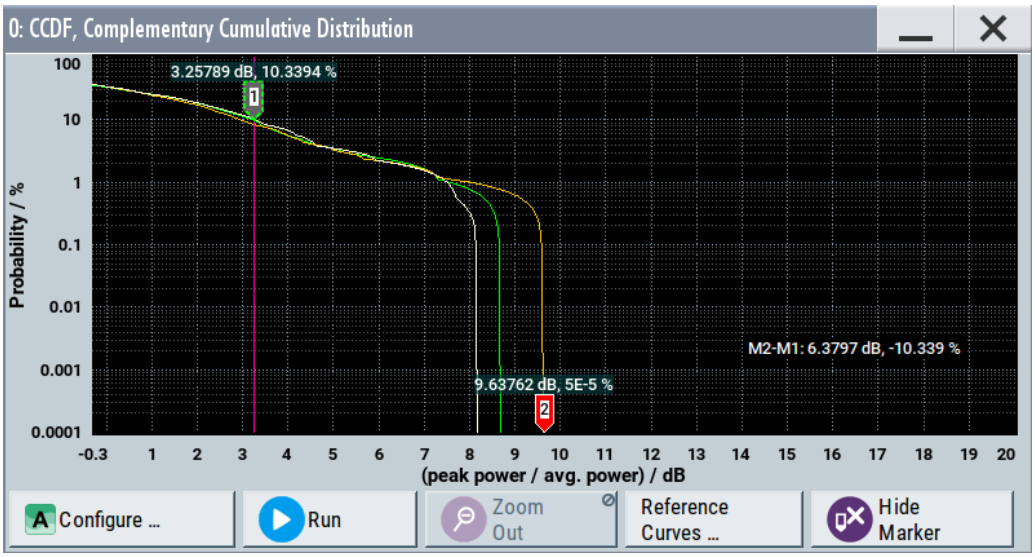


Figure 9-5: CCDF diagram of a 5 MHz LTE signal (Level -30 dBm) and two reference curves

X-axis = Level over the average signal power, where the average power (RMS) corresponds to the origin
Y-axis = Probability of exceeding the average power that is the percentage of time the signal spends at or above the power level specified by the X-axis
Marker 1 = Interpolation: 10.3% of the samples exceed 3.3 dB above average; 1% of the samples exceed 7.5 dB above average (not shown with a marker)
Marker 2 = The point where the trace crosses the x-axis; indicates the highest peak that is found in the sample block and is 9.6 dB higher than average.

Signal acquisition points: See Table 9-2.

9.2.1.6 Power spectrum

The power spectrum displays the signal spectrum which is calculated from the I/Q signal with fast Fourier transform (FFT). The power density over frequency is displayed.

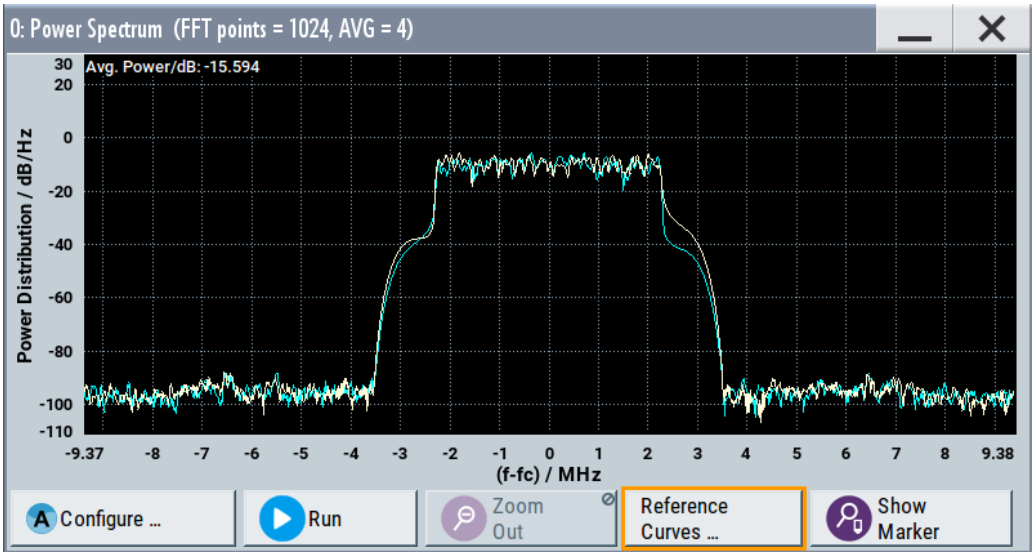


Figure 9-6: Power spectrum diagram of a 5 MHz LTE signal with enabled reference curve (blue)

"FFT points" = indicates the number of I/Q value pairs that are used for calculating a (part-)FFT
"AVG" = indicates the number of subspectra used for averaging
X-axis = frequency plotted symmetrically (- Sampling Rate/2 to +Sampling Rate/2)
Y-axis = power density

Signal acquisition points: See Table 9-2.

9.2.2 Signal acquisition points

Signal characteristics can be displayed using different methods and different acquisition points, also at the same time. Table 9-2 shows which signal acquisition point is suitable for which kind of graphics mode. Also, it provides associated graphics sources and the designation of the access points in the block diagram.

Table 9-2: Signal acquisition points, modes and sources

Signal acquisition points	Graphics modes	Graphics source	Designation
Baseband signals	Constellation diagram, eye diagram	"Baseband" "BB Input"	A A*
Input streams	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"Stream"	A
Analog outputs	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"RF"	A
Digital output streams	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"IQ Digital"	1

Figure 9-7 shows an example for locations of signal acquisition points.

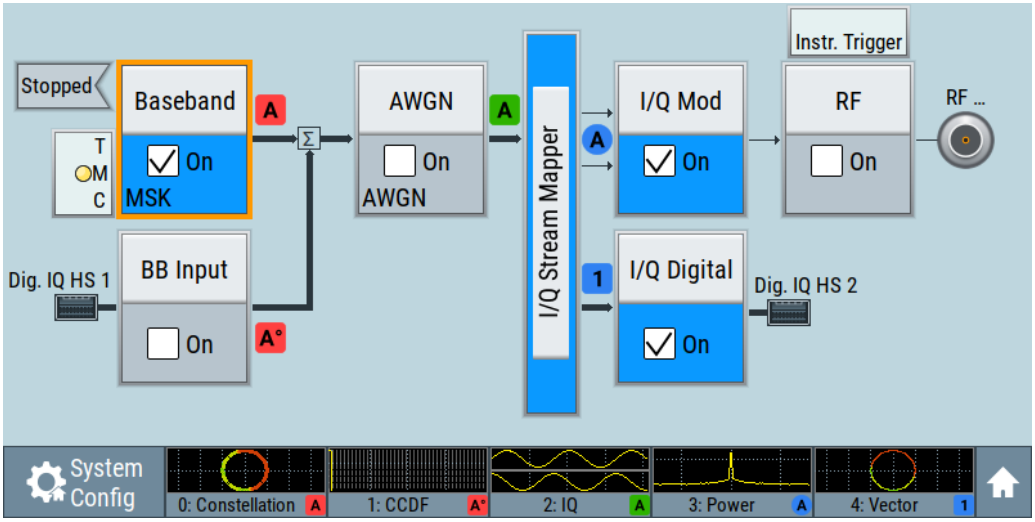


Figure 9-7: Block diagram with graphical signal display and signal acquisition points

9.2.3 Display functions

The graphical display provides general display functions known from other measurement instruments and offers zoom and markers.

Zooming

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

Zooming is merely a visual tool, it does not change the number of samples used for the calculation. You can increase the number of samples before zooming.

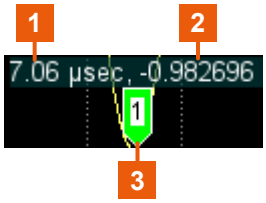
See also "To zoom into a diagram" on page 408.

Using markers

Markers are tools for numerical readout of measured data in diagrams. They help you analyze the displayed signal characteristics by determining particular values in the diagram.

Often you can use markers to measure the frequency distance of two peaks or to measure the power decrease of an oscillator at a given frequency offset, dBc value. Note that markers in the diagram are not related to the markers in the digital standards.

In the graphical display, the markers and their values (for example time or frequency) are displayed as usual.

Single marker indication	Delta marker indication
 • 1 = marker position on the x-axis in the current units • 2 = marker value on the y-axis • 3 = marker number	 • 1 = delta marker • 2 = result of the marker function, i.e. the delta values in the current units

See also "To enable markers to read-out measured data" on page 409.

Persistence and color maps

In addition to the standard representation, the vector, the constellation, and the power spectrum diagrams use a color map.

The color encodes the relative amplitude (in percent) of the probability distribution of the data points in the diagram. A detailed breakdown of the colors is below diagrams the colors are relevant for. Data points in areas with high probability are marked in red, data points in areas with low probability in blue. Thus, for example, you can observe not only the "level versus frequency" trace but also a third dimension, the probability of the power level.

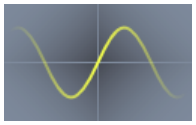
Reference trace

Reference traces help you analyze a displayed characteristic, as do the markers. Reference traces are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper power limits which are allowed from a device under test (DUT).

The R&S SMCV100B supports up to five reference traces. You can load reference traces and activate them simultaneously.

9.3 Graphics configuration settings

This section focuses on the graphics configuration dialog, which determines the number and kind of the graphical signal displays.



Access:

1. Select the sine wave icon.

   The "Graphics Configuration" dialog opens.

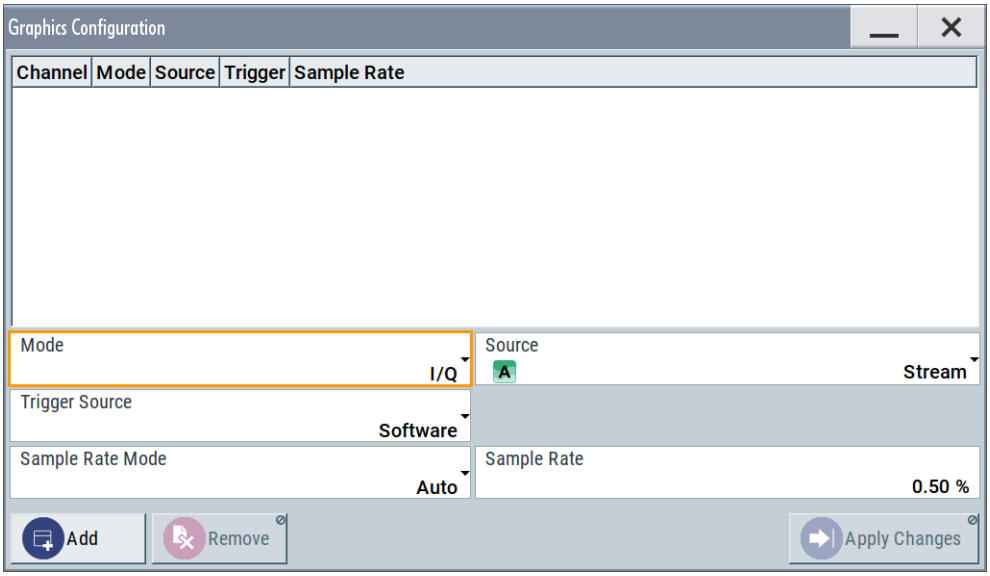


Figure 9-8: Graphics configuration dialog

2. To display a certain characteristic of the signal, use the parameter "Mode".
3. To select suitable signal acquisition points, use the parameter "Source".
4. To enable the graphical signal display, select "Add".

   A thumbnail of the graphical signal display is shown in the taskbar.

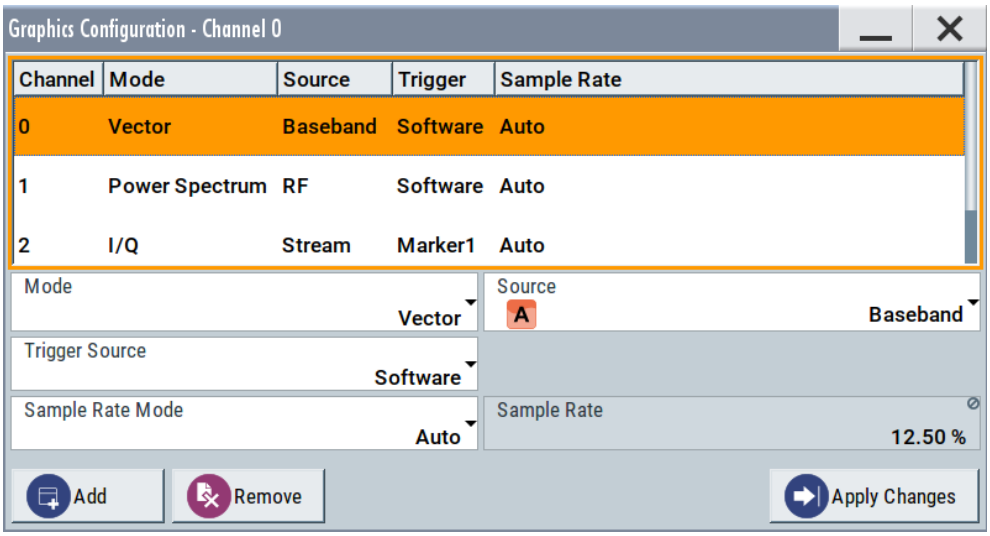


Figure 9-9: Graphics configuration dialog with active graphical signal displays

5. To enlarge the thumbnail, select it.

Settings:

Graphical Diagrams Table....401
Mode....401
Source....401

FFT Length....401
Full Scale (dBFS)....401
Trigger Source....401
Sample Rate Mode....402
Sample Rate....402
Add....402
Apply Changes....402
Remove....403

Graphical Diagrams Table
The active graphical signal displays are listed in the table at the top of the dialog.

Mode
Sets the graphics mode, see Section 9, "Monitoring baseband signal characteristics", on page 392.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:MODE` on page 765

Source
Sets the source for the signal acquisition point.

See Section 9.2.2, "Signal acquisition points", on page 397.

Remote command:
`[:SOURce]:BB:GRAPhics:SOURce` on page 766

FFT Length
In "Mode > Power Spectrum", selects the number of samples to be included in the graph of the power spectrum.

Remote command:
`[:SOURce]:BB:GRAPhics:FFTLen` on page 766

Full Scale (dBFS)
In "Mode > Power Spectrum", determines the normalization of the power values in the diagram.

Observe the change in the units on the y-axis.

"On" The maximal digital power |I|=|Q|=max is mapped to 0 dB in the power spectrum diagram.
The y-axis shows the normalized power in dBFS.

"Off" The frequency average of the displayed power (frequency domain) agrees with the average power in the time domain.
The y-axis shows the power distribution in dB/Hz.

Remote command:
`[:SOURce]:BB:GRAPhics:FFTFscale` on page 767

Trigger Source
Defines the trigger for signal recording.

"Software" Recording of signals starts automatically in predefined intervals. This asynchronous method is suitable if a representative display of the complete signal is required.

"Marker 1" The starting point for recording of signals is determined by the marker 1 setting of the activated digital standard ("Trigger/Marker" dialog). This synchronous method is suitable if specific signal segments are to be shown in greater detail. With periodic signals, a static image is obtained by selecting a period length of marker 1 that is equal to the signal period.
The displayed signal segment can be shifted by entering a marker delay in the "Trigger/Marker" dialog of the activated digital standard.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce` on page 767

Sample Rate Mode
Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a display covering the entire signal bandwidth. The higher the resolution, the shorter the length of the displayed signal segment.

"Auto" The resolution is set to an optimum value in terms of signal and display type.

"Full Bandwidth" The resolution is set so that the display covers the entire signal bandwidth.

"User" Activates the "Sample Rate" input field, where you can manually set the resolution.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE` on page 765

Sample Rate
- If "Sample Rate Mode = Auto/Full Bandwidth"
  Displays the percentage of the entire signal bandwidth which is used for the graphical signal display.
- If "Sample Rate Mode = User"
  Input for the percentage of signal bandwidth which is used for the graphical signal display.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:SRATe:USER` on page 765

Add
Adds a graphical signal display (as set in the "Graphics Configuration" dialog) to the taskbar/graphical diagrams table.

Remote command:
`[:SOURce]:BB:GRAPhics:ADD` on page 766

Apply Changes
Enables the current settings for the selected graphical signal display.

Remove
Removes the selected graphical signal display from the taskbar/graphical diagrams table.

Remote command:
`[:SOURce]:BB:GRAPhics:CLOSe` on page 766.
The command closes all graphical signal displays.

9.4 Graphical signal display settings

Access:

1. Select "Taskbar > System Config > Graphics > Add".
2. Double-click the thumbnail in the taskbar.

This section focuses on the functions of the enlarged graphical signal displays.

Settings:

Configure....403
Stop/Run....403
Zoom Out....403
Reference Curves....403
Display Units....403
Show / Hide marker....404
Reference Curve....404

Configure
Opens the "Graphics Configuration" dialog, see Section 9.3, "Graphics configuration settings", on page 399.

Note: This function is available for enlarged graphical signal displays and in the context menus of the thumbnails.

Stop/Run
Stops the processing of the displayed signal and freezes it.

"Run" continues a stopped displayed signal.

Zoom Out
Resets a previous zoom, see also "To zoom into a diagram" on page 408.

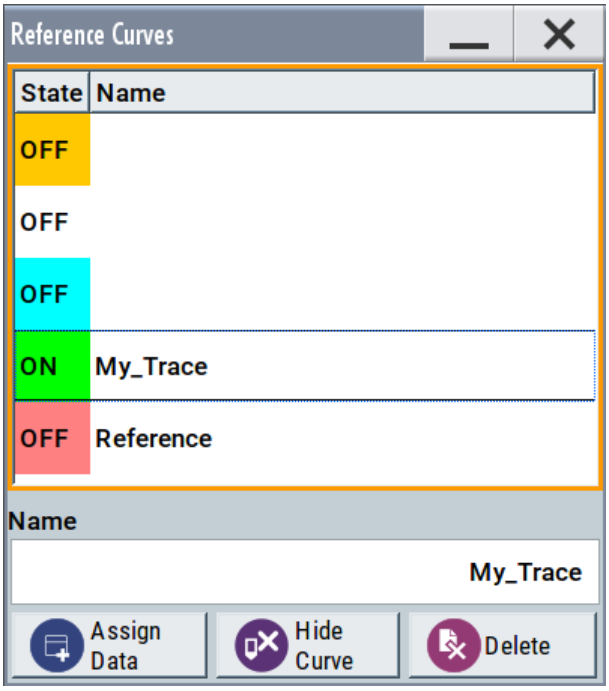
Reference Curves
Accesses the dialog for defining reference curves, see "Reference Curve" on page 404.

Display Units
Changes the units of the X-axis. The available values depend on the generated signal.

Show / Hide marker
Sets two markers to the displayed signal or hides them.

See also:
- "Using markers" on page 398
- "To enable markers to read-out measured data" on page 409

Reference Curve
Enable the indication of up to five configurable reference curves (traces).



See "Reference trace" on page 399.

"Reference Curves Table"
Lists the configured reference curves and their current state.
To change a curve, select it.

"Name" Enters the name of a new reference curve

"Assign Data" Opens the standard "File Select" function to load a file describing a reference curve.

"Show Curve" Toggles the show/hide state of the selected curve

"Delete" Removes the curve

9.5 Checking the generated signal graphically

This section shows you how to use the different graphic modes to visualize the signal characteristics of the generated signal. It also shows how to observe the effect of standard settings, like an applied filter, an enabled fading or AWGN. The examples use a simple custom digital modulated signal.

To generate a simple WCDMA-3GPP (QPSK 45° offset) signal

► Use the custom digital modulation. Enable a predefined WCDMA-3GPP signal.

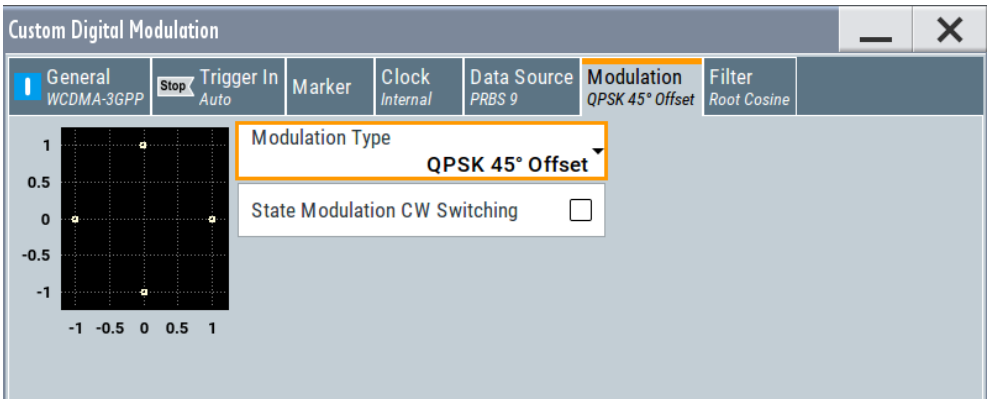
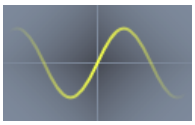


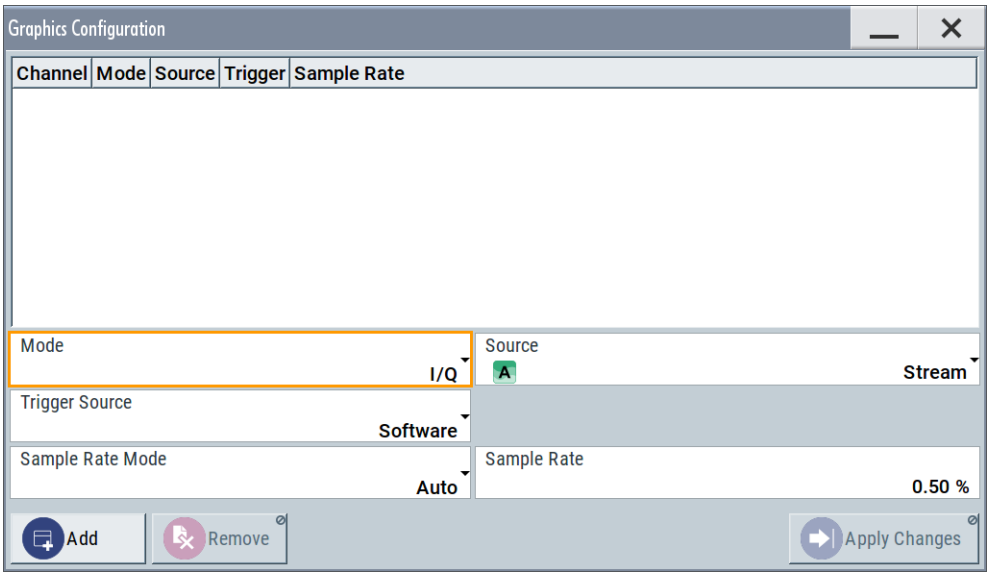
Figure 9-10: Used modulation type

Configure the graphical signal display

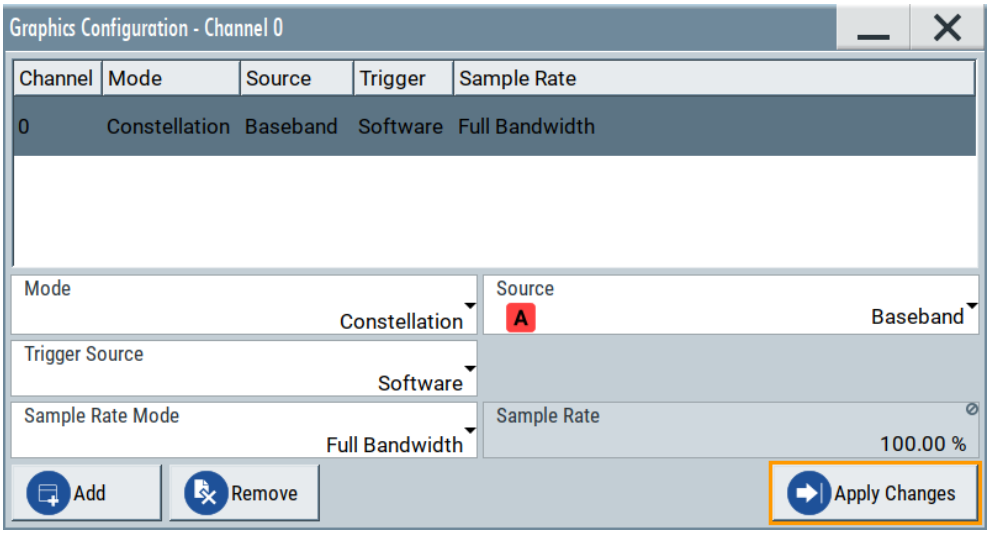
1. Select the wave icon:



The "Graphics Configuration" dialog opens.



2. Select "Mode > Constellation".
3. Select "Source > Baseband".
4. To view the signal, select "Add".



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

5. To enlarge the constellation diagram, select it.

   The displayed constellation diagram confirms the a QPSK offset modulation.

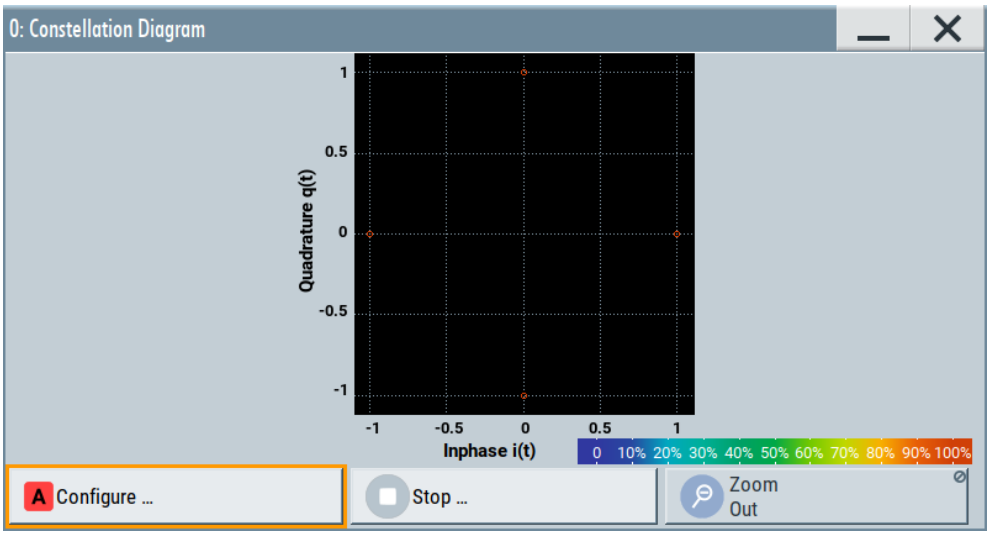
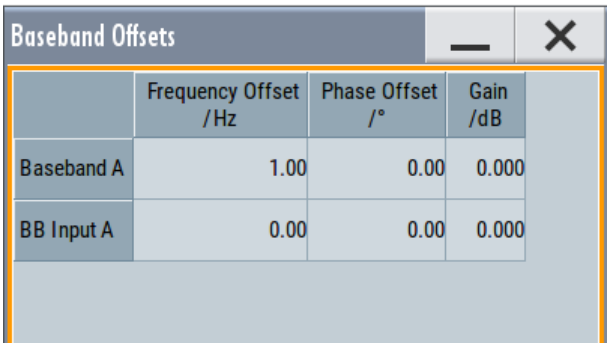


Figure 9-11: Constellation diagram of a WCDMA-3GPP (QPSK 45° offset) signal

To set and verify a baseband frequency offset

1. In "Baseband > Baseband Offsets", set "Baseband > Frequency Offset = 1 Hz"



2. In the "Constellation Diagram", select "Configure".
   The "Graphics Configuration" dialog opens.
3. Add a vector diagram with signal acquisition point "Stream"
4. Enlarge the vector diagram.
   The vector diagram rotates with 1 Hz.

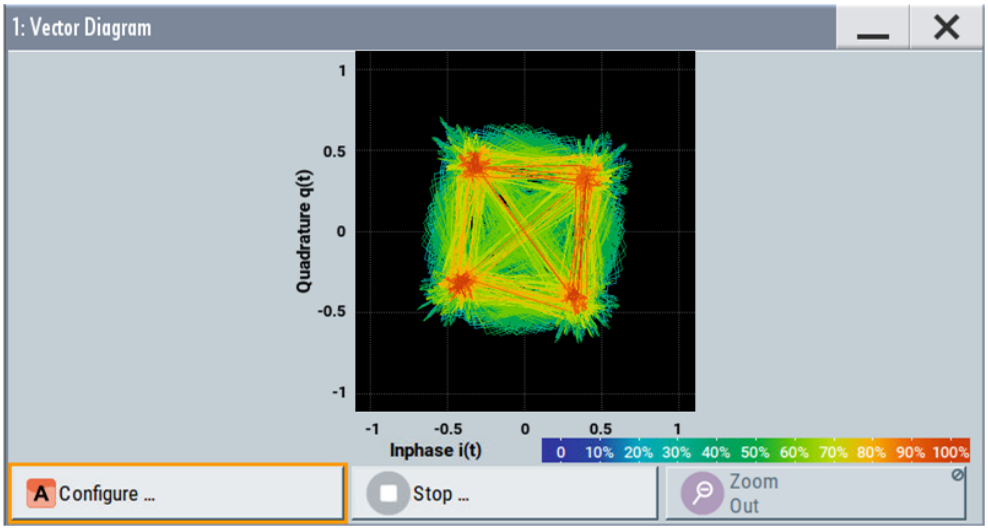
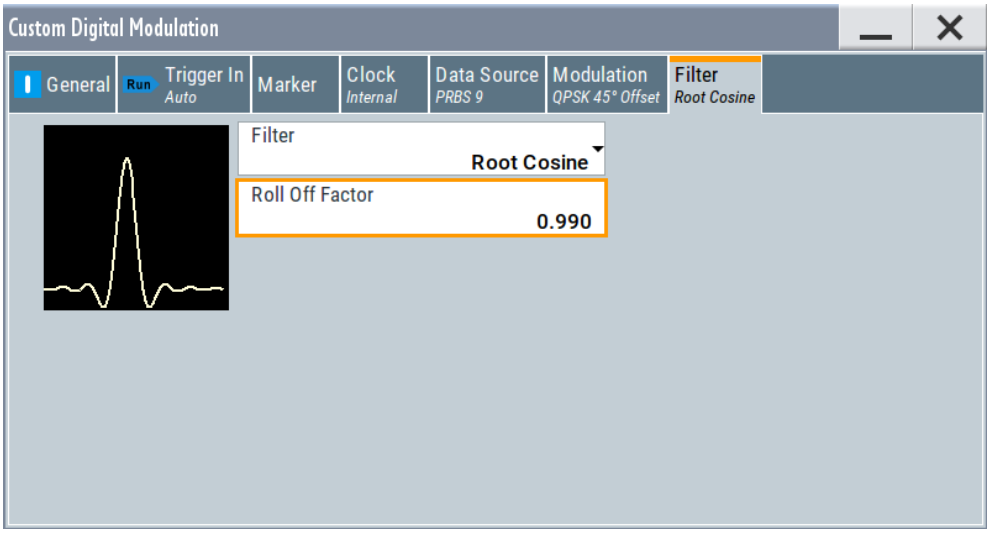


Figure 9-12: Rotating vector diagram

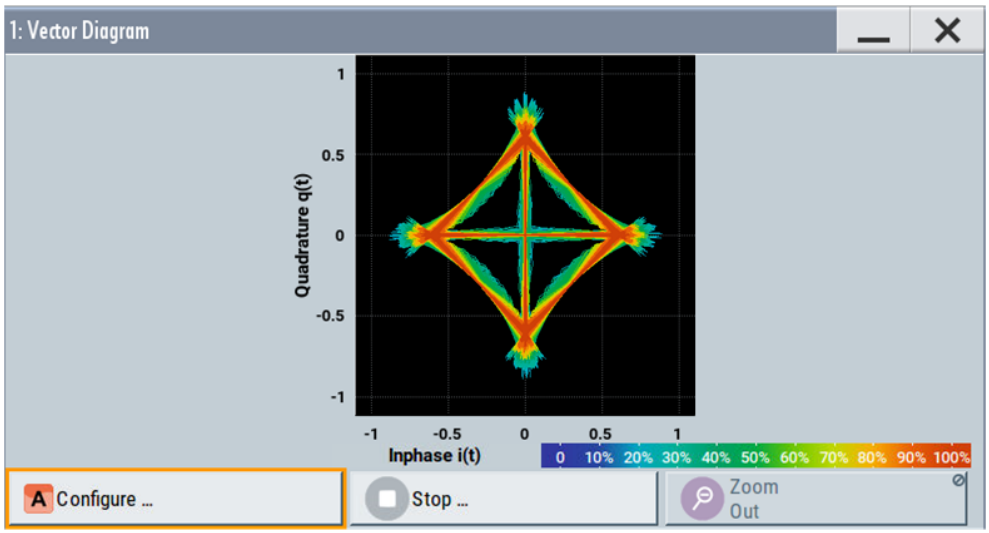
5. Reset the baseband frequency offset to 0 Hz.
   The vector diagram does not rotate anymore.

To visualize the effect of the filter parameters on the generated signal

1. Select "Baseband > Custom Digital Mod... > Filter > Roll Off Factor = 0.99"



The vector diagram changes.



2. Preset the rolloff factor.

To zoom into a diagram

In an enlarged diagram:

1. Use the one-finger zoom to zoom with a fixed zoom factor.
2. Use the two-finger zoom to do a custom zoom.
   This zoom works like the two-finger pinching for magnifying images on your mobile phone.

   If the diagram is zoomed, an overview window appears.
3. Move the visible area in the graphics or in the overview window.
4. For the reverse operation, select "Zoom out".

To enable markers to read-out measured data

In an enlarged diagram:

1. Select "Show Marker".

   Two markers appear, one over the other.

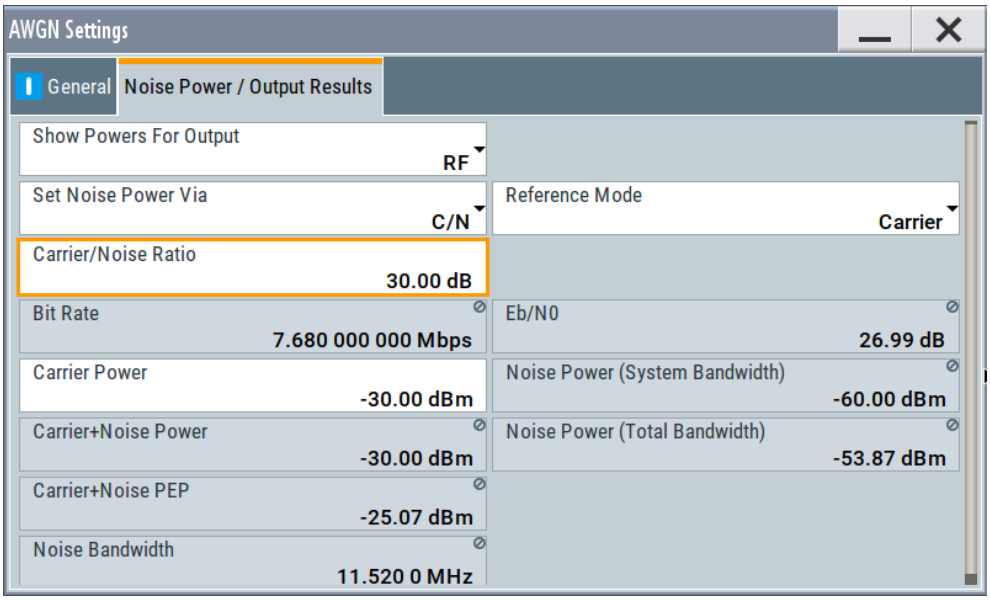
2. To position the markers, select and shift them.

   "M2-M1" indicates the distance of marker 1 and marker 2 on the x-axis (left value) and on the y-axis (right value).

3. To hide the markers, select "Hide Marker".

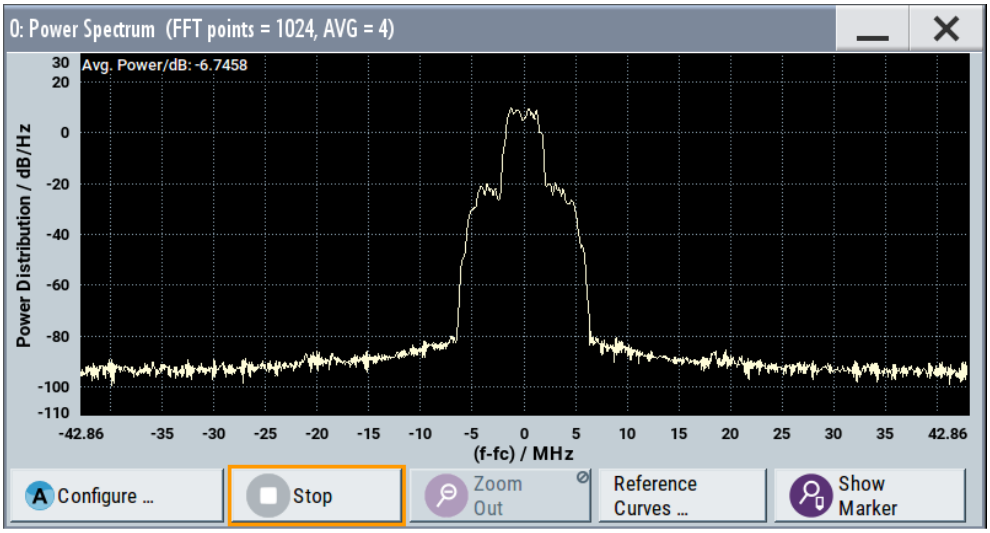
To observe the effect of enabled additive noise (AWGN)

1. Select "AWGN > General > Mode > Additive Noise".
2. Select "AWGN > General > Min Noise/System Bandwidth Ratio = 3".
3. Select "Noise Power / Output Results > Carrier/Noise Ratio = 30 dB".



4. Select "AWGN > State > On"
5. Observe the power spectrum display.

   The power spectrum shows a noise floor with constant level. Also, the power spectrum shows the digitally modulated signal over the whole bandwidth. In this case, the WCDMA signal has a bandwidth of 3.84 MHz.



To print the current power spectrum

1. Select "System Config" > "Setup" > "User Interface" > "Hardcopy".
2. Use the default settings.
3. Select "Save".

   The instrument creates a screenshot of the current screen and stores it in a file with a predefined filename in the default user directory `/var/user/`.
   See Section 11.11, "Creating screenshots of current settings", on page 446.
4. Use on of the standard file transfer methods to access the user directory of the instrument. Transfer the file to a PC.
   See Section 11.10, "Transferring files from and to the instrument", on page 440.
5. Print the file content.

10 Configuring a multi-instrument setup

R&S SMCV100B is rarely used as a standalone instrument. Usually, the instrument is connected to a device under test (DUT) or other measurement equipment.

Test setups have different requirements, for example:

- You can configure the R&S SMCV100B as secondary instrument in a multi-instrument setup. This configuration is useful for performance testing, e.g. nx4 MIMO configuration of 5G NR and WiFi in the frequency band above 6 GHz.
- Test setups comprising two or more instruments often require a common reference frequency.
- Some test setups also require control of the signal generation start and an exact generation start time, for example determined by a defined trigger event.
- etc.

10.1 Synchronizing instruments

For information on the possible scenarios concerning the distribution of reference frequency, test setups and the related settings:

See Section 8.8, "Reference oscillator", on page 317.

For information on how to generate time-aligned baseband signals:

See Section 5.5, "Generating time-aligned baseband signals", on page 281.

For information on how to configure a multi-instrument setup:

See Section 10.3, "Configuring the setup", on page 413.

10.2 Connecting to R&S SMW

Multi-instrument setup

Figure 10-1 shows a multi-instrument setup for, e.g. nx4 MIMO configuration:

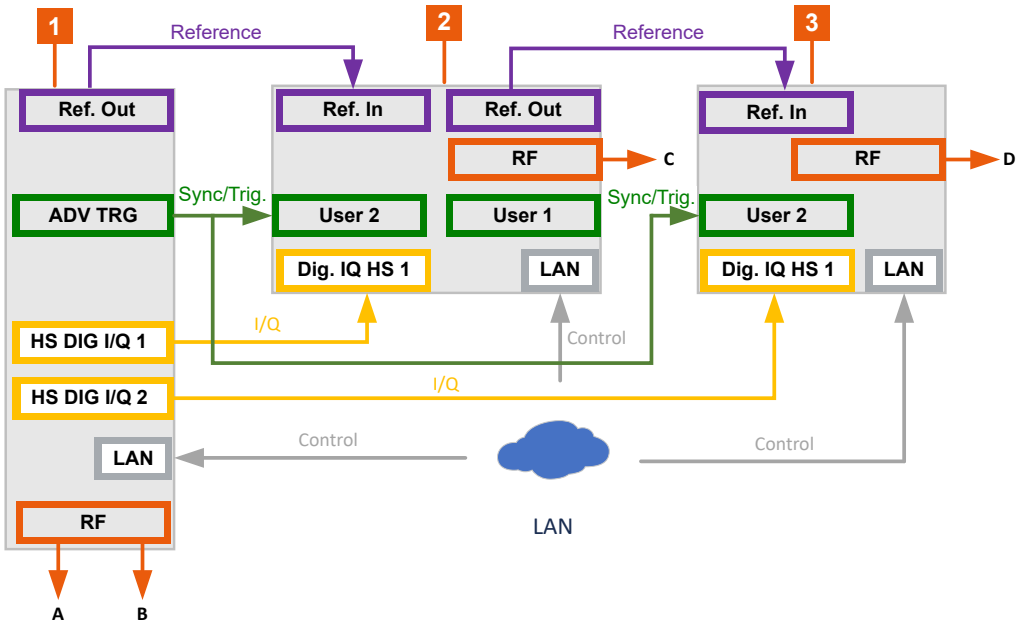


Figure 10-1: Multi-instrument setup

1 = R&S SMW
2 = R&S SMCV100B 1
3 = R&S SMCV100B 2

To connect the R&S SMCV100B

With the default connector settings of all instruments:

1. Connect all connections between R&S SMW and R&S SMCV100B as in Table 10-1.

   Table 10-1: Signals and connections

Signal	R&S SMW	R&S SMCV100B 1	R&S SMCV100B 2
I/Q	HS DIG I/Q 1 ("BBMM 1")	Dig. IQ HS 1	
I/Q	HS DIG I/Q 2 ("BBMM 2")		Dig. IQ HS 1
Sync/Trigger	ADV TRG	User 2	
Sync/Trigger	ADV TRG		User 2
Reference	REF OUT	Ref In	
Reference		Ref Out	Ref In
Control	LAN	LAN	LAN

   Note: Avoid unnecessary cable length and branching points. Use cables of the same length and type for all connections between the primary instrument and the secondary instruments and between secondary instruments.

2. Connect all instruments in the setup to the same LAN.

See
- The R&S SMW user manual
- Section 13.5.1, "Network settings", on page 522

10.3 Configuring the setup

We assume you have connected the R&S SMW and the two R&S SMCV100B generators as described in Section 10.2, "Connecting to R&S SMW", on page 411.

Setting the reference frequency

1. On the R&S SMCV100B, select "RF > Reference Frequency > Source > External".
2. On the R&S SMW, select "RF > Reference Frequency > Source > Internal".

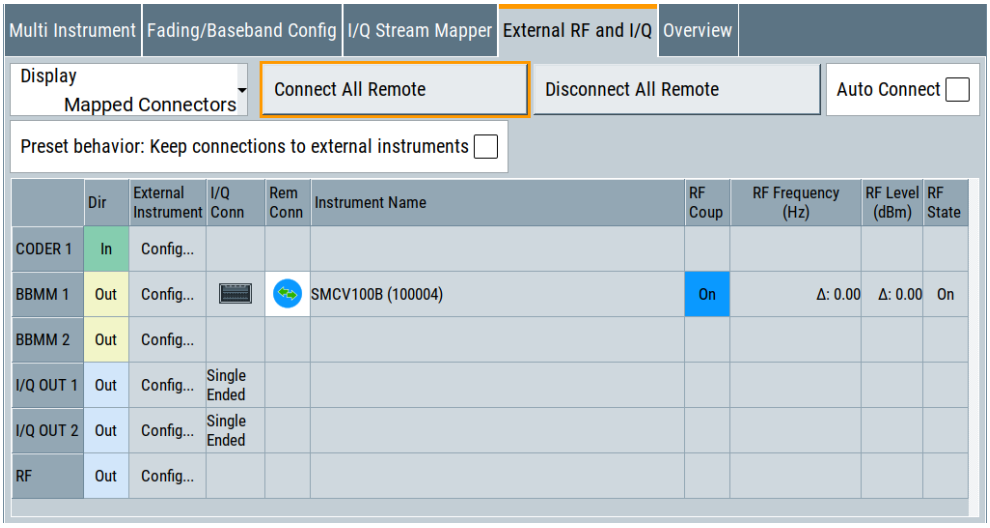
Configuring the primary instrument (R&S SMW)

1. Select "System Configuration" > "Fading/Baseband Config":
   a) Select "Mode > Advanced".
   b) Select "Signal Outputs > Analog & Digital (HS)".
   c) Click "Apply".
2. Select "Sytem Configuration" > "I/Q Stream Mapper".
3. In the "I/Q Stream Mapper", route the I/Q streams to the output connectors:
   - "Stream A": "RF A"
   - "Stream B": "RF B"
   - "Stream C": "BBMM 1"
   - "Stream D": "BBMM 2"
4. Select "System Config > System Config > Multi Instrument".
5. Select "Common Trigger" > "Multi Instrument Trigger" > **"Primary"**.
6. Select "State > On".

Configure the remote connection in the R&S SMW:

1. Select "System Config > System Config > External RF and I/Q".
   a) Select "BBMM 1 > External Instrument > Config".
   b) Select "External Instrument > R&S SMCV100B".
   c) If the list does not show the R&S SMCV100B, click "Scan".
   After the scanning procedure finishes, the R&S SMCV100B appears in the updated list.
   d) Click "Apply and Connect".

   Follow the same procedure for configuring the external instrument on "BBMM 2".
2. Check if the remote connections are active.



Configure the baseband signal as required for the particular test setup, for example:

1. Select "Baseband > 5G NR/Sidelink".
2. Configure the trigger signal:
   a) Select "Baseband > 5G NR/Sidelink > Trigger In".
   b) Select "Trigger Mode > Armed Retrigger" and "Trigger Source > Internal".
   c) Activate "Sync. Output to Ext. Trigger".

   The trigger parameters of all basebands are coupled. Once the basebands are activated, they use common trigger signal.

Activating the output:

► Activate "RF = On".

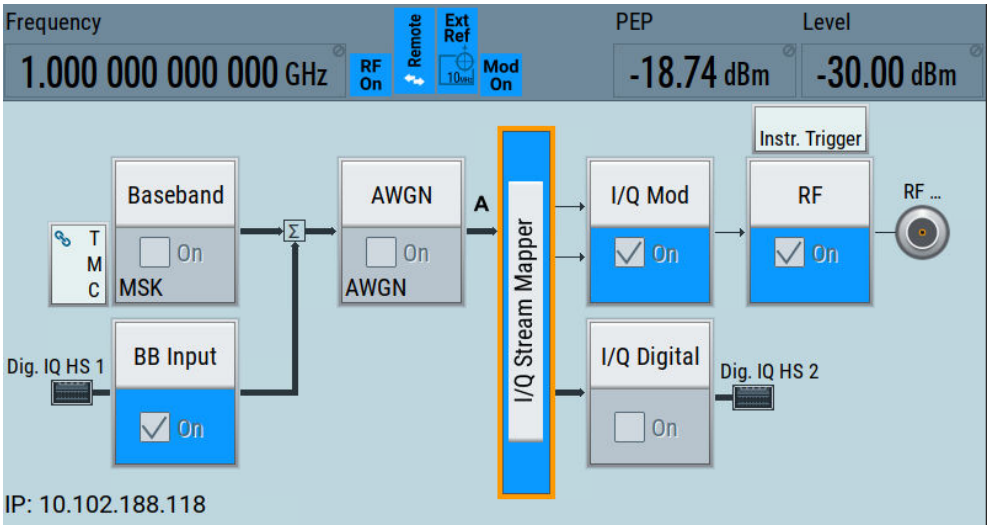
  Activating the output of the primary instrument R&S SMW automatically activates the RF output of the secondary instruments R&S SMCV100B in the setup.

Checking the settings of the secondary instruments (R&S SMCV100B)

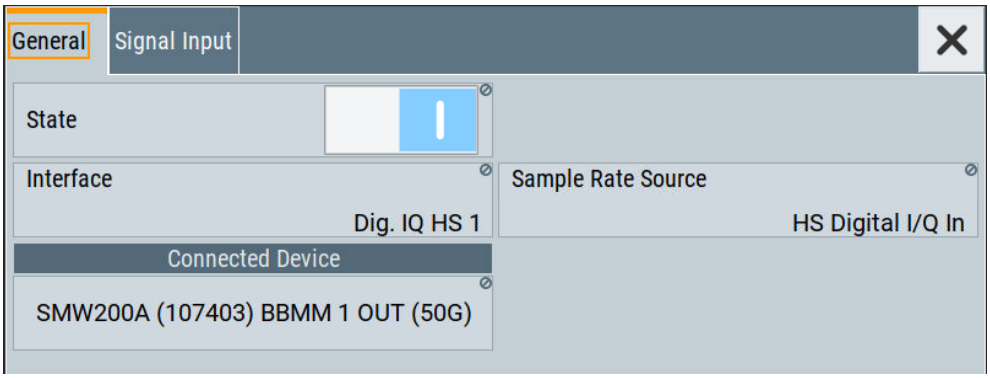
The secondary instruments are controlled by the primary instrument. The primary instrument sets the configuration of the secondary instruments remotely.

Check the settings of the secondary instruments:

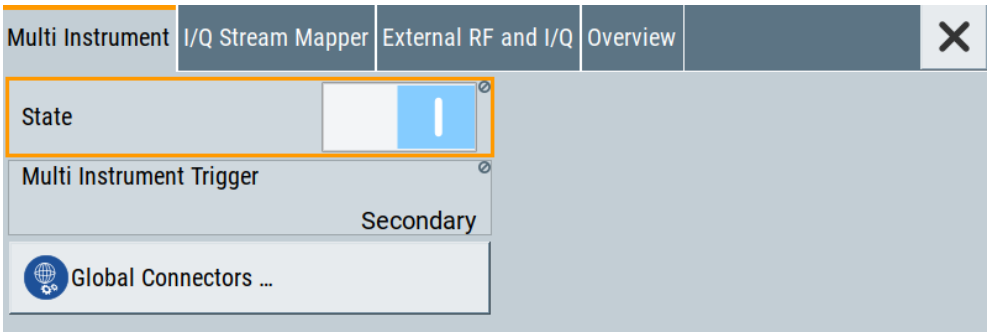
1. The block diagram after finishing the configuration of the primary instrument:



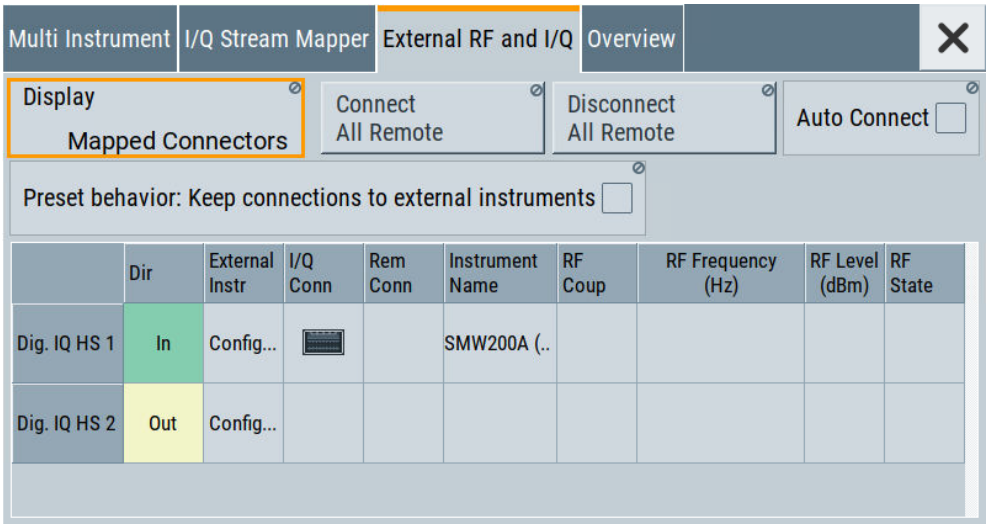
2. Select "BB Input > Baseband Input Settings".



3. Select "Block Diagram > I/Q Stream Mapper > System Configuration > Multi Instrument".



4. Select "Block Diagram > I/Q Stream Mapper > System Configuration > External RF and I/Q".

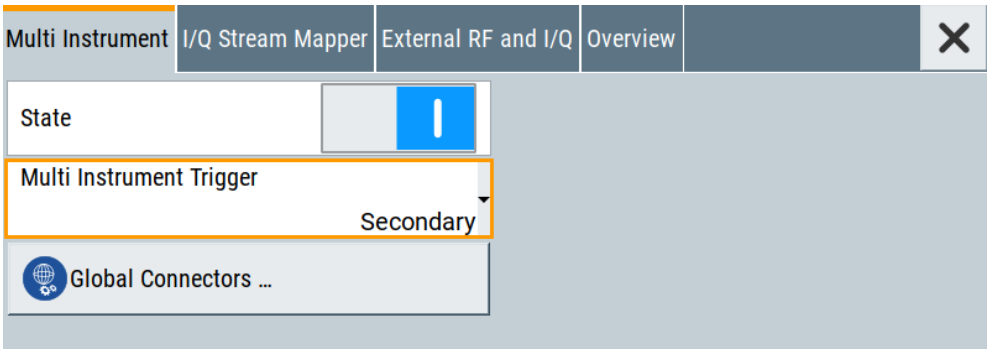


10.4 Multi-instrument settings

Access:

► Use one of the following:

- Select "Taskbar > System Config > System Configuration > Multi Instrument"
- Select "Block Diagram > I/Q Stream Mapper > System Configuration > Multi Instrument"



For step-by-step description, see Section 10.3, "Configuring the setup", on page 413.

Settings

State....416
Multi Instrument Trigger....417
Global Connector Settings....417

State
Activates the configuration.

With "State = Off", the instrument works in a standalone mode.

Remote command:
:SCONfiguration:MULTiinstrument:STATe on page 649

Multi Instrument Trigger
Requires "Multi Instrument > State = On".

Sets the mode in that the instrument works.

"Primary" Not available for R&S SMCV100B in multi-instrument mode.

"Secondary" Synchronizes to the supplied trigger signal from the primary instrument.

Remote command:
:SCONfiguration:MULTiinstrument:MODE on page 649

Global Connector Settings
Provides a quick access to the related global connector settings.

With "State = On", the synchronization signal is assigned per default as follows:
- "Multi Instrument Trigger > Secondary"
  "Connector = User 1": "Direction = Output", "Signal = Baseband Marker"
  "Connector = User 2": "Direction = Input", "Signal = Baseband Sync In"

See also:
- Section 12.2, "Configuring global connectors", on page 456

11 File and data management

The R&S SMCV100B uses files to save all instrument data. The instrument allows you to save and to load instrument settings, and to import and to export user data for processing in another instrument or later. Finally, you can create a screenshot of the current settings displayed on the screen and save it as a file.

This section focuses on the functions provided for managing of user data files and covers the topics listed below.

For information on the related remote control commands, see Section 14.5, "MMEMory subsystem", on page 590.

For information on how to save the displayed setting in a file, see Section 11.11, "Creating screenshots of current settings", on page 446.

- Accessing, retrieving and handling data 418
- About the file system 419
- Restoring an instrument configuration 422
- Protecting data 426
- Saving and recalling settings 427
- Accessing files with user data 432
- Exporting and importing remote command lists 434
- Loading, importing and exporting lists 434
- Using the file manager 434
- Transferring files from and to the instrument 440
- Creating screenshots of current settings 446

11.1 Accessing, retrieving and handling data

Depending on the origin and content, this description distinguishes between the following data types:

- Operational data
- Non-operational data

Operational data (data for intended use)

Your instrument uses and generates this data because of its intended use and according to the settings and configuration you have made. Thus, this data makes up most of the data that the R&S SMCV100B creates, such as user files that contain user-defined configurations or data, like instrument settings or measurement data. See also "Types of user data" on page 420.

You can access, retrieve and delete user files, see Section 11.9, "Using the file manager", on page 434.

Non-operational data (usage data)

The R&S SMCV100B generates this data during and through its use. Such data is collected e.g. for troubleshooting, to help our customer support center find solutions

quickly, or if you have purchased and activated the Health and Utilization Monitoring Service (HUMS).

The R&S SMCV100B does not generate this data continuously and in real-time; this data is saved on the product. You can store the data on a remote server, for example via a network connection.

The R&S SMCV100B generates the following data:

- User and authentication data
- Network and communication data
- Software and firmware update data
- Diagnostic and troubleshooting data
- Environmental conditions
- Hardware component metadata
- User behavior (HUMS only)

On demand, this data is stored in a ZIP file containing files in TXT format. The volume of the non-operational data depends on the usage of the product and typically amounts to about 30 Mbyte.

You can access, retrieve and delete this data, see:

- Network and communication data, see Section 11.5, "Saving and recalling settings", on page 427.
  The R&S SMCV100B displays the network address data on the screen.
- Hardware component metadata, see Section 15.8.1, "Hardware configuration settings", on page 872.
- User behavior, monitored by HUMS, see Section 13.5.5, "HUMS settings", on page 530.
  The R&S Health and Utilization Monitoring Service user manual is available on the Rohde & Schwarz internet.
- For all other data stored in the instrument, see Section 15.9, "Collecting information for technical support", on page 874.

For additional information on the different memory types of your product and on how to protect sensitive data, see:

- Section 11.4, "Protecting data", on page 426.
- Instrument security procedures document.

11.2 About the file system

Depending on their content, this description distinguishes between system files and user files. System files and the system directory are protected and not accessible. User files contain user-defined configurations or data.

This section focuses on user files. It provides an overview of the R&S SMCV100B file system and covers the following topics:

- "Types of user data" on page 420

- "File storage location" on page 420
- "File handling" on page 421
- "File naming conventions" on page 421
- "File contents" on page 422

Types of user data

The following data types contain user data:

- Settings or configuration files, for example, you save the current instrument settings and load these settings on another instrument.
  See Section 11.5, "Saving and recalling settings", on page 427.
- SCPI scripts that contain a series of commands. You can run the script to perform a task.
  See Section 11.7, "Exporting and importing remote command lists", on page 434.
- Externally generated waveforms. You can load the waveform files at the ARB application on the instrument.
  See Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 138
- Externally or internally generated lists, for example, user correction lists. You can load these list files on the instrument.
  See Section 11.8, "Loading, importing and exporting lists", on page 434 and Section 11.6, "Accessing files with user data", on page 432.

Depending on the **data storage method**, user data can be:

- *Persistent*, i.e. user files that are recorded on the data storage.
  Data is preserved when instrument is powered off and can be accessed and modified subsequently.
- *Temporary*, i.e. volatile data that the instrument retains while it is powered on.
  Volatile data is immediately lost when the R&S SMCV100B is switched off.

File storage location

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

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

Default storage location

The R&S SMCV100B stores user data in the user directory.

In the file system, user directory is always indicated as **`/var/user/`**.

In manual control, you access this directory via the "File Manager", see Section 11.9, "Using the file manager", on page 434. In remote control, you can query it with the command `:SYSTem:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command `:MMEMory:CDIRectory`.

File handling

To *access files* and the file system of the instrument or to use the general file management functions such as copying and moving data, use the standard "File Manager" dialog.

See Section 11.9, "Using the file manager", on page 434.

To *transfer files* from and to the instruments or to exchange files, use one of the following alternatives:

- Connect a memory stick to one of the USB interfaces.
  The instrument automatically recognizes a connected memory stick and assigns the `/usb/` drive to it.
- Connect the instrument to a LAN.

  An instrument connected to a LAN supports two standard file transfer methods from a remote client:
  - FTP (file transfer protocol)
  - File sharing according to the SAMBA/SMB (server message block) protocol.

  Both file transfer methods open the folder `/user` that is the `/var/user/` folder on the instrument.
  For a step-by-step description, see Section 11.10, "Transferring files from and to the instrument", on page 440.
- Map a network folder or a computer to an instrument connected to a LAN.
  A mapped network folder is indicated as `/shares/<"Local Folder">`.
  For a step-by-step description, see Section 11.9.4, "Mapping a network folder", on page 438.

File naming conventions

To enable files to be used in different file systems, consider the following file naming conventions:

- The *filename* can be of any length and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters.
- All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the filename).
- Avoid using special characters.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

File contents

11.3 Restoring an instrument configuration

The R&S SMCV100B has various options to set default settings. You can preset the R&S SMCV100B to an initial state at any time as a known starting point for configurations. It is often useful as a first step during troubleshooting when unusual results arise.

The figure Figure 11-1 shows the impact of the particular reset functions.

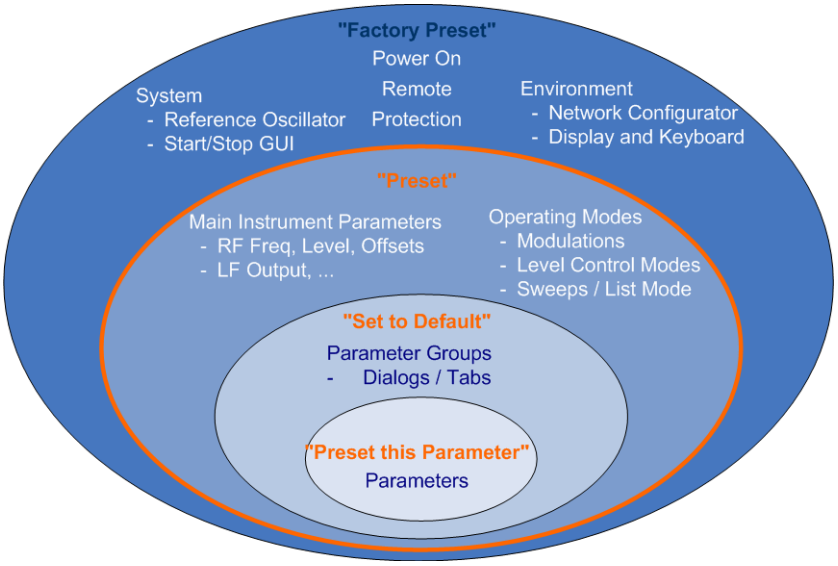


Figure 11-1: Preset functions for parameters and operating modes

Overview of the characteristics of the preset functions

Select the preset option that most fits to your particular application:



- [Preset]
  It is the most frequent function. A preset executes a defined instrument setup to provide an initial instrument state as a basis for a new configuration.
  It resets all parameters and switching states including the states of inactive operating modes. Also, it resets external instruments connected to the R&S SMCV100B. A preset does not change network settings, remote access settings or system settings.

► To execute a preset, press the [Preset] key at the front panel.



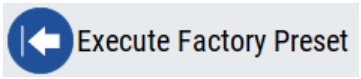
- "Set to Default"
  This function relates to individual dialogs or tabs and resets the associated settings of the corresponding dialog. All other settings are retained.

► To reset the settings, click "Set To Default".



- "Preset this parameter"
  Sets a single parameter to its default value.

1. To reset an individual parameter, open its context-sensitive menu.
2. Select "Preset This Parameter".



- "Factory Preset"
  A factory preset is the most profound preset function that resets almost all instrument settings, including reference oscillator, network and remote access settings.

  A factory preset does not change the following settings:
  - Security, password, and settings protected by these passwords
  - User-defined data, like setups or data lists
  - Settings that relate to an integration of the instrument in a measurement setup.

► **NOTICE!** Execute a "Factory Preset" only if it is necessary. After a "Factory Preset", the network connection to the instrument no longer exists.

  To restore the factory defaults, select "System Config" > "Setup" > "Settings" > "Factory Preset".

Presetting the instrument to a user-defined state

The reset functions set the parameters and operating modes to default values predefined by the factory. Alternatively to the instrument default settings, you can preset the instrument to a user-defined state:

- Save and reload user-defined settings as preset, see Section 11.3.3, "Presetting the instrument to a user-defined state", on page 425.
- Save and reload user-defined instrument states, see Section 11.5.2, "Saving and recalling instrument settings", on page 431.

Marking parameters with non-default values

To check the current state of the settings concerning default values, the R&S SMCV100B offers a feature that visually identifies deviations from the default values.

For more information, see Section 11.3.2, "Identifying parameters with non-default values", on page 424.

11.3.1 Preset, set to default and factory preset settings

Preset....424
Set To Default....424
Preset this Parameter....424
Execute Factory Preset....424

Preset
Resets all parameters and switching states, and closes all opened dialogs.

Note:
In contrast to the [Preset] key, the SCPI commands `*RST` and `:SYSTem:PRESet` do not close open dialogs in the GUI.

Consider also the following possibilities:

- You can define the settings that are restored when you preset the instrument (see Section 11.3.3, "Presetting the instrument to a user-defined state", on page 425)
- You can reset the instrument to the factory state (see "Execute Factory Preset" on page 424)

See also Table 11-1 that contains the key parameters that are reset by the corresponding preset functions.

Remote command:
`*RST` on page 586

Set To Default
Resets the associated settings of the corresponding dialog or tab.

Preset this Parameter
Restores the default value of a single parameter.

Execute Factory Preset
Resets the instrument to its factory settings.

Note: "Factory Preset" retains all security settings and does not delete any user files like setups or user data.
See also Table 11-1 that contains the key parameters that are reset by the corresponding preset functions.

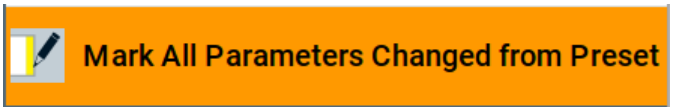
Remote command:
`:SYSTem:FPReset` on page 589

11.3.2 Identifying parameters with non-default values

To recognize the current state of the settings related to their default values at the first glance, enable a function that visually identifies parameters in states different than preset.

To enable this display:

1. To open the context-sensitive menu, touch and hold the screen anywhere in the GUI of the R&S SMCV100B.
2. Select "Mark All Parameters Changed from Preset".



If enabled, marks the parameters that deviate from their default values.

Example:

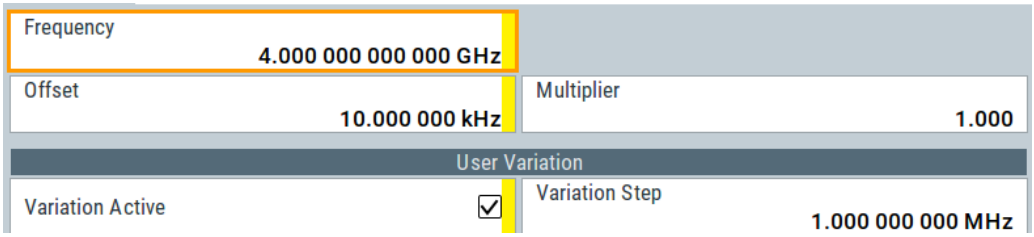


Figure 11-2: Marked parameters show that the value deviates from its default

Frequency = changed (default = 1 GHz)
Offset = changed (default = 0 kHz)
Multiplier = unchanged
Variation active = changed (default = disabled)
Variation step = unchanged

11.3.3 Presetting the instrument to a user-defined state

You can define the settings that are restored when you preset the instrument.

Note: The preset of the instrument to a user-defined state does not include all modified settings. For information, see the corresponding description of the settings.

1. Configure the settings as required.
2. Save them as described in Section 11.5.2, "Saving and recalling instrument settings", on page 431:
   a) Save the settings as a file with the predefined filename `UserPreset` without file extension.
   The save function assigns the file extension `.savrcltxt` automatically.
   b) Save this file in the directory **`/var/user/`**.

   The filename `UserPreset` and the directory `/var/user/` are mandatory.
3. Press the [Preset] key.

When operating the instrument remotely, send the `*RST` command.

The instrument restores the user-defined settings. An "Info" message appears and confirms loading of a file with user-defined preset settings.

11.3.4 Reference

See Table 11-1 for an overview of the main generator settings that are affected by the corresponding preset functions. While the regular [Preset] key primarily resets the signal relevant parameters of the instrument, the "Factory Preset" affects almost all instrument settings.

For information on the default values of further parameters, see the description of the corresponding remote commands.

Table 11-1: Key parameters affected by preset and factory preset

Parameter	Preset value	Preset	Factory Preset
RF frequency	1 GHz	x	x
RF level (RF output)	off	x	x
RF level limit	30 dBm	-	x
Offsets	0	x	x
Modulation state	off	x	x
Reference frequency settings	-	-	x
Network settings	-	-	x
Hostname	-	-	x
GPIB address	-	-	x
Start or stop display update	-	-	x
Display and keyboard settings	-	-	x
Password and password-protected settings	-	-	-
Security settings	-	-	-
User files (setups, user correction, etc.)	-	-	-
HUMS	off	-	x

11.4 Protecting data

During operation, the R&S SMCV100B saves user data permanently in the user directory, see "File storage location" on page 420.

To protect any classified data and to avoid saving any sensitive data on the R&S SMCV100B permanently, you have the following options:

- Activate the **volatile mode**. This mode redirects user data to the volatile memory, see "Volatile Mode" on page 493.
  The internal memory is write-protected.
  Once you power off the instrument for at least five minutes, all volatile memory modules lose their contents.
  To avoid loosing this data, connect an **external memory device**, for example, a USB flash drive.

  See also:

  - "Default storage location" on page 420
  - "Volatile Mode" on page 493
  - Section 11.10.4, "Using a USB storage device for file transfer", on page 444
- Save user files **temporarily in the `/var/volatile` directory**, which remains available only until the instrument is turned off.
  You can access data in the volatile memory just as data that is saved permanently in the `/var/user/`.
  See also Section 11.9.3, "Displaying all saved files", on page 438.

For detailed information on how to protect the instrument and to protect sensitive data from unauthorized access, refer to the document Instrument Security Procedures.

11.5 Saving and recalling settings

You can save and recall instrument settings, user settings and other related data for the following use cases:

- Reload or repeat a specific signal generation task on the instrument.
- Transfer a specific configuration of your instrument to another instrument, for example in multi-intrument setups.
- Save or load complete instrument settings to or from a file.
- Save or load settings of a particular digital standard or a firmware option.

Save or recall the complete instrument settings

Two different methods are available for managing *complete instrument settings*:

- Quick (immediate) Save/Recall
  A defined set of instrument settings are saved or recalled quickly in just one step, without defining a filename or storage location. This function enables a fast switching between different instrument settings.
- Save/Recall in files with user-defined names
  The defined set of instrument settings are saved to a definable storage location.
  The file extension is `*.savrcltxt`.
  Settings files created in this way are visible in the file system and accessible with the supported methods for file handling.

In the general case, a recall process replaces the instruments settings with the saved values. An exception is the frequency and level settings. During recall of the instrument settings, it is possible to retain the current settings or to overwrite them with the saved values.

Save/Recall the settings belonging to a firmware option

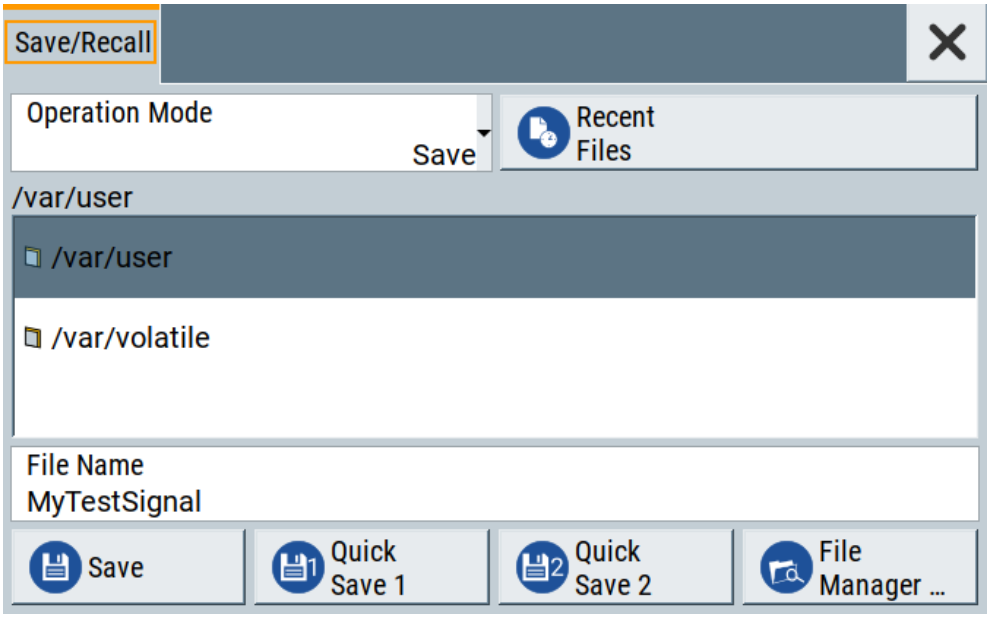
Each of the firmware option provides a special "Save/Recall" function to manage directly the settings associated to the corresponding digital standard, e.g. all settings in the "T-DMB/DAB" dialog.

The "Save/Recall" function creates files with user-defined names, predefined file extension and on a definable storage location. The files are accessible with the supported methods for file handling.

11.5.1 Save/Recall settings

Access:

1. Press the [Save/Recall] key.
2. Select "Operation Mode" > "Save" or "Recall" to open the corresponding settings.



The settings for both operation modes are similar and related.

Settings:

Operation Mode 429
Directory, File List and Filename 429
Recent files 429
Show SCPI List 429
SCPI List 429

Save....429
Quick Save x....430
Exclude Frequency....430
Exclude Level....430
Recall....430
Quick Recall x....430
File Manager....430

Operation Mode
Accesses the settings for storing ("Save") and loading ("Recall") of the instrument settings. Also, you can import SCPI-Files ("SCPI-Import") or export SCPI files ("SCPI-Export").

See Section 11.7, "Exporting and importing remote command lists", on page 434.

Directory, File List and Filename
Note:
You access this generic standard function each time you perform one of the following:
- Save or load (settings) files
- Define a folder in that these files are saved
- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

Use the settings for example as follows:
- To navigate through the file system, use the directory tree.
- To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Section 11.9, "Using the file manager", on page 434).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 595
`:MMEMory:CATalog?` on page 595

Recent files
Displays the files last used.

Show SCPI List
Opens the "SCPI List", which lists the current settings of the R&S SMCV100B as SCPI commands.

The R&S SMCV100B provides this function for Operation Mode > SCPI-Export.

SCPI List
Provides a list of all SCPI commands corresponding to the current instrument settings.

Save
Saves the current instrument settings or the settings belonging to a digital standard under the defined filename.

Remote command:
:MMEMory:STORe:STATe on page 601
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI commands:
[:SOURce<hw>]:BB:<Digital Standard>:SETTing:STORe
[:SOURce<hw>]:BB:<Digital Standard>:SETTing:DELete

Quick Save x
Stores the current instrument setting in one of the intermediate memories.

These instrument settings are retained until a different instrument setting is stored in the intermediate memory. When the instrument is switched off, the contents of the intermediate memories are retained.

Remote command:
*SAV on page 587

Exclude Frequency
The current frequency is retained when a stored instrument setting is loaded.

Remote command:
[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL on page 778

Exclude Level
The current level is retained when a stored instrument setting is loaded.

Remote command:
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL on page 812

Recall
Restores the selected configuration.

During recall, the instrument considers all related settings, for example sweeps in active state or lists. An error message indicates the settings which cannot be implemented.

Remote command:
:MMEMory:LOAD:STATe on page 599

Quick Recall x
Loads the selected configuration from one of the intermediate memories. A message appears if no instrument configuration is stored in this memory.

Remote command:
*RCL on page 586

File Manager
Accesses the "File Manager" dialog, see Section 11.9, "Using the file manager", on page 434.

11.5.2 Saving and recalling instrument settings

Instrument settings can be saved to a file and loaded again later, so that you can repeat the tests with the same settings.

To access and recall instrument setups quickly

► Assign the appropriate action to the [★ (User)] key.
See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

To save and recall instrument settings

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode" > "Save".
2. Select "Quick Save 1".

   The instrument saves its settings in the intermediate memory 1. The filename and the storage location cannot be changed.
3. Adapt the instrument settings as required. Select "Quick Save 2"
4. To restore the settings, select the "Operation Mode > Recall"
5. Select "Quick Recall 1"

   The instrument is restored to the previous state.
6. Select "Quick Recall 2" to switch to the settings saved in the second file.

To save complete instrument settings

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode" > "Save".
2. In the file selection dialog, select a filename and storage location for the settings file.
3. Select "Save".

   A file with the defined name and path and the extension `*.savrcltxt` is created.

To restore an instrument configuration

Save the configuration as described in "To save complete instrument settings" on page 431.

1. To restore settings, select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode > Recall".
2. To retain the current frequency settings, enable "Save"/"Recall" > "Exclude Frequency",
3. To retain the current level settings, enable "Save"/"Recall" > "Exclude Level",

4. In the file select dialog, select the filename and storage location of the settings file.

   The settings are restored, but the frequency and level settings are retained. You can repeat the signal generation with the same settings.
   See also Section 11.3.3, "Presetting the instrument to a user-defined state", on page 425.

11.6 Accessing files with user data

Signal generation in list mode, the generation of pulse train signals or applying user correction values use data from list files. Whenever a list file is required as a data source, the instrument provides direct access to the standard "File Select" function. This function enables you to select, create and edit the list files.

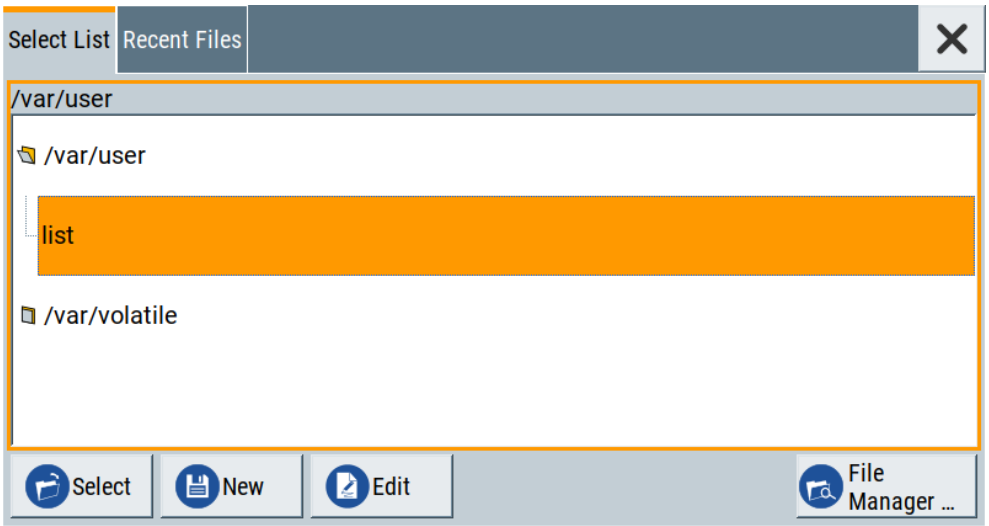
11.6.1 File select settings

The "File Select" dialog opens automatically each time you select a data list file as data source or you select a control list.

To access a loadable data list file

1. Select "RF" > "Sweep / List" > "List Mode Data" > "List Mode" = "Data".

   A file select dialog for loading, creating and modifying a file opens.



   Tip: The name of the dialog is context-sensitive and differs depending on the particular function this dialog is from. However, the provided functions are similar.

2. To load an existing file:
   Navigate through the file system.
   Select the file and confirm with "Select".

3. To create a file, for example if there is no data list file specified:
   Navigate through the file system.

Select "New" and specify the filename.

A new empty file is created and saved in the selected folder.

4. To edit an existing or newly created file:
   Navigate through the file system.
   Select the file and select "Edit".

   The standard "Data List Editor" dialog opens.

5. Edit the file content.
   Confirm with "Save".

Settings:

Directory, File List and Filename....433
Functions for handling of data lists....433
Recent files....433
File Manager....434

Directory, File List and Filename
Note:
You access this generic standard function each time you perform one of the following:
- Save or load (settings) files
- Define a folder in that these files are saved
- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

Use the settings for example as follows:
- To navigate through the file system, use the directory tree.
- To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Section 11.9, "Using the file manager", on page 434).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 595
`:MMEMory:CATalog?` on page 595

Functions for handling of data lists
Provided are the following standard functions for file handling:

"Select"	Select and load the file. Remote command: `[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 704
"New"	Creates file with the specified "Filename". To confirm, select "OK"; use "Cancel" to undo the operation. To edit the file content, select "File Select > Edit".
"Edit"	Accesses the "Data List Editor" and loads the selected file for editing

Recent files
Displays the files last used.

File Manager
Accesses the "File Manager" dialog, see Section 11.9, "Using the file manager", on page 434.

11.7 Exporting and importing remote command lists

To set specific instrument settings or perform tasks automatically, you can create scripts or import scripts that contain the settings in the form of remote control command sequences.

The R&S SMCV100B also offers a SCPI macro recorder with code generator to record manual settings and create an executable script.

Completed scripts are saved in files and possibly converted to different formats, depending on the language of the source code.

The R&S SMCV100B supports the following commonly used languages:

- Plain SCPI: `*.txt`
- MATLAB: `*.m`
- NICVI: `*.c`
- Python: `*.py`

It is also possible to convert the SCPI command list to a user-specific language.

11.8 Loading, importing and exporting lists

The R&S SMCV100B provides built-in editors for creating list files, for example for the list mode or lists with user correction data. You can also create or evaluate them with an external application. The instrument provides interfaces with the following functionality:

- Import and export list files in a standard ASCII format file
- Load an internally or an externally generated waveform file

Lists are saved and loaded in the corresponding dialogs. For example, the user correction data list is created and saved in the "User Correction" dialog.

11.9 Using the file manager

The "File Manager" is a tool similar to a standard Windows Explorer. It helps you manage mass storage media and files saved on the R&S SMCV100B.

You can perform the following tasks:

- Copying multiple files from disk to other media
  See Section 11.10, "Transferring files from and to the instrument", on page 440
- Copying files into another directory

See Cut, Copy&Paste and Delete

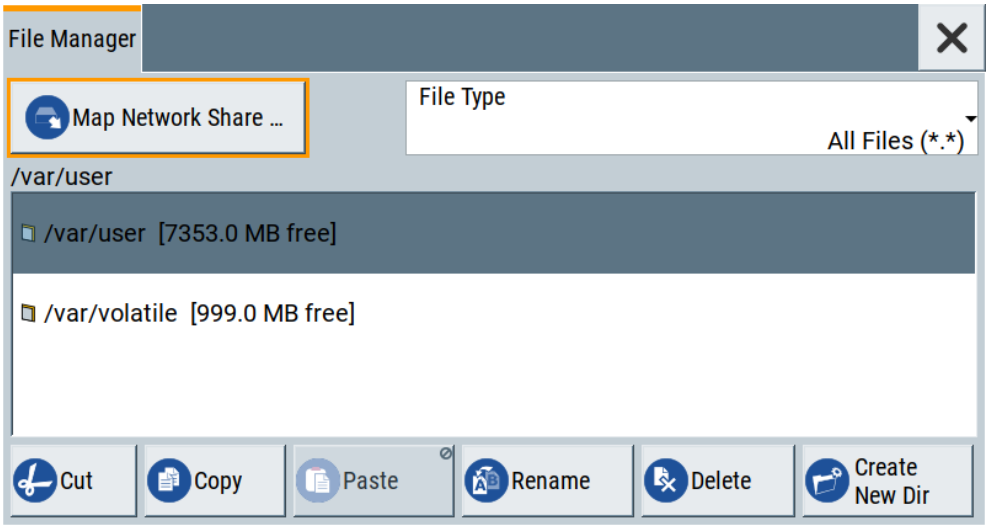
- Renaming and deleting files
- Creating directories
  See Create New Directory
- Mapping shared network folders
  See Section 11.9.4, "Mapping a network folder", on page 438
- Displaying saved files
  See Section 11.9.3, "Displaying all saved files", on page 438

11.9.1 File manager settings

Access:

► Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".

Tip: Each "Save/Recall" dialog and each "File Select" dialog provides a quick access to the "File Manger".



The "File Manager" dialog provides all standard functions required for file management. It displays the contents of the selected folder on the R&S SMCV100B and provides functions to rename, delete, copy, or move individual files.

Settings:

Map Network Share 436
File Type 436
Directory and Filename 436
Cut, Copy&Paste and Delete 436
Rename 436
Create New Directory 436

Map Network Share
Opens a dialog where you can map one or more network folders. See Section 11.9.2, "Map network share settings", on page 436.

See also Section 11.9.4, "Mapping a network folder", on page 438.

File Type
Selects the file type to be listed. If a file type with a specific file extension is selected, only files with this extension are listed.

Directory and Filename
Selects the directory in which the file to be deleted or copied is located. The dialog lists all files in this directory. Selected files are highlighted. The path is indicated above the directory tree.

Unlike the "Save/Recall" and "File Select" dialogs, the "File Manager" displays the full filenames including extensions.

Remote command:
`:MMEMory:CDIRectory` on page 595

Cut, Copy&Paste and Delete
Standard file management functions.

Before a file is deleted, you have to confirm the delete operation.

Remote command:
`:MMEMory:DELete` on page 599
`:MMEMory:COPY` on page 596

Rename
Renames the selected file or directory.

Remote command:
`:MMEMory:MOVE` on page 600

Create New Directory
Creates a folder and opens an edit dialog box to enter name and path (absolute or relative to the current directory) of the new folder.

Remote command:
`:MMEMory:MDIRectory` on page 600

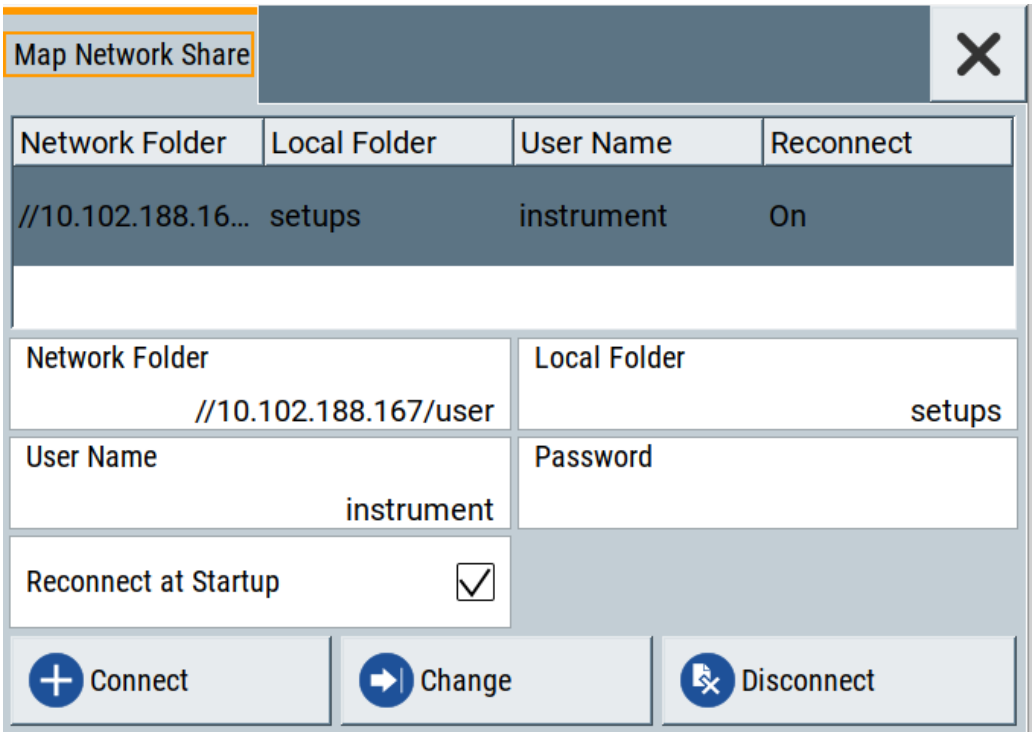
11.9.2 Map network share settings

Access:

► Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager" > "Map Network Share".

The "Map Network Share" dialog provides settings that are similar to the standard Windows Explorer function "Map network drive". These settings help you to create up to 10 "shortcuts" to shared folders or computers in the network.

The dialog displays a list of current mapped network folders. The directory tree of the "File Manager", "Save/Recall", and "File Select" dialogs indicate a mapped network folder as `/shares/<"Local Folder">`.



See also Section 11.9.4, "Mapping a network folder", on page 438.

Settings:

Network Folder....437
Local Folder....437
User Name....438
Password....438
Reconnect at Startup....438
Connect....438
Change....438
Disconnect....438

Network Folder
Enter the path of the folder or computer, e.g. `//<IP Address>/user` or `//<server name>/user`.

Local Folder
Enter a letter or an alias name to describe the folder.

In the directory tree, a mapped network folder is indicated as `/shares/<"Local Folder">`.

User Name
Enter a user name of a user that has the permission to access the selected network folder.

Password
Enter the user password of the selected user.

Reconnect at Startup
Enables reconnecting every time you start up the instrument.

Connect
Triggers the instrument to prove the credential and to map (i.e. connect) the selected network folder or computer to the instrument.

You can map up to 10 network folders.

Change
Applies the changes.

Disconnect
Disconnects the network drive.

11.9.3 Displaying all saved files

To display all files on the internal memory

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/var/user/`.

To display all files on a connected USB flash drive

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/usb/`.

To display all files in the volatile memory

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/var/volatile/`.

11.9.4 Mapping a network folder

Possibly you would like to transfer instrument or user settings to another R&S SMCV100B, distribute waveform files to several instruments or you have to access frequently the same network drive. In these cases, on a R&S SMCV100B connected to a LAN you can create a shortcut to this network folder or this computer.

How to: Section 3.1.7, "Connecting to LAN", on page 27

To map a network folder, proceed as follows:

1. On the computer or the network folder you want to map, enable remote access. You can specify a list of users allowed for remote access.

   Note: The remote access settings depend on the operating system the remote computer is using. For step-by-step instructions, refer to the documentation of the particular operating system.

2. On the R&S SMCV100B, enable file transfer via SMB (samba).

3. Select "System Config" > "Setup" > "Remote Access" > "Network" to configure the following network settings:

   a) Select "Address Mode" > "Auto (DHCP)".
   b) Check that the "DNS Suffix" and "DNS Server" are correct.

4. In the "Save/Recall" dialog, select "File Manager" > "Map Network Share".

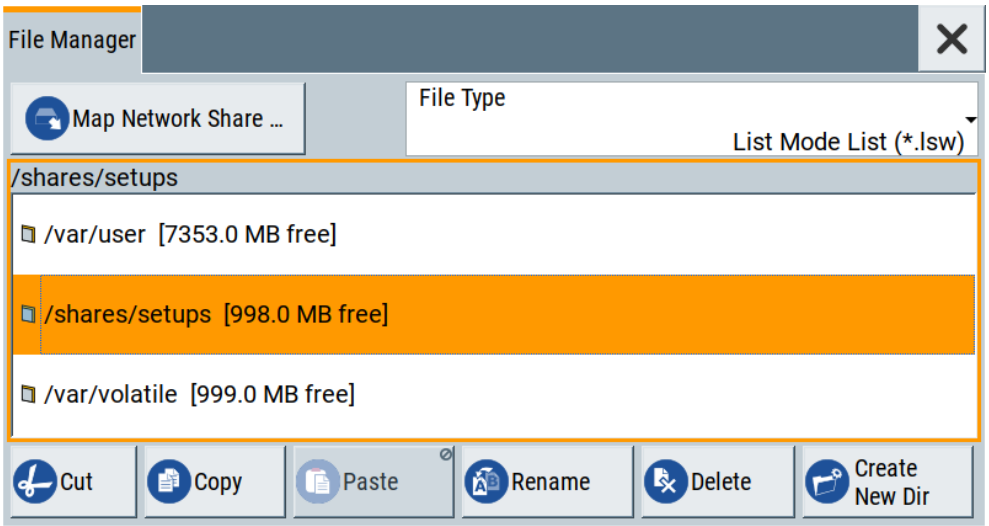
5. In the "Map Network Share" dialog, select:

   a) In the "Network Folder" field, enter `//<IP Address>/user` or `//<Server Name>/user`.
   b) In the "Local Folder" field, enter an alias name, e.g. *setups*.
   c) Enter the "User Name" and "Password" of a user with a remote access permission to the selected network folder.
   d) If necessary, enable "Reconnect at Startup".
   e) Select "Connect".

   The selected network folder is mapped to your instrument. The list of mapped network folders is updated.

6. Close the "Map Network Share" dialog.

   The navigation tree in the "File Manager" dialog displays the mapped network folder as `/shares/Setups`.



If the connection does not succeed, consider to check the following:

- Is the network folder or computer you try to map turned on?
- Is the network folder or computer enabled for remote access?
- Does the selected user name have the necessary permissions?

See also Section 11.10.5, "Using a file server for test files exchange", on page 445.

11.10 Transferring files from and to the instrument

As explained in "File handling" on page 421, you access the file system of the R&S SMCV100B via one of the following ways:

- Via the built-in "File Manager"
  See Section 11.9, "Using the file manager", on page 434.
- On an instrument connected to a LAN:
  - Via one of the standard functions FTP or SMB (samba)
    See Section 11.10.2, "Accessing the file system using FTP", on page 442 and Section 11.10.3, "Accessing the R&S SMCV100B file system using SMB (Samba)", on page 443
  - Via mapped network drives
    See Section 11.9.4, "Mapping a network folder", on page 438.
- Via a connected USB storage device
  See Section 11.10.4, "Using a USB storage device for file transfer", on page 444

Mainly because of security reasons, the access to the file system of your R&S SMCV100B can be denied, because one or all these access methods are deliberately disabled. Access to the file system via LAN and/or USB requires that the corresponding service is enabled and a write access to the file system is enabled. Refer to Section 11.10.1, "Removing file system protection", on page 440 for description of the required steps.

This section provides an introduction to the topic. For comprehensive information, refer to the application note 1GP72: Connectivity of Rohde&Schwarz Signal Generators.

- Removing file system protection 440
- Accessing the file system using FTP 442
- Accessing the R&S SMCV100B file system using SMB (Samba) 443
- Using a USB storage device for file transfer 444
- Using a file server for test files exchange 445

11.10.1 Removing file system protection

Before you try to access the file system via FTP, SMB (samba) or USB, fulfill the following:

- Disable write protection on the file system
- Enable the corresponding service or interface

To enable write permission on the file system

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "General" > "Disk & Memory".
3. Enable "Volatile Mode".
4. Enter the "Security Password".
   The default password is *123456*. For more information, see Section 12.6, "Using the security settings", on page 490.

   The R&S SMCV100B requests a reboot.
5. Confirm the request.

   The system reboots. The enabled settings are active.

To enable file transfer over FTP

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "LAN Services" > "Common Services" > "LAN" > "On".
3. Enable "FTP"
4. Enter the "Security Password".
   The default password is *123456*. For more information, refer to Section 12.6, "Using the security settings", on page 490.
5. Select "Accept".

To enable file transfer over SMB (samba)

1. Select "System Config > Setup > Security > Security > LAN Services"
2. Enable "LAN Interface"
3. Select "Samba Services".
4. Enable the "SMB 1.0/2.0 Client".
5. Enable the "SMB 1.0/2.0 Server".
6. Enter the "Security Password".
   The default password is *123456*. For more information, see Section 12.6, "Using the security settings", on page 490.
7. Select "Accept".

To enable file transfer over USB

1. Select "System Config > Setup > Security > Security > General"
2. Select "Disk & Memory".
3. Enable "USB Storage"
4. Enter the "Security Password".

The default password is *123456*. For more information, see Section 12.6, "Using the security settings", on page 490.

5. Select "Accept".

11.10.2 Accessing the file system using FTP

If the R&S SMCV100B is connected to a LAN, you can use file transfer protocol (FTP) to access the file system and to transfer files from and to the instrument.

How to: Section 3.1.7, "Connecting to LAN", on page 27

To access the file system over FTP

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via FTP
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
4. In the address field, enter `ftp://<"IP Address" of the Instrument>`, e.g. *ftp://10.124.0.166*.
   Tip: The R&S SMCV100B indicates its IP address on the block diagram.

   A log-on dialog opens and requests a password.

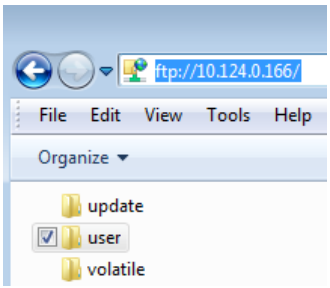
   The default user name and password is *instrument*.

   Tip:
   Default password

   The FTP and SAMBA file access use the user "instrument" with default password "instrument".

   We recommend that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network.

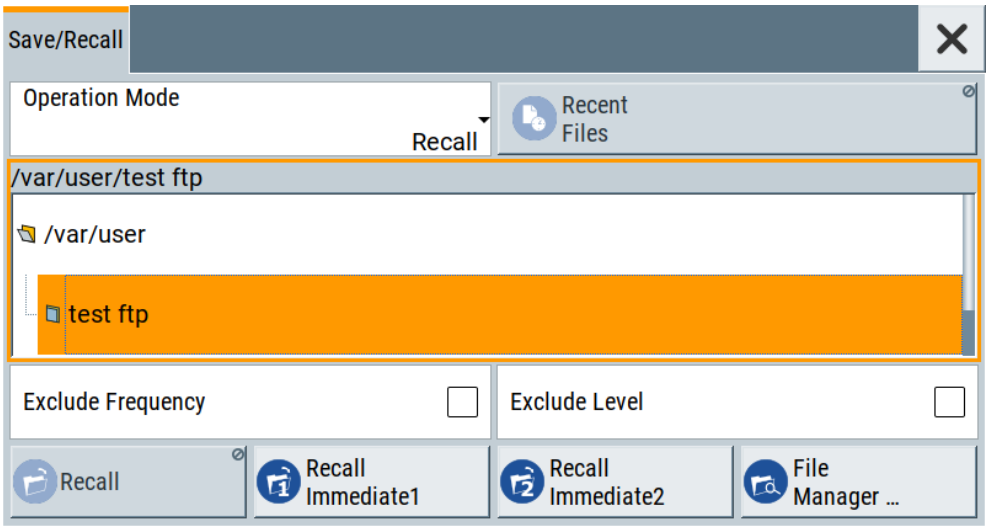
   See Section 12.6.4, "Password management", on page 500.
5. Enter the password to access the `user` directory.
   The `user` directory corresponds to the `/var/user/` directory of the instrument.

   There, you can perform standard functions like creating directory, or saving files.
6. In the `user` directory, create a directory, e.g. `test ftp`.

7. Select "System Config" > "Setup" > "Settings" > "Save / Recall".
   Open the `/var/user/` directory.

   The dialog displays the `/var/user/test ftp` directory.



11.10.3 Accessing the R&S SMCV100B file system using SMB (Samba)

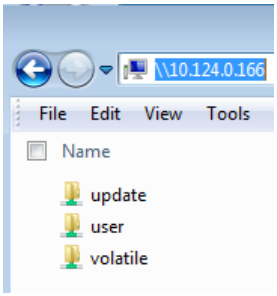
The SMB (Samba) protocol is an alternative way to access the file system of the instrument from a remote PC. This protocol works if both the instrument and the PC are connected to a LAN.

How to: Section 3.1.7, "Connecting to LAN", on page 27

To access the file system over SMB

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via FTP
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
4. In the address field, enter `//<"IP Address" of the Instrument>`, e.g. *ftp://10.124.0.166*.
   Tip: The R&S SMCV100B indicates its IP address on the block diagram.



The `user` directory corresponds to the `/var/user/` directory of the instrument; the `volatile` directory - to the `/var/volatile` directory.

To map the R&S SMCV100B as a network drive to the remote PC

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via SMB (Samba)
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
   Open the "Map Network Drive" dialog.
   a) Select a valid "Drive", e.g. *W*.
   b) In the "Folder" field, enter `//<"IP Address" of the Instrument>/user`
   or `//<"Hostname" of the Instrument>/user`
   For example: *//10.124.0.166/user* or *//SMCV100B-102030/user*.
   Tip: The R&S SMCV100B indicates its IP address on the screen.
   c) Select "Finish".

   A log-on dialog opens and requests a user name and a password.

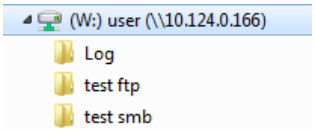
   Tip:
   Default password

   The FTP and SAMBA file access use the user "instrument" with default password "instrument".

   We recommend that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network.

   See Section 12.6.4, "Password management", on page 500.
4. Enter the user name and the password of your instrument.

   The `/var/user/` directory of the instrument is mapped to and displayed as a network drive of the remote PC.



   You can access the files in the `/var/user/` directory, perform standard function like creating directory, or saving files.

11.10.4 Using a USB storage device for file transfer

Alternatively to the file transfer possibility via LAN, you can use a USB storage device for direct file transfer from and to the instrument.

We recommend that you transfer files with user data (like lists or instrument setup files) to the instrument, rather than load and play them from a connected USB storage device.

To transfer a file with user data to the instrument

1. Connect a USB storage device, for example a USB memory stick to one of the USB interfaces of the instrument.

   The R&S SMCV100B recognizes the connected USB storage device automatically.

2. Enable file transfer via USB
3. Enable write permission on the file system
4. Select "System Config" > "Setup" > "Settings" > "Save / Recall".

   The dialog displays the `/var/user/` directory and the `/usb/` drive.

5. In the "Save/Recall" dialog, select "File Manager".
6. In the directory tree, navigate to the `/usb/` drive.
   Select the required file with user data.
7. Select "Copy".
8. In the directory tree, navigate to the `/var/user/` directory.
   Select "Paste".

   The file with user data is transferred to the instrument.

11.10.5 Using a file server for test files exchange

You can use a central file storage location like a file server in your company network to save setup files, SCPI scripts, application programs, or waveform files on it. Usually, you would like to distribute the files to several instruments. If the R&S SMCV100Bs are connected to a LAN, you can create a shortcut on the instruments to the file server.

To access the file server

1. On each R&S SMCV100B, map the required directory of the file server to the instrument.
   Perform the steps described in Section 11.9.4, "Mapping a network folder", on page 438.
2. On each R&S SMCV100B, use the same alias name for the directory of the file server, i.e. enter the same "Local Folder" (in this example `Setups`).

   On any of the R&S SMCV100B, you access the file server directly from the "File Manager" and under the same name, e.g. `/shares/Setups`.
   An extra advantage in remote control is that the same application program would control the instruments.
   For example, use the remote control command `MMEMory:CDIRectory "/shares/Setups"` to set the default directory for mass storage.

11.11 Creating screenshots of current settings

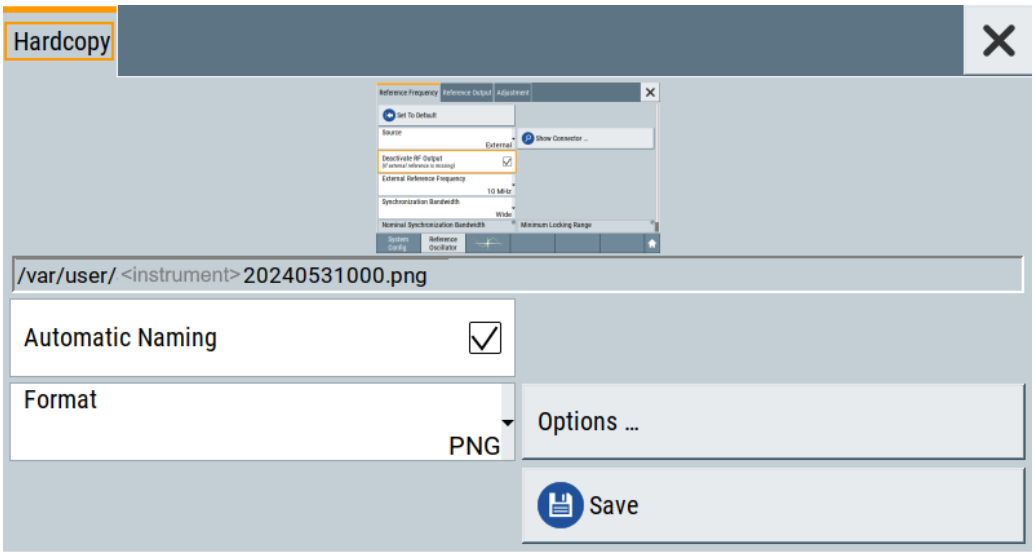
The save/recall function enables you to save current settings in a file. To document the most important settings for a performed signal generation, you can also save a hardcopy of the current display.

- Hardcopy settings 446
- Creating a hardcopy of the display 449

11.11.1 Hardcopy settings

Access:

► Select "System Config" > "Setup" > "User Interface" > "Hardcopy".



The remote commands required to define these settings are described in Section 14.11, "HCOPy subsystem", on page 623.

Settings:

Automatic Naming 447
File 447
Format 447
Options 447
Save 447
Hardcopy Options > Common 447
- Automatic Naming 447
- Format 447
- Region 448

Hardcopy Options > Automatic Naming 448
- Path 448

└ Clear Path....448
└ Prefix, Year, Month, Day....449
└ Current Auto Number....449

Automatic Naming
If enabled, creates the output filenames automatically according to the rules set with the Hardcopy Options > Automatic Naming settings.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO:STATe` on page 627

File...
In "Automatic Naming > Off" mode, accesses the standard file select dialog for selecting the filename and folder the hardcopy is stored in.

If you have enabled "Automatic Naming", the instrument displays the automatically generated filename.

Remote command:
`:HCOPy:FILE[:NAME]` on page 625

Format
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
`:HCOPy:IMAGe:FORMat` on page 624
`:HCOPy:DEVice:LANGuage` on page 624

Options...
Accesses Hardcopy Options dialog.

Save
Saves a hardcopy of the current display as a file.

Remote command:
`:HCOPy[:EXECute]` on page 625

Hardcopy Options > Common
Access: select "Hardcopy > Options... > Common".

With the provided settings, you can customize the file format and the syntax of the automatically assigned filename.

Automatic Naming ← Hardcopy Options > Common
If enabled, creates the output filenames automatically according to the rules set with the Hardcopy Options > Automatic Naming settings.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO:STATe` on page 627

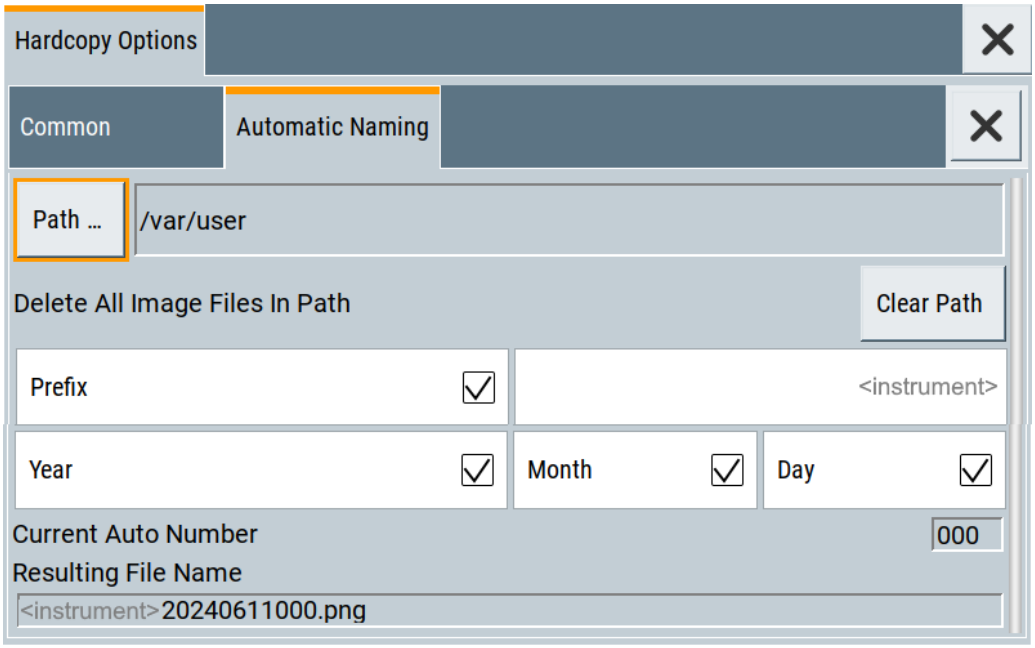
Format ← Hardcopy Options > Common
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
:HCOPy:IMAGe:FORMat on page 624
:HCOPy:DEVice:LANGuage on page 624

Region ← Hardcopy Options > Common
Displays the snapshot area.

Remote command:
:HCOPy:REGion on page 625

Hardcopy Options > Automatic Naming
Access: select "Hardcopy > Options... > Automatic Naming".



Provided are the following settings:

Path... ← Hardcopy Options > Automatic Naming
Selects the directory.

Note: To select the destination path, specify also a filename. Otherwise an error message is displayed and selection is canceled.

Remote command:
:HCOPy:FILE[:NAME]:AUTO:DIRectory on page 626

Clear Path ← Hardcopy Options > Automatic Naming
Deletes all image files with extensions *.bmp, *.jpg, *.png and *.xmp in the directory set for automatic naming.

Before the command is executed, a warning message prompts you to confirm the deletion of the files.

Remote command:
:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar on page 626

Prefix, Year, Month, Day ← Hardcopy Options > Automatic Naming
Determines the rules for "Automatic Naming".

Per default, the automatically generated filename is composed of:

`<Path>/<Prefix><YYYY><MM><DD><Number>.<Format>`, where `Y`, `M` and `D` mean year, month, Day; `Number` is the Current Auto Number.

You can activate or deactivate each component separately.

The "Resulting filename" indicates the current filename syntax.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix` on page 628
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe` on page 628
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe` on page 627
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe` on page 627
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe` on page 627

Current Auto Number ← Hardcopy Options > Automatic Naming
Indicates the number which is used in the automatically generated filename.

Note: When initially switching on the instrument, the number is reset to the lowest possible value. Starting with number 0 the output directory is scanned for existing files. As long as files with the same name are existing, the number is increased by 1. The number is automatically set so that the resulting filename is unique within the selected path. The current number is not in the save/recall file but is temporarily stored within the database. At the following save operation, the number is increased.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer?` on page 627

11.11.2 Creating a hardcopy of the display

To create a hardcopy

► Select "System Config" > "Setup" > "User Interface" > "Hardcopy".

Alternatively, you can use the following controls to create a hardcopy quickly:
- On the screen, select context-sensitive menu > (print).
- On an external keyboard, press the [Print] key.
- Assign the hardcopy function to the [User] key.

See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

The R&S SMCV100B creates a snapshot of the screen and opens the "Hardcopy" dialog for saving it in a file.

To configure and save the hardcopy

1. To define the output format, select "Format" > "JPG".
2. To enable the instrument to create output filenames, select "Automatic Naming" > "On".

3. Select "Options ...".
4. In the "Hardcopy Options" dialog:
   a) To change the default storage directory, select "Automatic Naming Settings" > "Path".
   b) Define a path and a filename.
   For example, select the default directory `/var/user`.
   c) If necessary, modify the parameters in the "Automatic Naming Settings".
   d) Close the "Hardcopy Options" dialog.
5. In the "Hardcopy" dialog, select "Save".

   The instrument saves a hardcopy of the current instrument display as a `*.jpg` file. Also, creates the filename automatically.

To export a hardcopy

1. Connect the instrument to the LAN.
2. Transfer the file to a remote computer
   See Section 11.10, "Transferring files from and to the instrument", on page 440.
3. On the remote computer, select the file.

12 General instrument functions

The general instrument functions include basic instrument settings, regardless of the selected operating mode and measurement. Some of these settings like screen display and peripherals are initially configured at the setup of the instrument, according to personal preferences and requirements. However, you can individually adjust the settings at any time, for example, for specific applications.

The following special functions help you in service and basic system configuration:

- Section 12.1, "Customizing the user interface", on page 451
  Allows you to adjust the display and keyboard language settings.
- Section 12.2, "Configuring global connectors", on page 456
  Allows you to map internal or external signals to the multipurpose connectors.
- Section 12.3, "Checking parameters and dependencies", on page 466
  Allows you to check for interdependencies between parameters and settings.
- Section 12.4, "Organizing frequently used settings as favorites", on page 467
  Enables you to group user-defined settings in a favorites list or to assign actions to the [★ (User)] as quick access for later retrieval.
- Section 12.5, "Managing licenses and license keys", on page 474
  If you have purchased an additional option for the R&S SMCV100B, you can enable it using a license key.
- Section 11.3, "Restoring an instrument configuration", on page 422
  At any time, you can restore a default configuration to start a measurement at a defined instrument state, or set the instrument to factory preset.
- Section 17.4, "Performing maintenance tasks", on page 880
  Special functions like calibration routines and selftests put your instrument to an initial state.
- Section 12.6, "Using the security settings", on page 490
  Special security and protection functions protect your instrument from unauthorized use or activate specific test routines.

12.1 Customizing the user interface

The R&S SMCV100B provides basic alignments of instrument settings regarding the user interface, that means the touch panel (screen), the appearance of the displayed dialogs and graphics, and an external keyboard.

Start / stop display update

The operating system of the R&S SMCV100B refreshes the displayed settings by default in almost real-time, to keep the display updated with the internally used values. However, you can turn off this function to reduce settling times when the instrument is remote controlled.

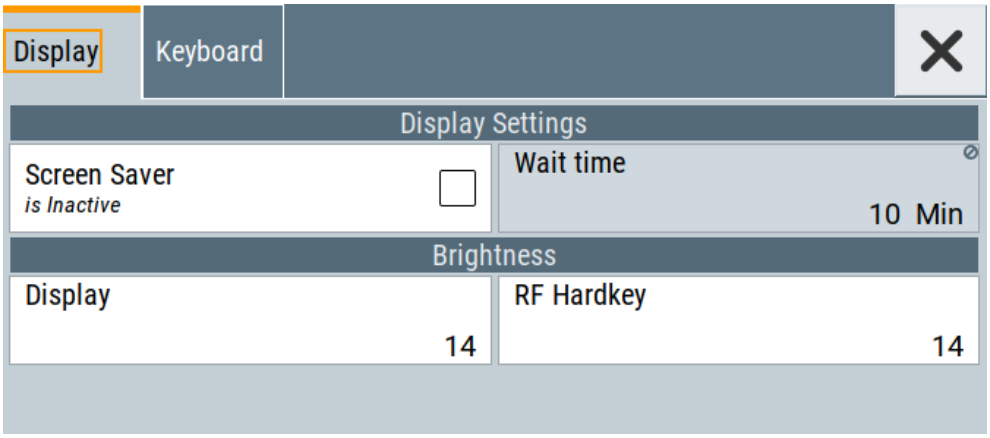
In detail described in the following paragraphs, you can:

- Set display and keyboard language, see Section 12.1.1, "Display and keyboard settings", on page 452
- Set date and time for the system clock, see Section 17.4.1, "Date and time", on page 881
- Configure and activate a Screen Saver
- Deactivate display update to improve performance, see Section 12.1.2, "Display update settings", on page 454
- Determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMCV100B, see Section 12.1.3, "Defining the RF signal state on power on", on page 454.

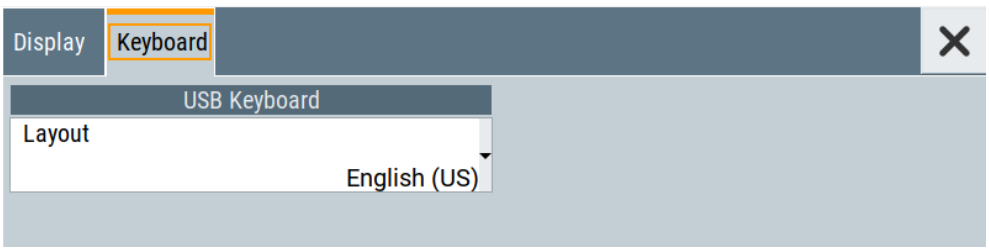
12.1.1 Display and keyboard settings

Access:

1. Select "System Config > Setup > User Interface > Display".



2. Select "Keyboard".



In the "Display" and "Keyboard" dialogs, you can enable the screen saver function and configure the language for the key assignment of an external keyboard and the keypad.

The remote commands required to configure the display and keyboard are described in Section 14.9, "DISPlay subsystem", on page 617 and Section 14.12, "KBOard subsystem", on page 628.

Screen Saver 453
Wait Time 453
Display 453
RF Hardkey 453
Layout 453

Screen Saver
Activates the screensaver.

If activated, the display including backlight is switched off after the selected Wait Time elapses and if no entries via touch panel, front panel, external mouse, or external keyboard are made

Remote command:
`:DISPlay:PSAVe[:STATe]` on page 618

Wait Time
Enters the idle time that must elapse before the display lamp is shut off when no entries are made.

Remote command:
`:DISPlay:PSAVe:HOLDoff` on page 618

Display
Adjusts the brightness of the display.

Increase the value to turn up the display brightness.

Remote command:
`:DISPlay:BRIGhtness` on page 618

RF Hardkey
Adjusts the brightness of the [RF On/Off] key.

Increase the value to change the contrast between the key and the front panel background color.

Remote command:
`:DISPlay:BUTTon:BRIGhtness` on page 619

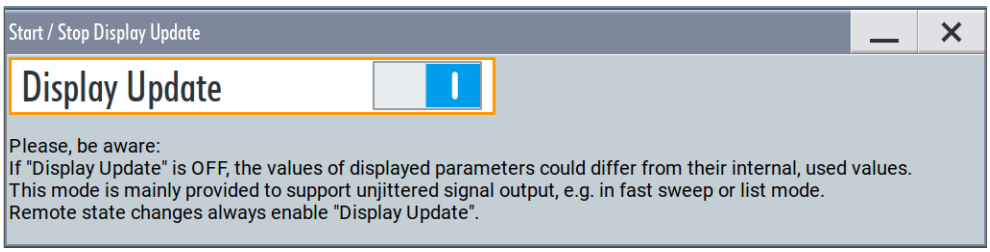
Layout
Selects the language of an external keyboard connected over USB. The function assigns the corresponding keys automatically.

Remote command:
`:KBOard:LAYout` on page 628

12.1.2 Display update settings

Access:

► Select "System Config > Setup > User Interface > Start/Stop Display Update".



This dialog enables you, to deactivate updating the display.

The remote command to switch off the display update is described in Section 14.9, "DISPlay subsystem", on page 617.

Display Update is
Disables the automatic refreshing of the displayed values.

Remote command:
`:DISPlay:UPDate[:STATe]` on page 619

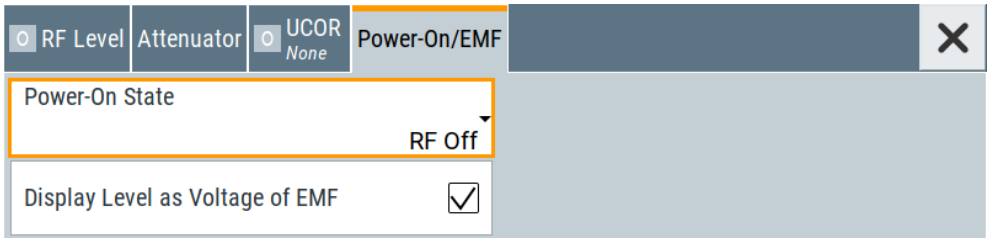
12.1.3 Defining the RF signal state on power on

As additional functions for the level settings, you can determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMCV100B.

Power-On/EMF settings

Access:

► Select "RF" > "RF Level" > "Power-On / EMF".



The "Power-On/EMF" dialog contains all settings for configuring the power-on behavior and the level display.

Settings:

Power-On State....455
Display Level as Voltage of EMF....455

Power-On State
Determines the RF signal output state when the instrument is switched on.

You can disable the RF output signal in general, or start it in the same state as it had been when it was switched off.

Remote command:
`:OUTPut<hw>[:STATe]:PON` on page 630

Display Level as Voltage of EMF
Activates display of the signal level as voltage of the EMF (no-load voltage).

If disabled, the level is displayed as a voltage over a 50 Ohm load.

Note:
The setting is not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
`[:SOURce<hw>]:POWer:EMF:STATe` on page 805

12.1.4 How to set the initial instrument settings

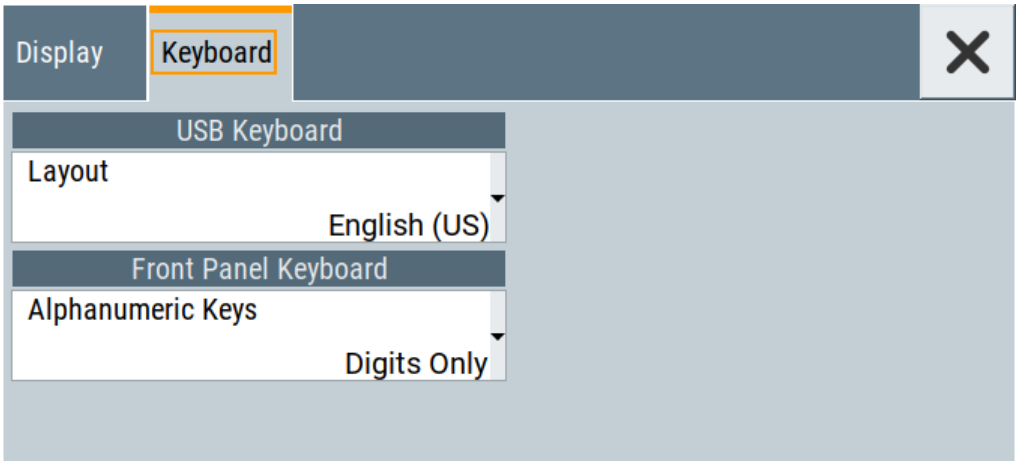
This section describes how to set up the R&S SMCV100B initially.

12.1.4.1 Setting the keyboard language

You can select the language of the external keyboard connected to the instrument.

To adjust the keyboard settings

1. Select "System Config > Setup".
2. Select "User Interface > Keyboard".



3. Select the "Layout".

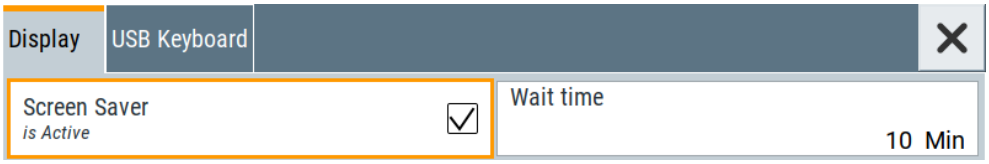
   The dialog closes and the changes take effect immediately.

12.1.4.2 Setting the screen saver

You can enable a screen saver that automatically turns off the display after a user-defined period of time. The screen saver is activated if no settings are made on the touch screen, or via keys or the rotary knob during the selected wait time.

To activate the screen saver

1. Select "System Config > Setup".
2. Select "User Interface > Display"
3. Activate the "Screen Saver".



4. Define the "Wait Time" in minutes.

   The instrument turns off the display after the defined period of time.
5. To reactivate the display, tap the screen or press any key on the front panel.

To deactivate the screen saver

1. Select "System Config > Setup".
2. Select "User Interface > Display"
3. Disable the "Screen Saver" state.

12.2 Configuring global connectors

The R&S SMCV100B is equipped with multipurpose bi-directional connectors.

Grouped according to their impact on the baseband or on the RF signal, the same connectors are divided into:

- Section 12.2.3, "Trigger marker clock settings", on page 459
- Section 12.2.4, "RF connectors settings", on page 460

12.2.1 Required options

The R&S SMCV100B is always equipped with two "User" connectors.

Additional options are not required.

12.2.2 About global connectors

Signal to connector mapping

As described in Section 4.4.1, "About common baseband characteristics", on page 78, the R&S SMCV100B uses several internally generated and externally supplied signals.

To handle these signals, the R&S SMCV100B introduces the concept of signal to connector mapping. The available signals are not dedicated to a particular connector but can be mapped to one or two "User" connectors.

The signal mapping and the polarity, the trigger threshold, and the input impedance of the input connectors are configurable parameters. The connectors settings are grouped in the dialog: Global connectors settings.

For required configuration steps, see "To map the signal to a connector" on page 465.

12.2.2.1 Global connectors

The R&S SMCV100B is equipped with "User x" connectors which can be freely assigned a selection of signals and which can be configured as both inputs and outputs.

A common threshold and input impedance is effective for all trigger and clock signal inputs provided at the "User" connectors. The settings influence the custom digital modulations, the generation of waveforms or multicarrier signals, and all digital standards.

See Section 8.9, "Varying the RF signal in list or sweep mode", on page 322.

Table 12-1 gives an overview of the signals that can be applied to and output at the User connector.

Table 12-1: Mapping control signals to the User x connectors

Connector	Direction	Assigned signal	Remark
"User 1" "User 2"	"Input"	"Global Trigger" "Global Next Segment" "Instrument Trigger"	Per default, the signal at "User 2" is a global trigger input signal.
	"Output"	"Baseband Marker"	Both "User x" connectors output the same "Baseband Marker" signal. Per default, the signal at "User 1" is an output signal.
	"Not Used"	"None"	No signal is input or output. The setting constitutes a switched-off User connector.

Connector	Direction	Assigned signal	Remark
"User 1"	"Input"	"TS" "ETI" "S/PDIF"	-
"User 2"	"Input"	"1 PPS" "Baseband Sync In"	-

12.2.2.2 Trigger, marker, clock and RF connectors

The Trigger marker clock settings and RF connectors settings dialogs provide an overview of the current mapping of the logical signals to the corresponding connectors. The dialogs are summary representation of related settings, as configured with the Global connectors settings settings.

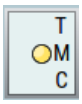
12.2.2.3 Status indicators

Connector status LEDs

A dedicated LED indicates the connector status:

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

TMC block



For a quick overview of the control signal sources, the block diagram provides the "TMC" block on the left side of the "Baseband" block.

If the baseband generator is enabled, a dedicated LED indicates the status of the control signal:

- Green: Uses an external signal.
- Yellow: Uses the signal as an output signal.

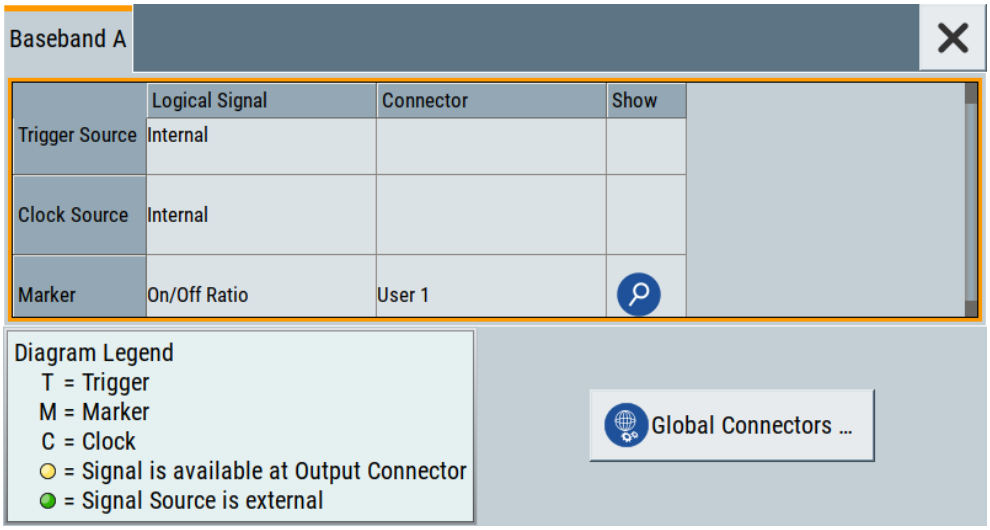
The R&S SMCV100B displays the "TMC" block only if you generate arbitrary waveform baseband signals and custom digital modulation baseband signals. Other baseband signals do not have the trigger, marker and clock signals.

12.2.3 Trigger marker clock settings

Access:

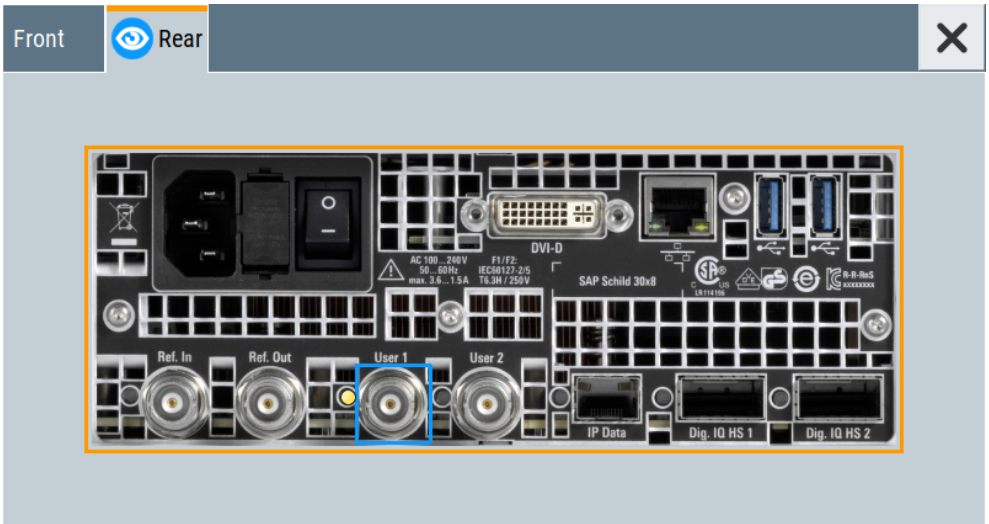
1. Perform one of the following:
   - In the "Block Diagram", select the TMC block on the left side of the "Baseband" blocks.
   - Select "Baseband > Trigger Marker Clock".

   The "Trigger Marker Clock" gives an overview of the current mapping of the logical signals to the connectors, as configured in the Global Connectors dialog. Clicking the connector name directly accesses the related connector settings.



2. Use the built-in Show Connector function to display the physical location of the selected connector.

   A blinking LED on the rear panel indicates the selected connector, too.



The eye icon in the tab header indicates the location of the connector on the panel (front, rear or both).

12.2.3.1 Overview table

Logical Signal
Displays the logical signal, as configured in the "Trigger In", "Marker" or "Clock" tab of the active baseband signal. Only the signals as configured in the "Baseband > ARB/ Custom Digital Mod" tabs are applied. See for example Section 4.6.3, "ARB settings", on page 144.

Connector
Displays the assigned connector.

Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

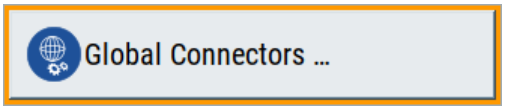
A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

12.2.3.2 Global connector settings

Opens a dialog to configure global connectors.

The button is available in the following dialogs or tabs:

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



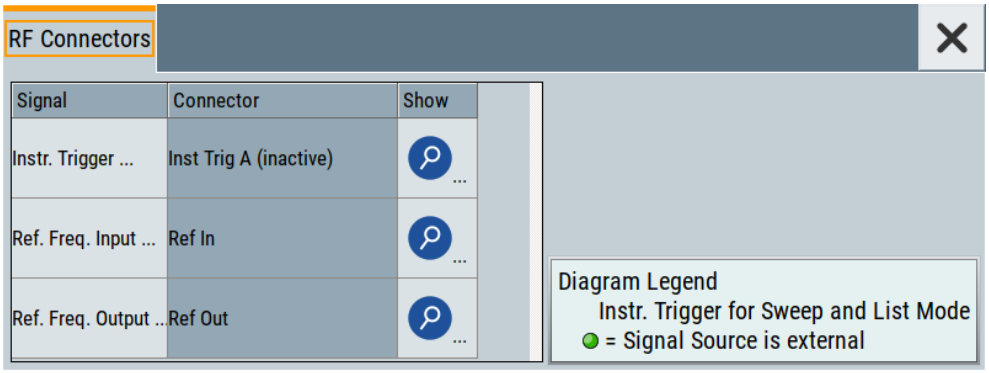
See also Section 12.2, "Configuring global connectors", on page 456.

12.2.4 RF connectors settings

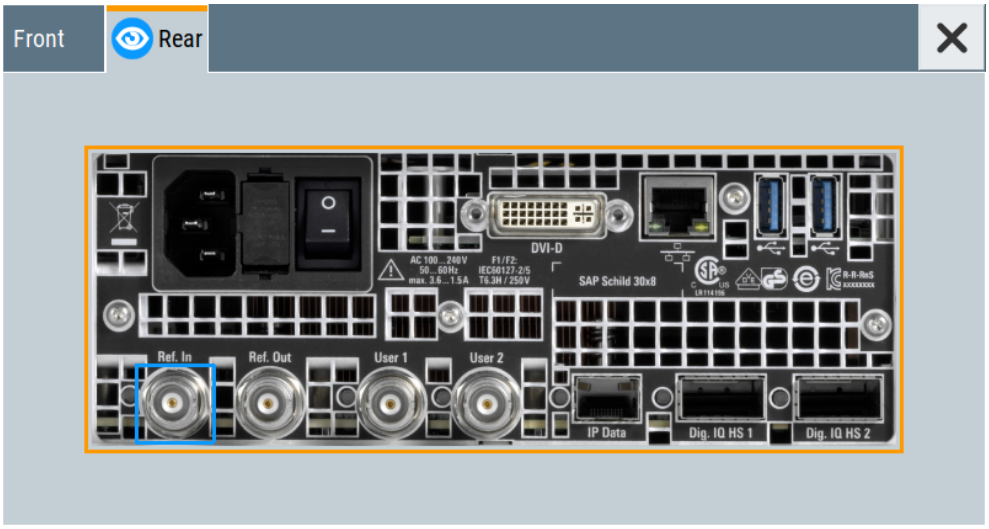
Access:

1. In the control signal block next to the "RF" block, select "Instr. Trigger".

   The "RF Connectors" dialog gives an overview of the mapping of the logical signals to the connectors; the displayed connectors depend on the installed options.



2. Select the signal type ("Signal") to open the dialog with related signal settings.
3. Use the built-in Show Connector function to display the physical location of the selected connector.



The eye icon in the tab header indicates, if the connector is on the front panel or rear panel. A blinking blue rectangle marks the connector or multiple connectors, if supported.

Settings:

Signal 461
Connector 461
Show Connector 462

Signal
Opens the dialog with the corresponding settings.

Connector
Displays the assigned connector.

Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

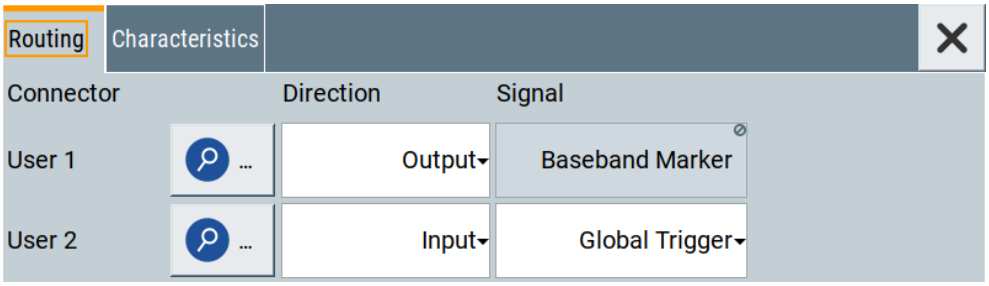
A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

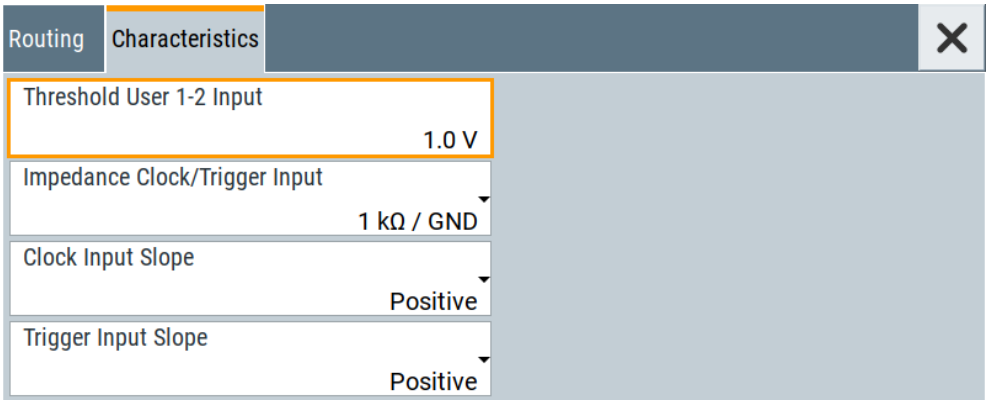
12.2.5 Global connectors settings

Access:

1. To access global connector settings via the signal control blocks of the block diagram, select the TMC block.
2. In the opening dialogs, try one of the following:
   - Select "Connector" > "User x".
   - Select "Global Connectors".
3. To access global connector settings via the baseband block of the block diagram, select one of the following:
   - Select "Baseband" > "ARB"/"Custom Digital Modulation" > "Trigger In" > "Global Connectors".
   - Select the tab "Input Signal" > "Global Connectors" in some baseband standard signal generation configuration dialog.

The "Global Connectors" dialog provides settings to configure the signal to connector routing and the physical characteristics of the input connectors for trigger, clock and control signals.





Use the built-in Show Connector function to display the physical location of the selected connector. Also, a blinking LED on the rear panel indicates the selected connector.

Settings

Show Connector....463
Direction....463
Signal....463
Threshold User1-2 Input....464
Impedance Clock/Trigger Input....464
Clock Input Slope....464
Trigger Input Slope....465



Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Section 12.2.2.3, "Status indicators", on page 458).

Direction
Sets the direction of the signal at the connector that can be input or an output.

If you do not use the connector, select "Not Used".

Remote command:
`[:SOURce]:INPut:USER<ch>:DIRection` on page 663
`:OUTPut:USER<ch>:DIRection` on page 663

Signal
Determines the control signal that is input or output at the selected connector. Whether the connector is used as an input or an output is selected by the parameter Direction.

The Table 12-1 lists the available control signals.

"Baseband Marker"
Marker signal output for triggering and control of external devices with user-definable marker signals. The output signal is available at "User 1"/"User 2" connectors.

"Global Trigger"
Input for triggering custom digital modulations, digital standards and ARB. A trigger event affects the signal generation in all basebands for which the "Global Trigger" signal is enabled.
The input signal is available at "User 1"/"User 2" connectors.

"Global Next Segment"
Input next segment for triggering of multi-segment waveform files, see Section 4.8, "Generating multi-segment waveform files", on page 192.
The input signal is available at "User 1"/"User 2" connectors.

"Instrument Trigger"
Input for triggering sweeps and list mode available at "User 1/2" connectors.

See Section 8.9, "Varying the RF signal in list or sweep mode", on page 322.

"TS"
Transport stream (TS) input signal for transport stream application available at "User 1" connector only.

"ETI"
Ensemble transport interface (ETI) input signal available at "User 1" connector only.

"S/PDIF"
Sony/Philips digital interface (S/PDIF) input signal available at "User 1" connector only.

"1 PPS"
1PPS (one pulse per second) input signal available at "User 2" connector only.

"Baseband Sync In"
In the secondary instruments, at most one input for the synchronization (and trigger) signal. Signal available at "User 2" connector only.

"None" No signal is assigned to the connector.

Remote command:
`[:SOURce]:INPut:USER<ch>:SIGNal` on page 663
`:OUTPut:USER<ch>:SIGNal` on page 664

Threshold User1-2 Input
Sets the high/low threshold in volts for the signal at the User1-2 connectors.

The input signal is defined with the parameter Signal. The same threshold applies for both connectors and any input signal.

Remote command:
`[:SOURce]:INPut:USER:TRIGger:LEVel` on page 664
`[:SOURce]:INPut:USER:CLOCk:LEVel` on page 664

Impedance Clock/Trigger Input
Selects the input impedance for the external trigger/clock inputs.

Set the value to 1 kΩ/GND for high clock rates.

Remote command:
`[:SOURce]:INPut:USER:TRIGger:IMPedance` on page 664
`[:SOURce]:INPut:USER:CLOCk:IMPedance` on page 664

Clock Input Slope
Sets the polarity of the active slope of an externally applied clock signal.

Remote command:
`[:SOURce]:INPut:USER:CLOCk:SLOPe` on page 665

Trigger Input Slope
Sets the polarity of the active slope of an applied instrument trigger.

Remote command:
`[:SOURce]:INPut:USER:TRIGger:SLOPe` on page 665

12.2.6 Routing signals to the connectors

This chapter provides step-by-step instructions to route control signals from input connectors or to output connectors of these signals. It covers the following topics:

- "General workflow" on page 465
- "To map the signal to a connector" on page 465
- "To find out the input connector location" on page 465

General workflow

The table Table 12-2 shows the main configuration steps and related settings.

Table 12-2: Mapping signal to connector workflow

Workflow task	Related settings
Checking the signal to connector mapping	"Trigger Marker Clock" "Global Connectors" > "Routing"
Configuring and enabling the control signal	"Trigger In", "Marker" or "Clock" tabs of the baseband signal dialog
Cabling the connector and the source or sink of the control signal	-

To map the signal to a connector

To map the signal to the connector, proceed as follows:

1. Check the current connector configuration.
2. If necessary, change the signal direction and the signal type.
3. Configure the control signal, for example a trigger signal or a marker signal.
4. Enable the control signal.
5. Connect a suitable external instrument or device to the connector of the control signal.

See also Section 3.3.4, "Enabling and configuring a marker signal", on page 50.

To find out the input connector location

Proceed as follows:

1. In the block diagram, select the "TMC" block to open the "Trigger / Marker / Clock" dialog.

2. In the block diagram, select the "Instr. Trigger" block to open the "RF Connectors" dialog.
3. For the corresponding connector, select the "Show Connector" icon.

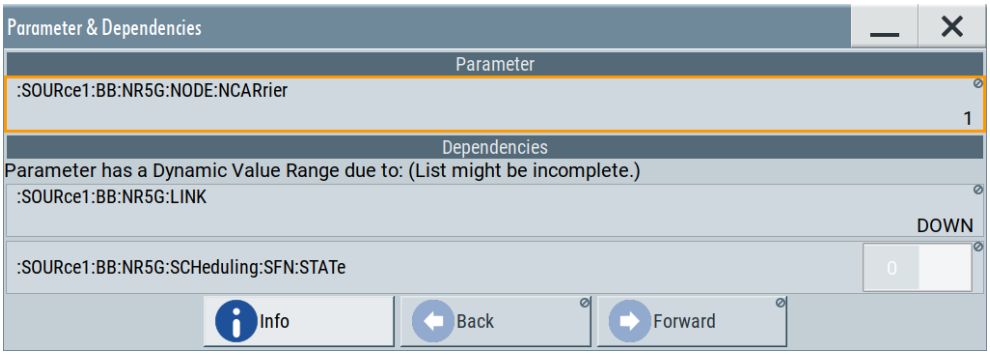
   The "Show Connectors" dialog opens and displays the location of the selected connector on the front panel or rear panel of the instrument.

If enabled, the LED next to the connector is green or yellow, see Section 12.2.2.3, "Status indicators", on page 458.

12.3 Checking parameters and dependencies

You can check settings on a parameter-level for incoming dependencies. These dependencies include R&S SMCV100B configurations that affect properties of the parameter. Properties are, for example, selectable values, ranges, minimum or maximum value depending on the parameter type. After the dependency check, a dialog displays R&S SMCV100B configurations that include a list of dependent parameters or dependent settings that affect the parameter.

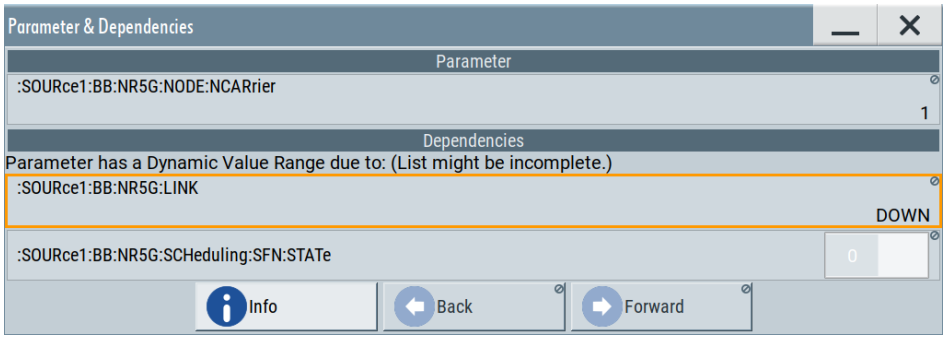
1. Select the parameter that you want to check.
2. Right-click the parameter, to open the context menu.
3. Select "Show Incoming Dependencies".



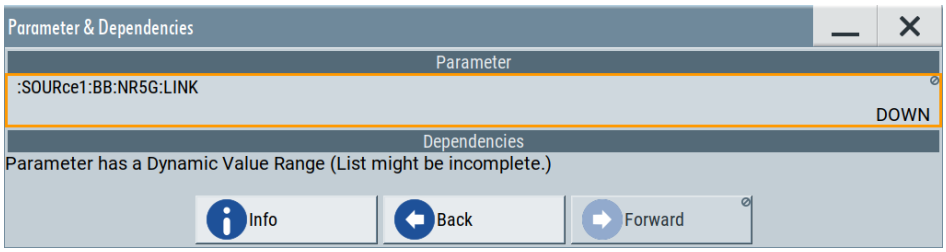
The "Parameter & Dependencies" dialog opens. The "Parameter" panel of this dialog displays the SCPI command including its setting or query parameters. The "Dependencies" panel displays dependent parameters and their settings that affect the setting of the parameter, that you want to check initially (2).

4. In the "Dependencies" panel, you can further check for dependencies within the dependent parameters.

a) Select the parameter that you want to check from the list in the "Dependencies" panel, e.g.:
`:SOURce1:BB:NR5G:LINK DOWN` for the "Link Direction" > "Downlink".



b) Select "Show Incoming Dependencies".



The list in the "Dependencies" panel is empty. I.e., the "Link Direction" setting does not depend on any further parameters or settings.

5. Optionally, navigate via "Back" and "Forward" to move up or down the dependency tree for parameters with dynamic value range.

Settings:

Info
Accesses the help of the selected parameter, see Section 12.3, "Checking parameters and dependencies", on page 466.

Back/Foward
Toggles between parameter dependencies for dependent parameters.

If you select "Show Incoming Dependencies" for parameters or settings from the "Dependencies" panel, you can move back or move forward through the dependency tree-like structure.

12.4 Organizing frequently used settings as favorites

The R&S SMCV100B provides two possibilities to define frequently used settings and procedures for later retrieval individually.

User menu and [★ (User)] key

These two functions work similar to the favorites function of a browser or other programs. They allow you to create a list of frequently used actions or to group frequently used settings in one dialog.

You can collect the parameters of your configuration in a favorites list, i.e. in the "User Menu", or define settings and actions with the [★ (User)] key:

- "User Menu" to group settings of specific tasks.

  Similar to a favorites function, you can use this menu for:
  - Grouping the settings required for a task in one dialog.
  - Saving and recalling the settings of a task.
  - Transferring the settings for use on multiple instruments.
- [★ (User)] key, with customizable function.

  You can perform the following steps using this key:
  - Open the "User Menu" (default functionality).
  - Add or remove settings and functions.
  - Execute actions and access functions.

Possible applications

The ★ (User) key and the "User Menu" are useful for the following situations:

- There are functions or tasks you have to perform in a defined order but the setting parameters are distributed across several dialogs.
- There are functions or tasks you have to perform frequently but they are not accessible via the front panel keys.
- The required functions are grouped in a dialog that is not directly accessible from the block diagram.
- Your task involves loading and executing of SCPI scripts.
  See Section 13.11.4, "How to record / create SCPI lists", on page 567 for information on how to create a SCPI script.
- A quick access to saved setups is required.
- There are functions and tasks you have to perform on several instruments.

Dialog identification

To identify each dialog, the instrument uses a dedicated dialog ID. The dialog ID contains the dialog position on the display and the current active tab. The action that triggers the instrument to open a dialog uses this identification.

Save/Recall vs. recall setup

If you need to restore a specific signal generation setup and perform further configurations based on this particular instrument state, the R&S SMCV100B provides two options:

- "Save/Recall" function
  For a detailed description, refer to Section 11.5, "Saving and recalling settings", on page 427.

- "Recall Setup" function
  If the "Recall Setup" is the only user action assigned to the [★ (User)] key, pressing this key triggers the R&S SMCV100B to load the user-defined preset file immediately.

12.4.1 User menu settings

The "User Menu" dialog contains function keys to organize, save and load a favorites list. You can also modify, add or delete list entries directly in the dialog.

Clear User Menu
Removes all entries from the "User Menu" at once.

Save User Menu
Saves the current "User Menu" under the defined filename.

Recall User Menu
Loads the selected "User Menu" file.

This function enables you to use the user specific favorites file on another instrument. However, if functions or parameters are not provided due to varying configuration of the instrument, the settings of these particular parameters take no effect.

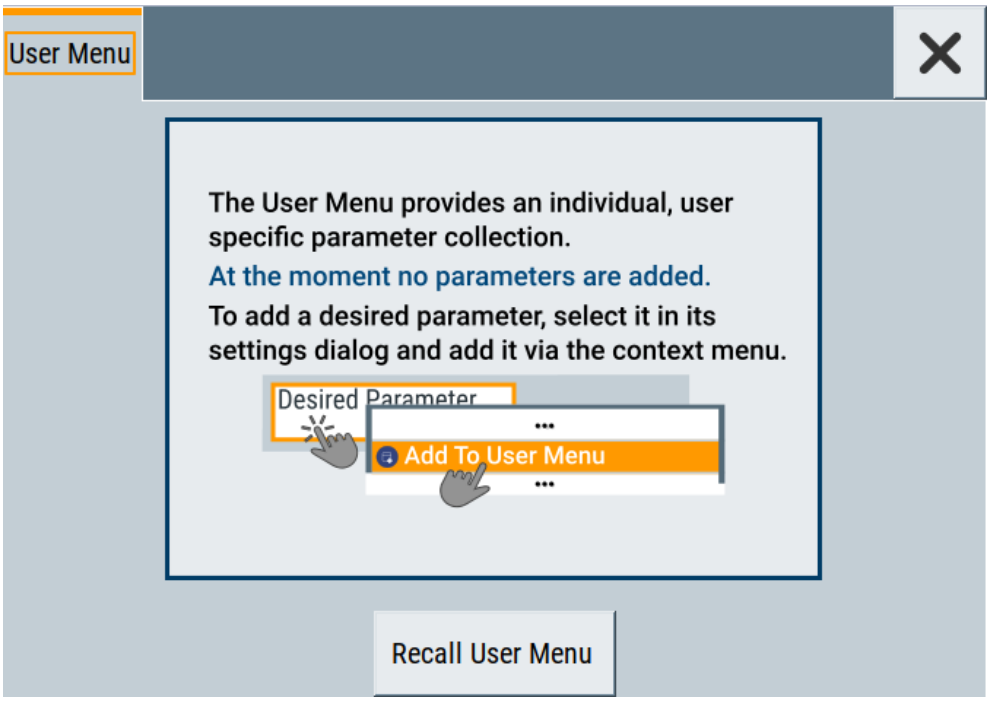
12.4.2 How to use the user menu for fast adjustments

Access:



1. Press the [★ (User)] key.

   The "User Menu" dialog opens.



   If you execute this action for the first time, the dialog displays instructions on how to use the "User Menu".

2. If you already have a saved user menu file on the instrument, you can load with "Recall User Menu".

Creating a user menu

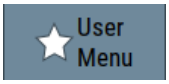
To create your own user dialog with settings:

1. Open a dialog with settings you frequently use.
2. Select a parameter.
3. Open the context menu and select "Add to User Menu".





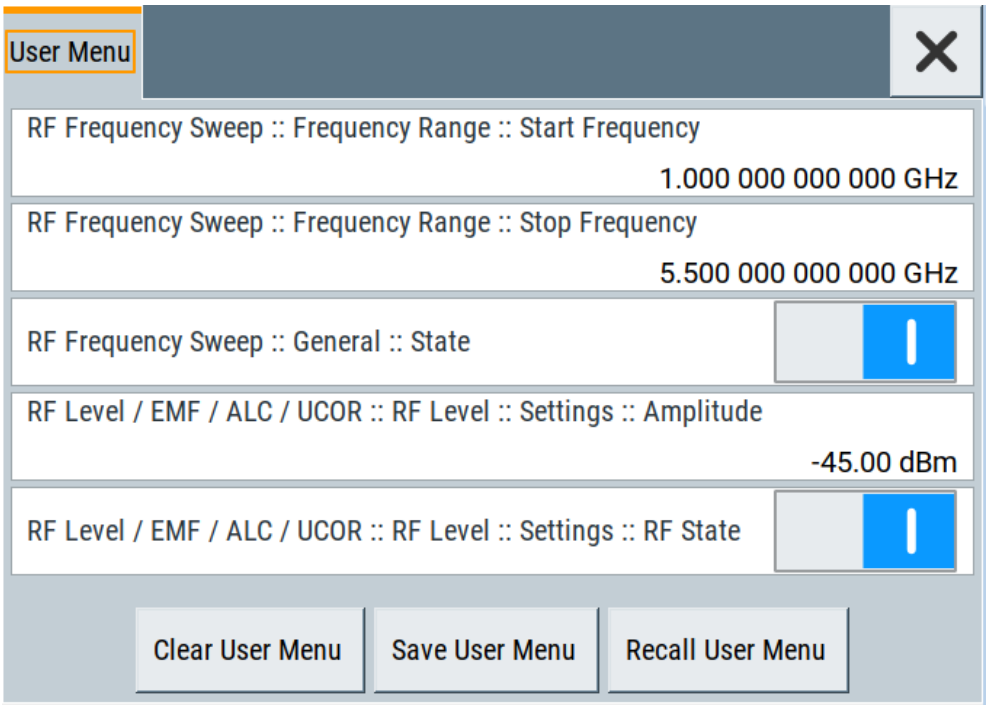
A favorites icon ★ indicates that the parameter is used in the "User Menu".



The "User Menu" button in the taskbar confirms that you have created a "User Menu" with at least one entry.

4. Press the [★ (User)] key.

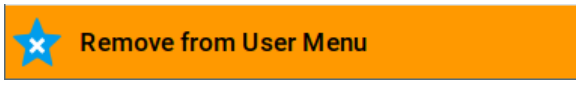
   The "User Menu" dialog shows all parameters that you have added to the list.



   You can modify the parameter settings directly in this dialog, e.g .change a state or set values, as you do in the particular dialog the parameter originally belongs to.

5. To remove an entry, select the parameter either in the "User Menu" or in the dialog where it originally belongs to.

   a) Open the context menu and select "Remove from User Menu".



6. To remove all entries at once, select "Clear User Menu".
7. To save your individual favorites list, select "Save User Menu", and follow the file managing instructions.
   The file system automatically assigns the file extension `*.user_menu`.
8. To recall a previously saved user menu, select "Recall User Menu" and proceed accordingly.

Providing a user menu favorites list for several instruments

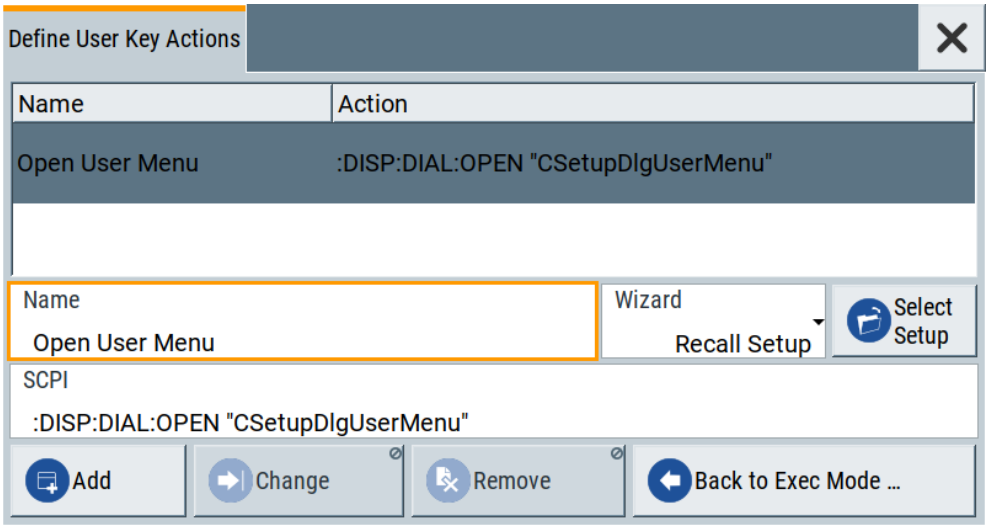
To transfer files from or to an instrument:

1. Create the favorites list, as described in "Creating a user menu" on page 470.
2. Save the favorites list.
3. To tansfer a file from or to an instrument, the R&S SMCV100B provides several options, see "File handling" on page 421.

12.4.3 Define user key actions settings

Access:

► Select "System Configuration > Setup > User Interface > Define User Key".



The dialog displays a list of the currently enabled actions and provides functions to define new, edit or remove existing actions. If no actions have been defined, the list is empty.
See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

The remote commands required to define these settings are described in Section 14.9, "DISPlay subsystem", on page 617.

Name
Enters a user-defined name for the action.

Wizard
Defines the action to be executed.

"Load SCPI Script"
Selects and executes the SCPI script.

"Recall Setup" Opens the file dialog for selecting a saved setup with user-defined settings.

"Open Dialog"
Selects an open settings dialog or menu.

Select
Depending on the selected "Wizard", provides access to:
- the standard "File Select" function for loading an SCPI script or setup file
- a list of all currently opened dialogs.
  See SCPI.

SCPI
For the currently selected action, displays the corresponding SCPI command with the associated parameter for dialog identification (dialog ID). The automatically displayed SCPIs are enabled for subsequent modification.

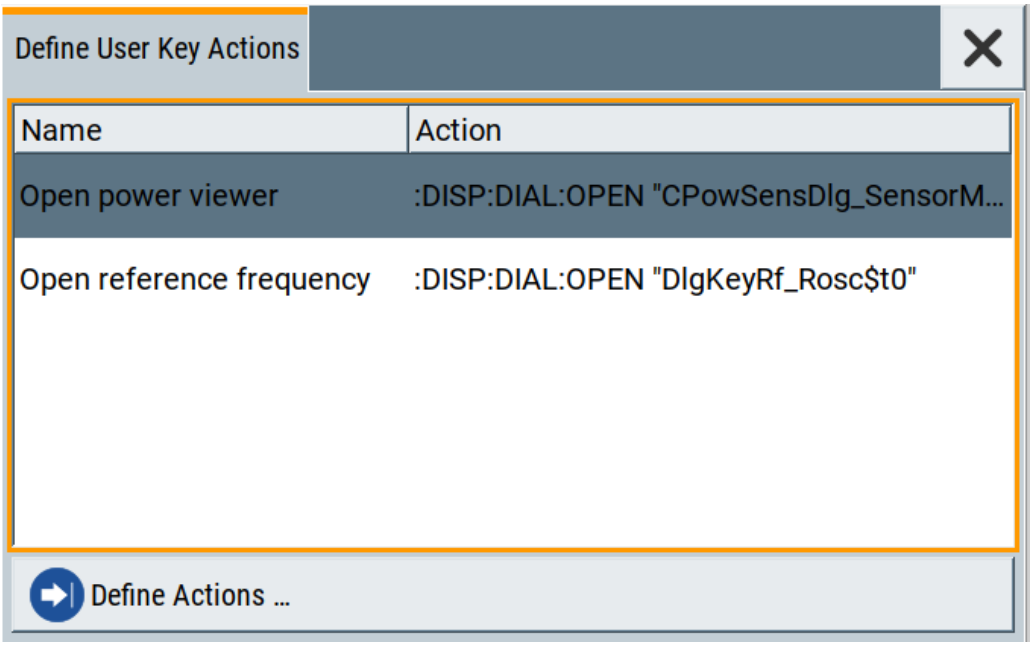
Remote command:
`:DISPlay:DIALog:OPEN` on page 621
See also `:DISPlay:DIALog:ID?` on page 620

Add, Change, Remove
Standard functions for managing of the actions.

Back to Execute Mode
Opens the "Select Action to Execute" dialog. Select an Action form the list to execute it.

To return to the "Define User Key Actions" dialogs, select Select Action to Execute > Define Actions.

Select Action to Execute > Define Actions



Opens the "Define User Key Actions" settings dialog.

12.4.4 How to assign actions to the [★ (User)] key

The customizable [★ (User)] key has no predefined function assigned. You can individually define actions to be executed or functions to be accessed when pressing this key.

To assign a frequently used dialog to the [★ (User)] key:

1. Open the dialog you want to quickly access.
2. Select "System Configuration > Setup > User Interface > Define User Key".
3. To create an action:
   a) Specify the "Name".
      E.g. *Open reference frequency*.
   b) Select "Wizard > Open Dialog"
   c) Select "Select Dialog" and select a settings dialog from the list

   The corresponding SCPI command is automatically displayed and can be modified.
4. Select "Add" to save the new action in the list of user key actions.
5. To execute the created action, press ★ (User).
   In the list of actions ("Select Action to Execute" dialog), navigate to the required action.

   The R&S SMCV100B executes the action and opens the dialog.

12.5 Managing licenses and license keys

The R&S SMCV100B provides options for all required applications, as, e.g., for digital standards, you can purchase and activate.

Various license types enable you to manage licenses for options as follows:

- Activate an option locally on an instrument.

An option is ready to operate after it is enabled with a license keycode supplied with the option. The license key is delivered as a file or on paper. Unregistered licenses must be registered for a particular instrument before the corresponding option can be enabled for operation.



For reliable operation, a software option usually requires the latest firmware version. The required version is specified in the delivery. If your instrument works with a former firmware version, update the firmware before enabling the software option.

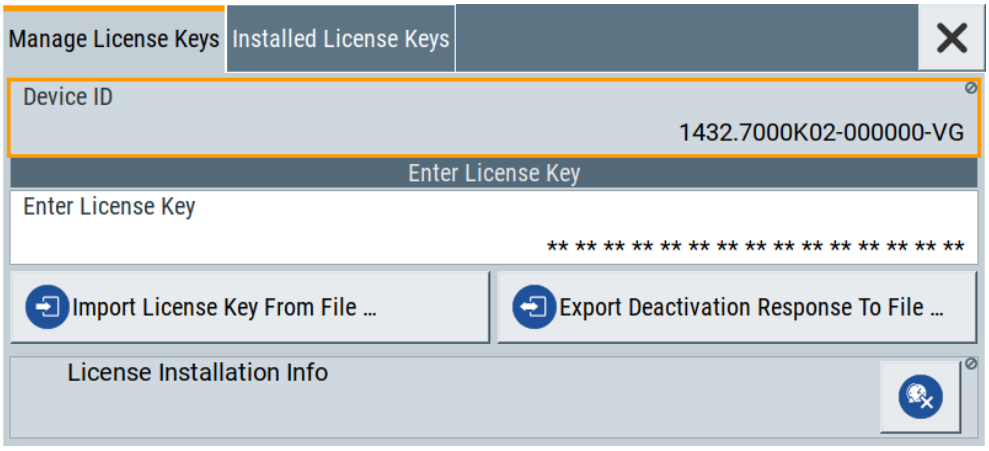
The firmware update is described in the release notes provided on the product page of the R&S SMCV100B.

12.5.1 Manage license keys settings

The "Manage Licnese Keys" dialog provides all information on the available licenses. Instrument-related steps guide you through the process of registering or deactivating licenses.

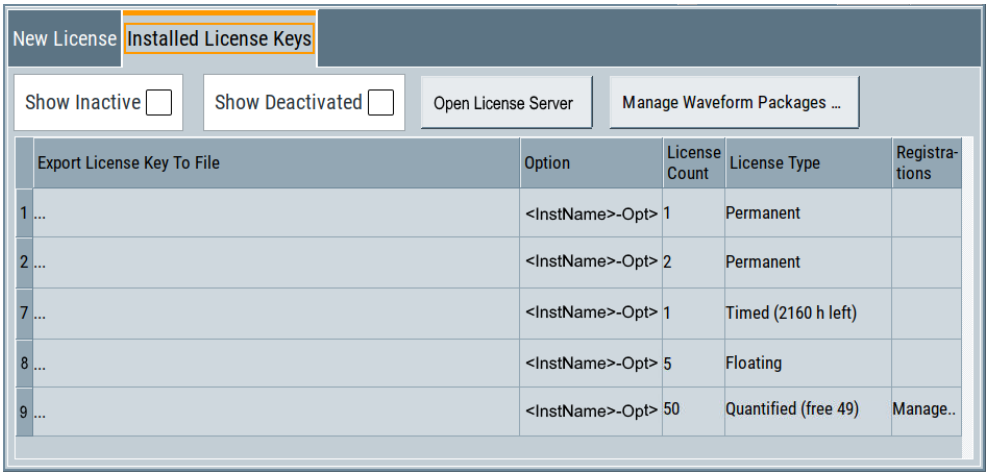
Access:

1. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Manage License Keys".



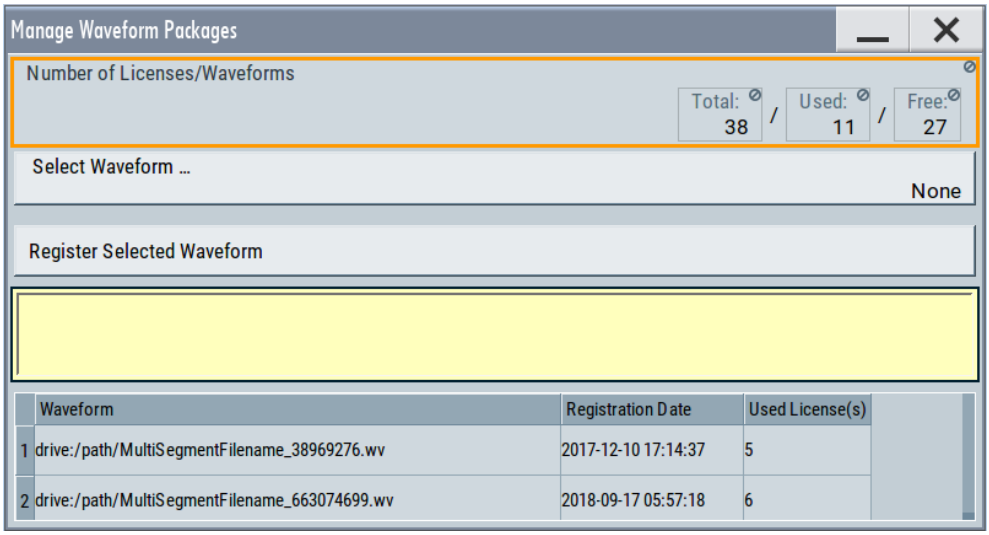
In this tab, you can activate licenses for newly purchased or newly registered options.

2. Select "Installed License Keys".



This tab lists all active options, with information on the available number of an option, the license type and registration. You can query inactive or disabled options also.

3. Select "Open License Server".
4. Select "Manage Waveform Packages".



This tab enables you to select and register purchased waveform packages.

The "Manage License Keys" dialog covers all required parameters for activating or deactivating newly purchased or newly registered options, and provides access to the onboard license server, see Section 12.5.2, "Using the license server", on page 478.

Settings:

Device ID....476
Enter License Key....476
Import License Key from File....477
Export Deactivation Response to File....477
License Installation Info....477
Installed License Keys....477
- Show Inactive....477
- Show Deactivated....477
- Installed License Keys Table....477

Open License Server....478
Manage Waveform Packages....478
- Number of Licenses/Waveforms....478
- Select Waveform....478
- Register Selected Waveform....478
- License Table....478

Device ID
Displays the instrument-specific identification number. The device ID is a unique string with the following structure:

`<stock number>-<serial number>-<checksum>`

Enter License Key
Type here the license key provided with the option.

For license keys delivered as a file, use Import License Key from File....

Import License Key from File...
Opens a dialog for selecting the file with the license key.

Use this function also to import the deactivation key file generated by the R&S License Manager online tool (see How to move a portable license).

Export Deactivation Response to File...
Exports the generated deactivation response key to a file and opens a file management dialog to save the file.

This key is required during the unregistration process, e.g. when you want to deinstall an option or have a portable option, which you want to register later on another instrument (see How to move a portable license).

License Installation Info
Indicates status information on the performed actions.

Installed License Keys
Access: select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys".

Comprises information on the installed options.

Show Inactive ← Installed License Keys
Enables the display of the inactive (expired) licenses in the Installed License Keys Table.

Show Deactivated ← Installed License Keys
Enables the display of the deactivated licenses in the Installed License Keys Table.

See How to move a portable license for information on how to activate deactivated licenses.

Installed License Keys Table ← Installed License Keys
Shows information on the currently installed options.

"Export License Key to File"
Opens a dialog to save the generated license key file. This file is required during the unregistration process.
If you have a portable unregistered option, you can register it later on another instrument (see How to move a portable license).

"Option" Displays the short designation of the option.

"License Count"
Displays the number of the licenses for the selected option key.

"License Type" Displays the type of license.
A license type determines the common qualification application duration and the portability of a license. The following license types are provided: evaluation, permanent, portable, quantified, time-controlled with a duration of 1, 3, 6 or 12 months. A license can also be deactivated or expired.
For time limited licenses, the left time of applicability is displayed too.

"Registrations" (reserved for future use)

Open License Server
Opens the R&S License Server of the R&S SMCV100B, see Section 12.5.2, "Using the license server", on page 478.

Manage Waveform Packages
Access: select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys > Manage Waveform Packages".

Opens the "Manages Waveform Packages" dialog that enables you to register waveform files.

With a waveform packages license, the R&S SMCV100B can play a waveform file generated with the R&S WinIQSIM2 software, even if it is not equipped with the corresponding digital standard option for using R&S WinIQSIM2 (R&S SMCVB-K2xy/K4xy).

Note: One waveform packages license per waveform is required, and for multisegment waveforms, you need a license per segment.
Once registered license cannot be moved to another instrument.

A waveform packages license does not allow R&S SMCV100B to play waveforms of options R&S SMCVB-K256/-K352/-K353/-K354.

Number of Licenses/Waveforms ← Manage Waveform Packages
Displays the number of the available and used R&S SMCVB-K200 licenses.

Select Waveform ← Manage Waveform Packages
Opens a standard dialog to select the waveform to be registered.

Register Selected Waveform ← Manage Waveform Packages
Executes the registration.

License Table ← Manage Waveform Packages
Gives an overview of the registered waveforms, the registration date and the number of used licenses.

"Waveform" Displays the directory, path and file name of the waveform file.

"Registration Date"
Displays date and time of registration.

"Used License(s)"
Shows the number of licenses the waveform file requires.

12.5.2 Using the license server

The R&S SMCV100B now supports handling of software licenses using the license server from Rohde & Schwarz.

As a browser application you can access the R&S License Server either in a browser and also directly in the R&S SMCV100B. The onboard license server integrated in the instrument firmware has connection to a *local smartcard* memory. The local smartcard holds local licenses, i.e. licenses that are intended for use on this specific instrument.

NOTICE

Direct operation requires an external keyboard

The touch screen of the R&S SMCV100B does not support the complete GUI functionality of the R&S License Server.

Use an external keyboard when configuring the settings on the R&S SMCV100B directly.

As opposed to local licenses, the application also manages licenses referred to as *floating licenses*.

For managing floating licenses, the same license server application runs on a PC at customer's site. In this context referred to as *remote license server*, with connection to the customers memory, the *remote smart card*. The remote smartcard holds floating licenses, i.e. licenses you can use on instruments everywhere without restrictions on the location.

When you need a specific application, you can obtain a license from the server. When you no longer need the license, return it to the server.

The license server releases a returned floating license for use in another instrument only after a follow-up time of 10 minutes.

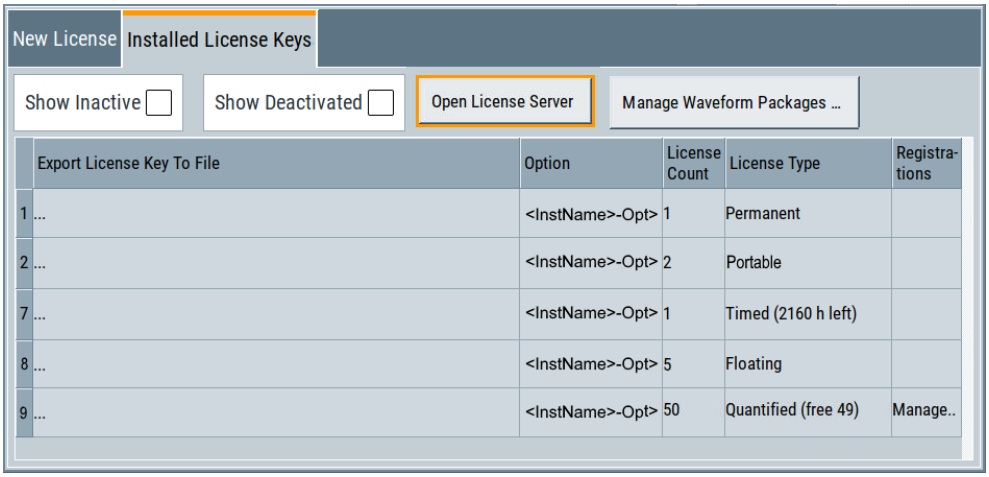
At startup, the license server checks the available floating licenses. During this check, it returns the licenses immediately.

The floating license server application is part of the configuration at purchase. Included in delivery, you get an installation package that consists of a smart card dongle with the software and the corresponding user documentation.

To open the license server

Access:

1. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys".



2. Select "Open License Server".

   The license server opens in a browser window and starts initially in the "Configuration" view for configuring floating license servers. It lists already configured floating license servers, with information on the host address, designation and state. You can add or remove a floating license server configuration and customize the information to be displayed. The control elements in the upper area enable you to access the "Analytics" or "Licenses" views.

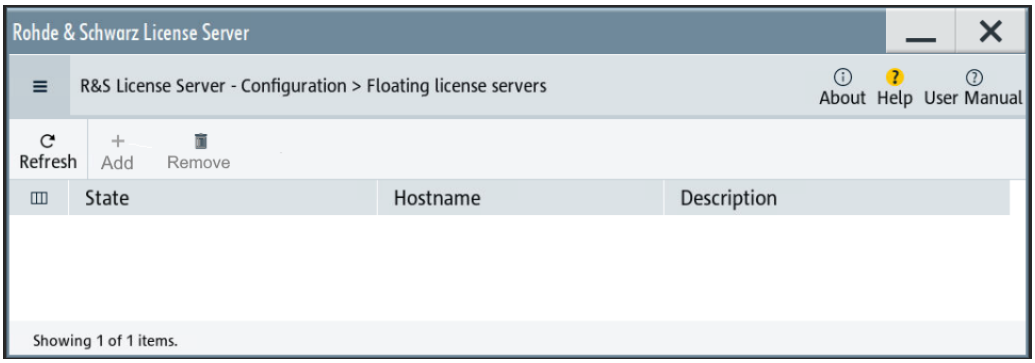
The icons in the status bar on the right lead you to information on the license server:

- "About": shows the software version.
- "User Manual": opens the embedded license server user manual.
- "Help": provides the functional description on a specific dialog and its settings.

For security reasons, the license server of the R&S SMCV100B enables you to restrict the access to the floating licenses from an external instrument.

For information on how to restrict the access to the connections, see "To restrict remote connection access" on page 485. To release a restriction, see "To enable remote connection access" on page 487.

For more information, see the user manual of the license server.



Short glance at the main views

The section provides a brief insight into the main windows of the license server. For details and handling of the application, refer to the embedded user documentation.



1. To access a view, select the menu button.

2. Select "Configuration".

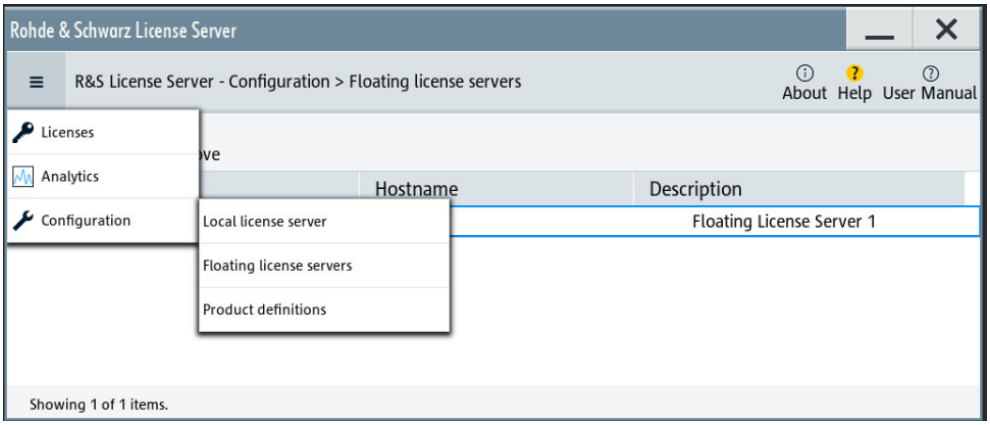


Figure 12-1: Configuration menu

Accesses the configured license servers, access lists and installed product definitions.

a) Select "Local license server".

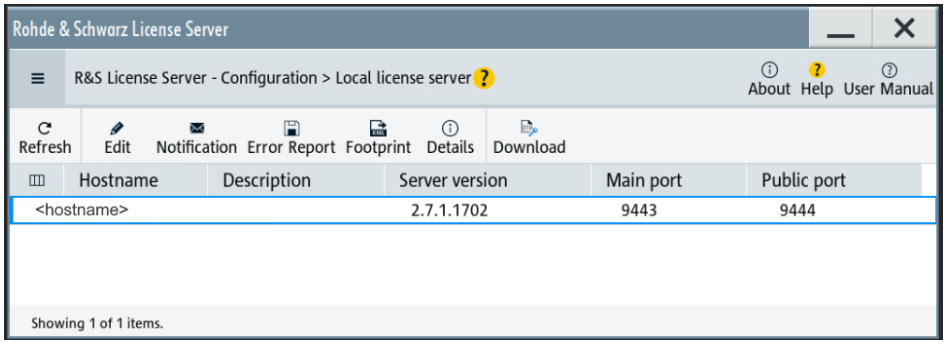


Figure 12-2: Example of a local license server view

Shows the onboard license server of the instrument. With the column selection, you can indicate or unhide characteristics of the available server. The task bar buttons provide access to the corresponding functions and access lists.

b) Select "Floating license server".

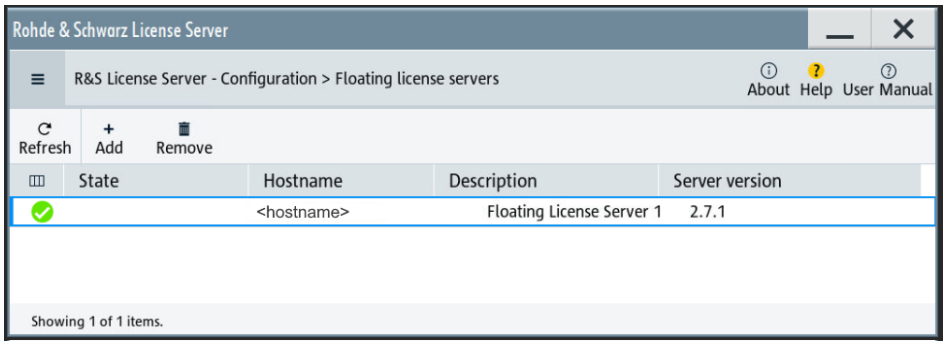


Figure 12-3: Example of a floating license server view

To add the connection to a floating license server, see "To add a remote connection to an external license server" on page 488.

c) Select "Product definitions".

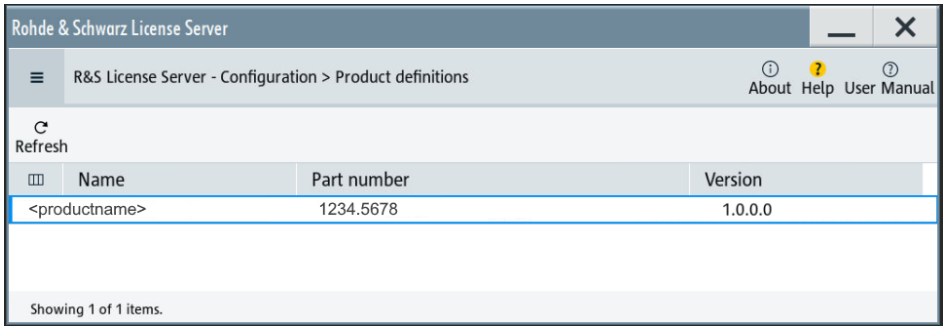


Figure 12-4: Example of a product definition view

Shows installed product definitions. To view the available characteristics, use the column selection.

3. Select "Licenses".

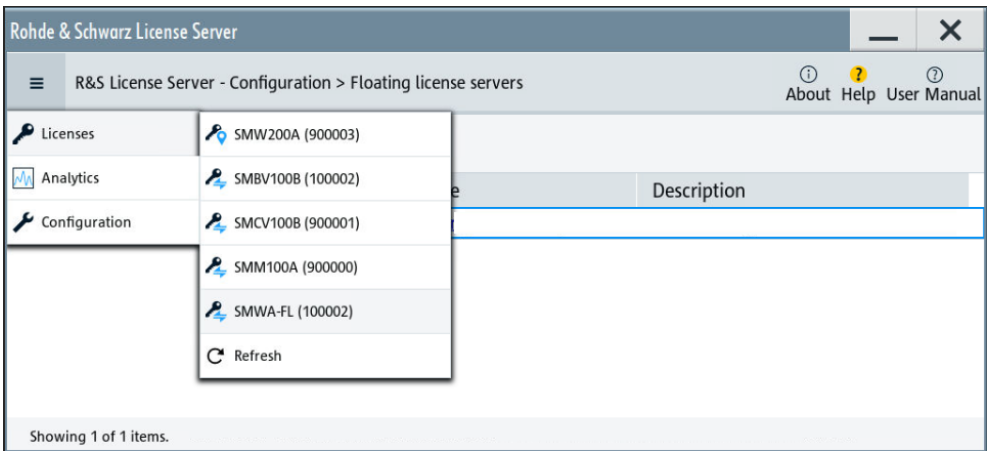


Figure 12-5: Licenses menu

Provides access to the available license servers.

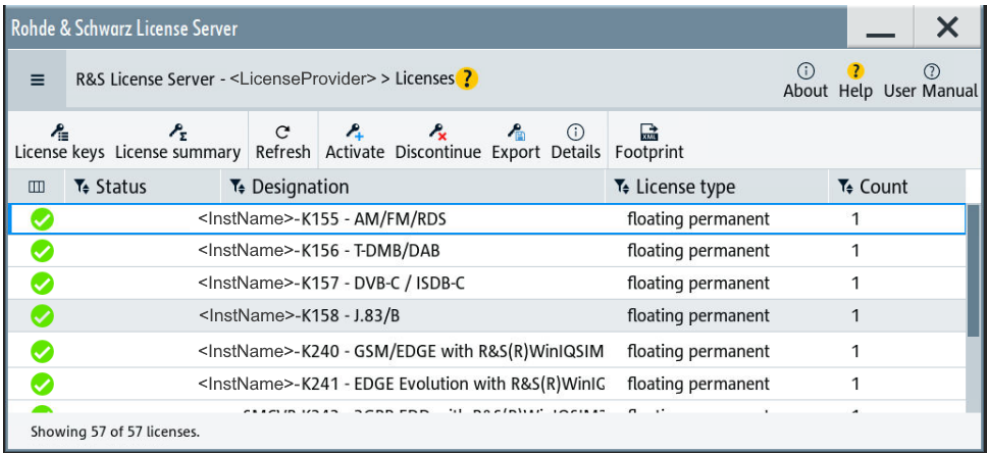


Figure 12-6: Example of a license list view

The "License keys" view lists the license key options that are available on the selected server. To show additional information, use the column selection.
The task bar functions enable you to activate or deactivate a license, to get details on an option and export license keys or information on the selected product.

4. Select "Analytics".

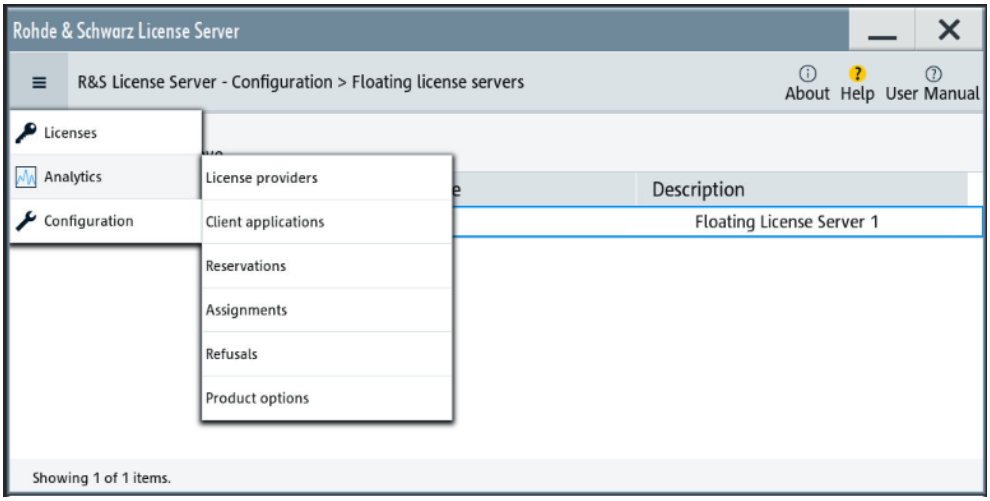


Figure 12-7: Analytics menu

Provides access to the license providers, client applications and enables you to export statistics data for evaluation in external applications.

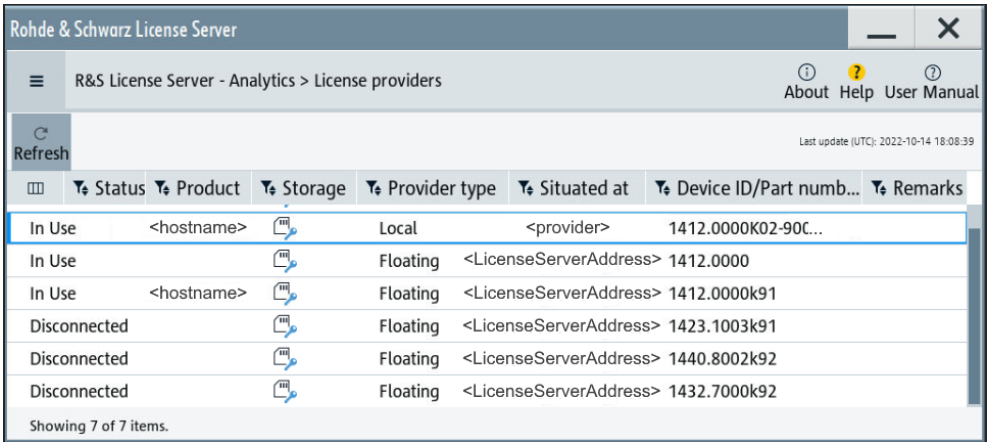


Figure 12-8: Example of the license providers view

Shows information on configured client applications, license providers and license types. To show additional information, use the column selection.

To manage licenses on the R&S SMCV100B

To request or return a license, proceed as follows:

1. Access: see "To open the license server" on page 479.

   The browser application opens.

2. Select "Licenses"
3. Select a license server in the menu list, e.g. "R&S SMCV100B".

   The "License keys" view lists the enabled options available on the selected server.

4. Select "Status" > "Select all" to list also options that are currently deactivated.

   The "Licenses" view shows all active, inactive and time limited options.

5. To get detailed information on a specific option:

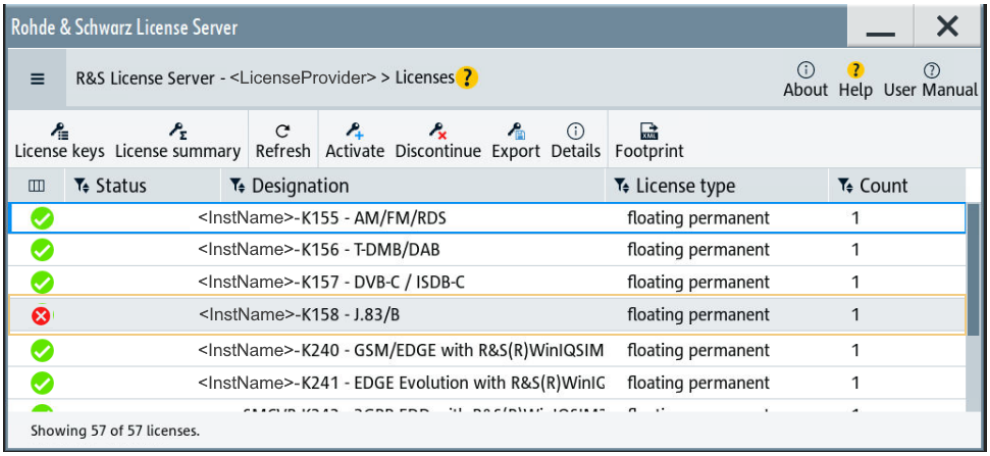
   a) Select the option in the list.

b) In the task bar, select "Details".



Figure 12-9: Example of the license characteristics of an option

6. To enable a discontinued license: , select Activate in the taskbar.



a) Select the license you want to activate.
b) In the task bar, select Activate.

7. To return a license, proceed the same way:
   a) Select the license.
   b) Deactivate the license with Discontinue.
8. Follow the instructions on the screen.

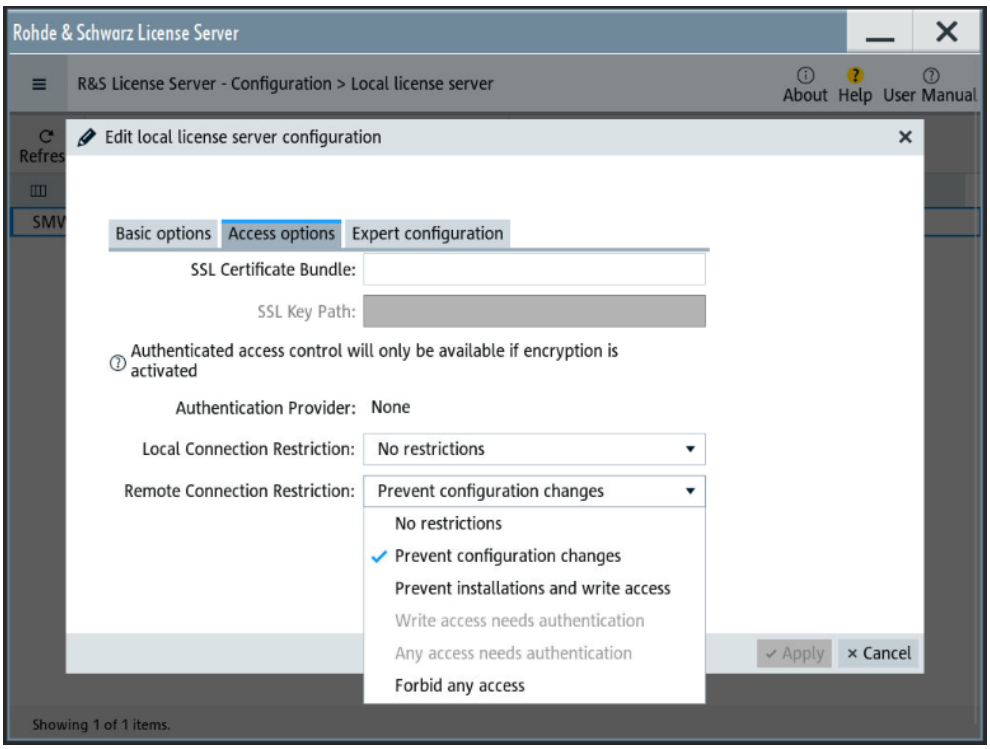
To restrict remote connection access

If you want to restrict the remote connection to the floating license server of the R&S SMCV100B, you can configure specific levels to prevent unauthorized access:

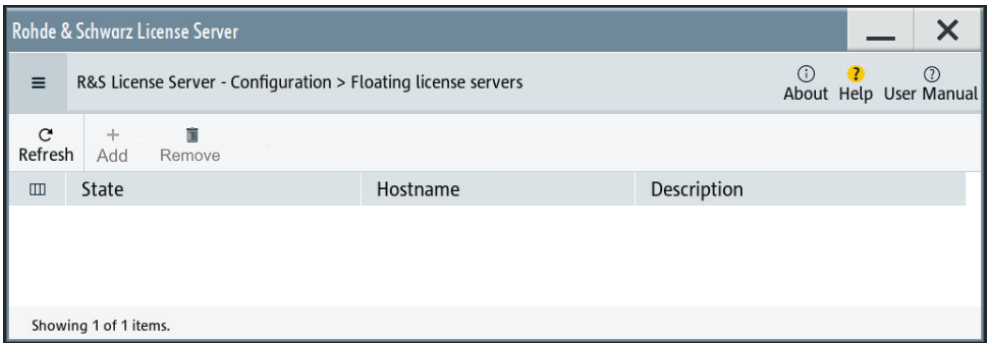
1. Open the license server as described in "To open the license server" on page 479.

   The onboard license server browser opens.

2. Select "Configuration" > "Local license server".
3. In the task bar, select "Edit".
4. Select the "Access options" tab.
5. Under "Remote Connection Restriction" restrict the access according to your requirements.



6. Confirm with "Apply" and close the dialog.



The R&S SMCV100B blocks the remote connection of an external floating license server. The "Add" and "Remove" buttons are disabled (grayed out).
The restriction also disables the remote access to the "Edit" mode of the local server. You can release the restricted access only directly on the instrument.

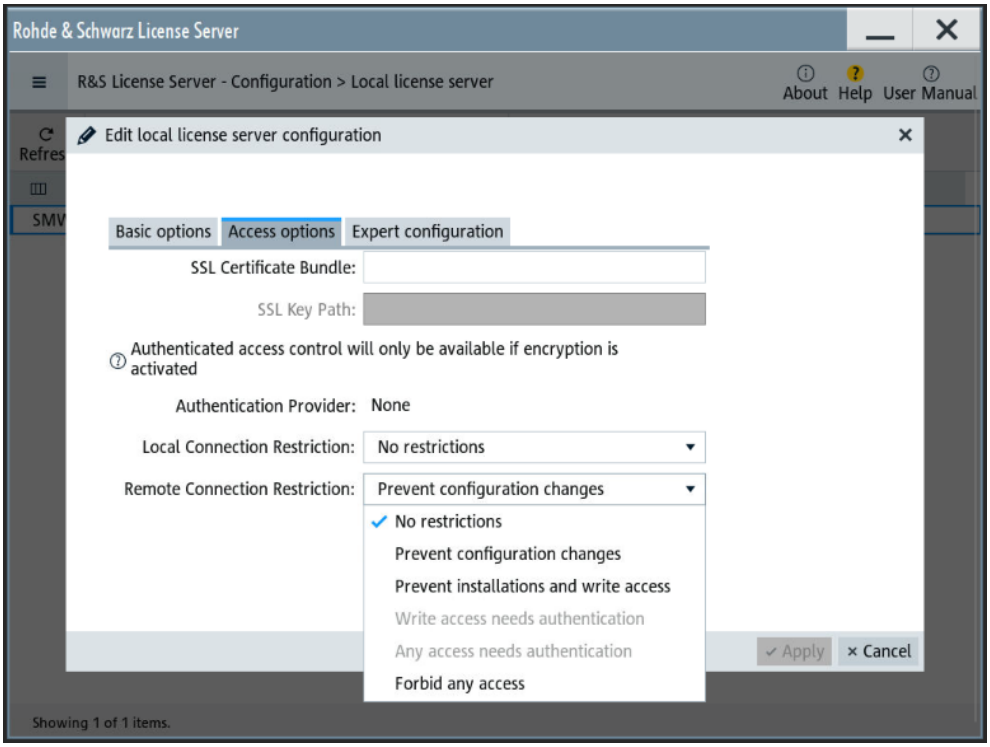
To enable remote connection access

If the remote connection to the floating license server is blocked, you can release the restriction or configure specific levels to prevent unauthorized access:

1. Open the license server as described in "To open the license server" on page 479.

   The onboard license server browser opens.

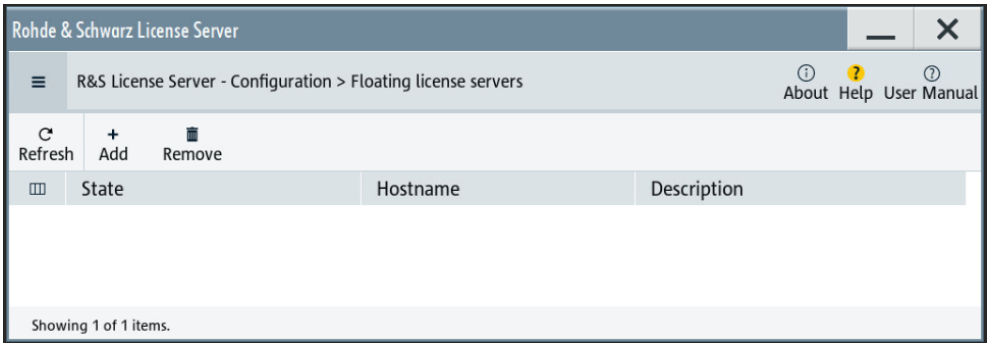
2. Select "Configuration" > "Local license server".
3. In the task bar, select "Edit".
4. Select the "Access options" tab.
5. Under "Remote Connection Restriction" release the access according to your requirements.



6. Confirm with "Apply" and close the dialog.

   If your selection no longer restricts the access, you can assign a floating license server.

7. Select "Configuration" > "Floating license server".



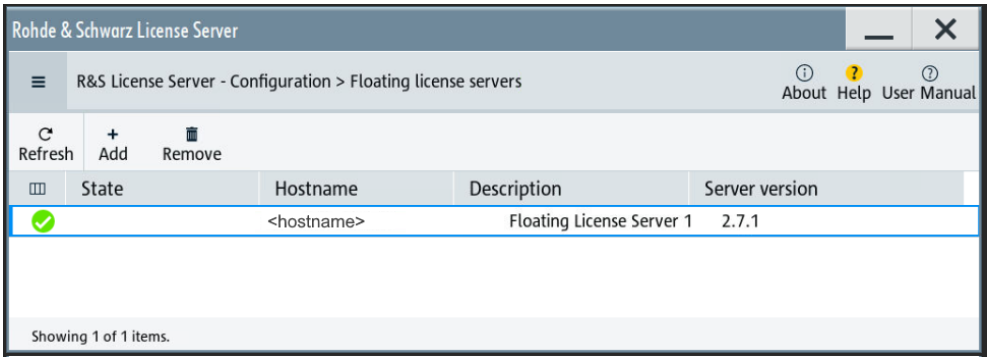
The "Add" and "Remove" buttons in the task bar are no longer blocked.

To add a remote connection to an external license server

1. Open the license server as described in "To open the license server" on page 479.

   The onboard license server browser opens.

2. Select "Configuration" > "Floating license server".
3. Select "Add".
4. Enter hostname and port of the license server you want to use.
5. Confirm with "Add".



The access to the server is established.

12.5.3 How to move a portable license

This example is intended to explain how to perform the required steps at the instrument.

Use a USB flash drive to transfer the license key files between the instruments and the browser.

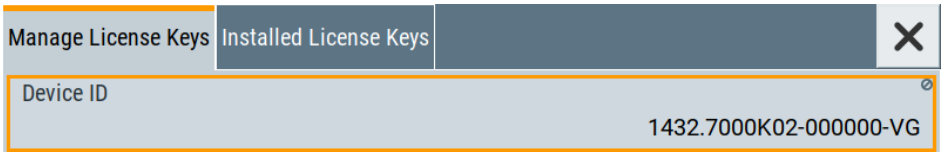
We assume knowledge about the handling of the R&S License Manager online tool and the description of the whole process.

1. Open your browser. Enter https://extranet.rohde-schwarz.com/service.

Select "Manage Licenses > Move Portable License".

The first step requires the Device IDs of the source and target instruments.

2. To find out the Device IDs, proceed as follows:
   a) On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Manage License Keys > Device ID".



   b) On the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys".
   c) In the "Mange License Keys" tab, select "Device ID".
   d) In the browser, select "Manage Licenses > Move Portable License > Select Devices".
   e) Enter the Device IDs.
3. On the source instrument, select "System Config > Setup > Instrument Assembly > Installed License Keys > License Keys Table".
   a) Navigate to the portable license that you want to move.
   b) Select the "Export License to File" column.

   A standard file manager dialog opens.
4. Enter a filename.
5. Save the exported license key, e.g. `k123_portable_key_to_move.xml`.
6. In the browser, select "Manage Licenses > Move Portable License > Select License (from file)":
   a) Select the exported license key.
   b) Check the selection.
   c) Create the deactivation key.
   d) Save it to file.
7. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Import License Keys from File".
   Select the transferred deactivation key.
8. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Export Deactivation Response to File".
9. In the browser, go to "Manage Licenses > Move Portable License > Install Deactivation Key (from file)".
10. Enter the deactivation response of the instrument.

    The license is deactivated for the source instrument.
11. In the "Manage Licenses > Move Portable License", go to step "Create License" to generate a license key for this portable option and the selected target instrument.

a) Download the license key as a file.
b) Transfer it to the target instrument.

12. In the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Import License Keys from File".
13. Select the created license key file.

    The portable option is installed on the target instrument.

12.6 Using the security settings

The protection function of the R&S SMCV100B provides several levels to activate particular functions like self-test or tests for service purposes specifically.

Protection

The five protection levels are automatically active on startup that means all protected functions are locked.

To unlock a protection level:

► In the "System Config > Setup > Security > Protection" dialog, enter the correct password.

To lock a protection level:

► Clear the corresponding checkbox.

Protection levels

The following functions are protected in the respective levels:

- Protection level 1
  Protects against accidental changes, like, for example, the clock and date, several internal adjustments functions and the self-test, as well as network settings or the instrument hostname.
  You can access this level with the password 123456.
- Protection level 2
  Unlocks protected service functions. It is accessible to authorized personnel of Rohde & Schwarz service department only.
- Protection level 3 to 5
  Are reserved for internal use.

Security

The security concept of the R&S SMCV100B helps you to protect your instrument against uncontrolled access and changes. All provided security services require that you enter the security password.

Provided security services are:

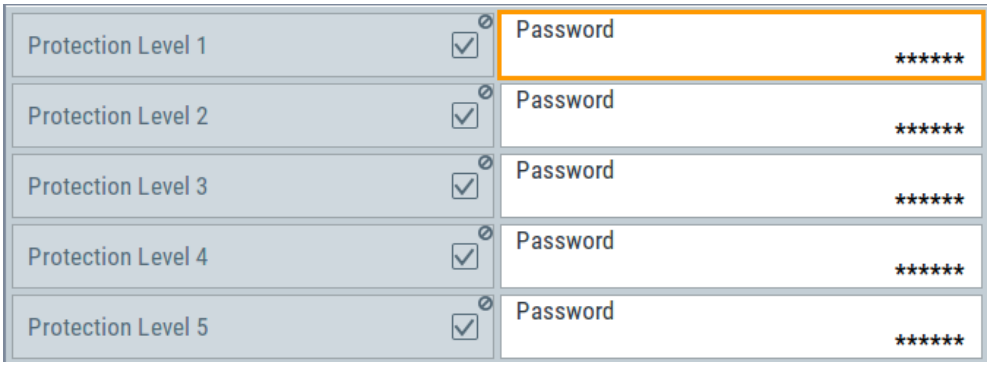
- **General** security parameters, such as:
  - **USB storage** that secures controlled access to the mass memory of the instrument
  - **Volatile mode** that prevents information to be written to the internal memory permanently.
  - **Sanitizing** that prevents the instrument from leaving a secure environment with stored user information.
  - **Annotation** frequency and amplitude prevent reading the display.
- **Password** management secures controlled user access to the instrument
  With the two-step password concept, you can assign a user-defined password for the operating system, and a security password for accessing the mass storage of the instrument.
  See Section 12.6.4, "Password management", on page 500.
- **LAN services** secure controlled network access
  You can individually lock and unlock supported LAN interface services, including the SMB client and SMB server that use versions 1.0 and 2.0 of the SMB protocol. Remote control over LAN requires you have enabled the interface, but you can disable not needed LAN services individually.
  Note: Disabling LAN services needed for remote control over LAN locks the instrument access persistently. You cannot address the instrument any longer.
  See Section 12.6.3, "Configuring LAN services", on page 496.
- **User interface** prevents front panel operation and/or reading the display.

For more information, see the document R&S SMCV100B Instrument Security Procedures.

12.6.1 Protection level settings

Access:

► Select "System Config > Setup > Security > Protection".



The "Protection" dialog provides access to the unlocking of different protection levels.

Several functions in the instrument are password-protected to prevent for example accidental changes, "Protection" on page 490.

The remote commands required to unlock a protected stage are described in Section 14.17, "SYSTem subsystem", on page 825.

Protection Level/Password
Unlocks the selected level of protection, if you enter the correct password.

The default protection level 1 password is 123456.

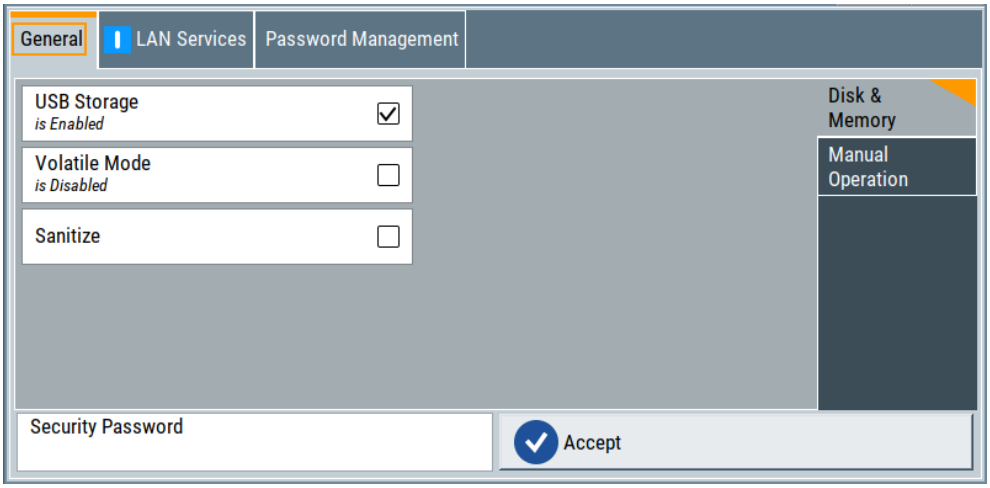
To lock the protection level again, clear the checkbox.

Remote command:
`:SYSTem:PROTect<ch>[:STATe]` on page 836

12.6.2 Setting security parameters

Access:

► Select "System Config > Setup > Security > Security > General".



In the "General" tab, you can determine the security level for firmware updates, and configure the security settings for the mass memory and manual operation.

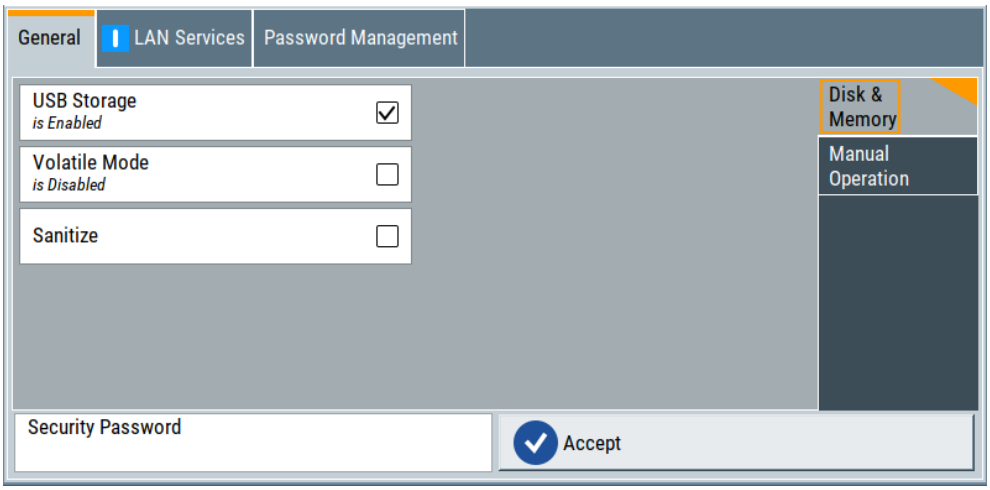
All modified settings in this dialog are not applied until you enter the Security Password and confirm with Accept.

12.6.2.1 Disk & memory security settings

Access:

1. Select "System Config > Setup > Security > Security".

2. Select "General > Disk & Memory".



The "Disk & Memory" tab secures controlled access to the mass memory and prevents information from leaving a secure environment.

The remote commands available to control security settings are described in Section 14.17, "SYSTem subsystem", on page 825.

USB Storage
Activates the access to external USB storage media.

To apply the change: enter the security password and confirm with "Accept". Otherwise the change has no effect.

See Section 11.10.4, "Using a USB storage device for file transfer", on page 444.

Note: Remove all USB memory devices before disabling the USB storage. If any USB memory device remains connected, disabling is blocked, and the instrument returns a warning message.

Volatile Mode
Activates volatile mode, so that no user data can be written on the internal memory permanently.

In volatile mode:
- Data that the instrument normally stores on the internal memory is redirected to volatile memory.
- The user directory is mapped to the volatile memory. You access the temporary data just as data stored in the `/var/user/`, see Section 11.4, "Protecting data", on page 426.
- Data on the internal memory cannot be changed. It is protected against modification or erasure.
- You can only save data:
  – Temporarily in the volatile memory
  – On a connected external storage device, such as a memory stick

To activate volatile mode: enter the security password, confirm with "Accept" and reboot the instrument. Otherwise the change has no effect.

Activated volatile mode is indicated by the icon .

Remote command:
:SYSTem:SECurity:VOLMode[:STATe] on page 846

Sanitize
Executes the erase procedure that sanitizes the internal memory.

The sanitizing function makes sure that no user information is stored on the instrument when it leaves the secure environment.

To apply the change: enter the security password and confirm with "Accept". Otherwise the change has no effect.

Note: If the instrument is subject to high security, and you have disabled volatile mode, the internal memory holds user-data, and thus poses a security risk.

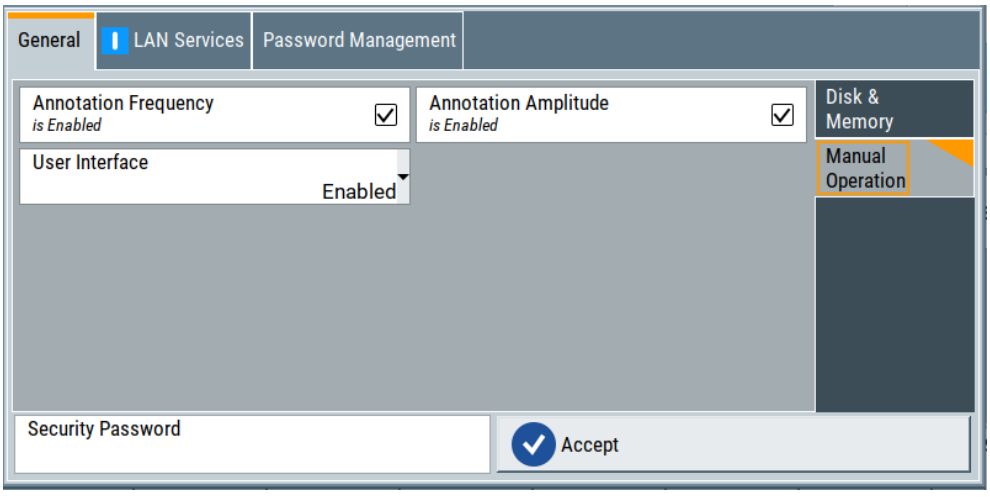
See also Section 12.6, "Using the security settings", on page 490 for more information on the security concept.

Remote command:
:SYSTem:SECurity:SANitize[:STATe] on page 845

12.6.2.2 Manual operation security settings

Access:

1. Select "System Config > Setup > Security > Security".
2. Select "General > Manual Operation".



The "SW Update" tab enables you to lock front panel operation and/or reading the display.

The remote commands available to control security settings are described in:

- Section 14.9, "DISPlay subsystem", on page 617
- Section 14.17, "SYSTem subsystem", on page 825.

Annotation Frequency
Enables the display of the currently used frequency in the status bar.

How to: see "To disable frequency and level indication in the status bar" on page 506.

Remote command:
:DISPlay:ANNotation:FREQuency on page 619

Annotation Amplitude
Enables the display of the currently selected level in the status bar.

How to: see "To disable frequency and level indication in the status bar" on page 506.

Remote command:
:DISPlay:ANNotation:AMPLitude on page 619

User Interface
Allows you to lock the controls for manual operation and the display individually.

How to: see "To disable the user interface" on page 506.

See also Section 12.6, "Using the security settings", on page 490.

"Enabled" Enables the display and all controls for the manual operation of the instrument.

"Touchscreen Off"
Locks the touch sensitivity of the screen.
This security feature protects the instrument against unintentional change of settings by accidentally touching of the screen.

Still available controls for manual operation are:
- The keys at the front panel, including the rotary knob
- The external mouse and keyboard
- Remote operation over VNC

The instrument indicates the locked touchscreen by an icon .
Unlocking is possible via VNC, external controls or remote control.

"VNC Only" Locks the keys at the front panel, the touchscreen and externally connected keyboard and mouse.
The display on the screen remains and shows the current settings and changes.
The instrument indicates the activated "VNC only" feature by the icon .
Unlocking is possible via VNC or turning off and on again.

"Display Only" Locks the manual operation of the instrument. The display on the screen remains and shows the current settings and changes.
This security feature protects the instrument against unauthorized access, but still shows the current settings and processes, for example when you operate the instrument via remote control.

The function disables:
- The touchscreen functionality of the display
- The keys at the front panel of the instrument
- The external mouse and keyboard

The instrument indicates the locked controls by a padlock softkey.
How to unlock: see "Unlocking (reactivating) the user interface for manual operation" on page 506.

"Disabled" Locks the display and all controls for the manual operation of the instrument.
This security feature protects the instrument against unauthorized reading and access, for example when you operate the instrument via remote control.

The function disables:
- The display
- The touchscreen
- The keys at the front panel of the instrument
- The external mouse and keyboard

The screen shuts off and displays a padlock symbol instead.
How to unlock: see "Unlocking (reactivating) the user interface for manual operation" on page 506.

Remote command:
:SYSTem:ULOCk on page 834
:SYSTem:DLOCk on page 833
:SYSTem:KLOCk on page 833

Enabling a locked user interface for manual operation
Follow the instructions listed in "Unlocking (reactivating) the user interface for manual operation" on page 506.

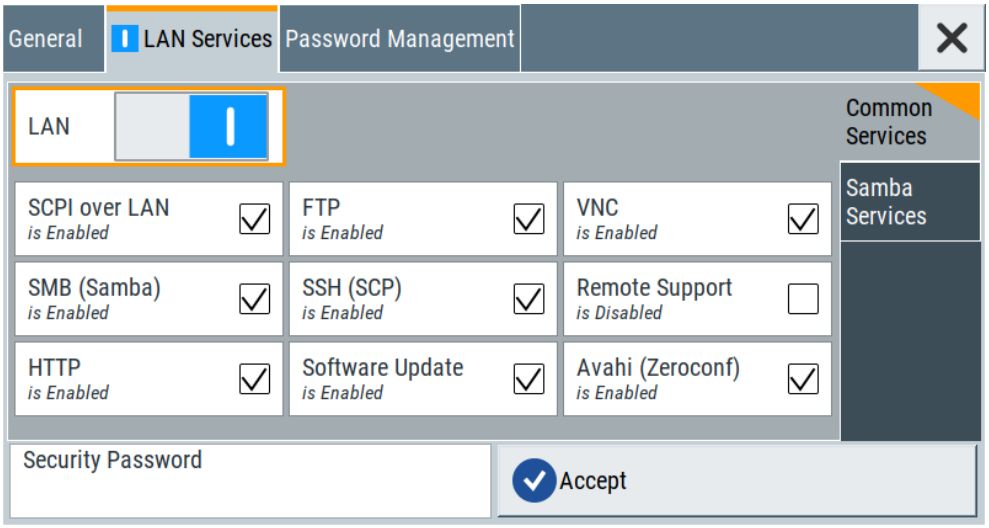
Remote command:
:SYSTem:ULOCk on page 834
:SYSTem:DLOCk on page 833
:SYSTem:KLOCk on page 833

12.6.3 Configuring LAN services

Access:

1. Select "System Config > Setup > Security > Security > LAN Services > Common Services".
2. **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or the common services "SCPI over LAN", "VNC" and "HTTP" locks the remote access to the instrument.

   Do not disable the LAN interface or LAN services needed for remote control while you operate the instrument remotely.
   Proceed with step step 4 for troubleshooting disabled services.

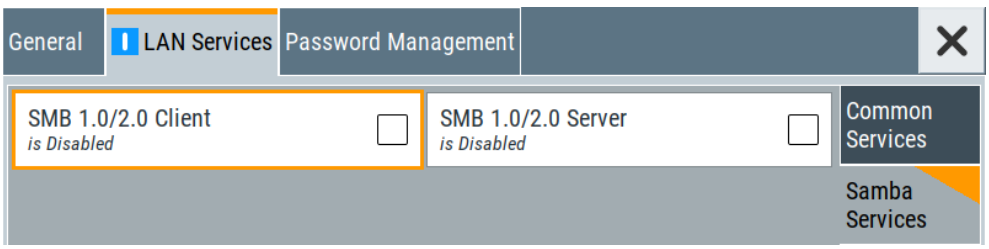


In the "Common Services" side tab, you can individually disable the supported services of the LAN interface.

3. Disable LAN services as needed.
   a) Disable the service.
   b) To confirm disabling, enter the security password.
   c) Select "Accept".

4. If you have locked the access accidentally, you have the following options:
   - Update the instrument firmware using ISO image (`<instrument>_<version-number>.iso`).
     Note: A firmware update with the ISO image resets the instrument. The instrument reset dismisses user-specific configurations and deletes user data. Contact the Rohde & Schwarz (https://www.rohde-schwarz.com/support) to get the ISO image.
   - Ship the instrument to your local service department. The service center experts can enable the remote access over LAN without loosing user-specific settings and data.
     See www.services.rohde-schwarz.com.

5. Select "System Config > Setup > Security > Security > LAN Services > Samba Services".



In the "Samba Services" side tab, you can activate former versions of the SMB client and SMB server.

The remote commands available to control security settings are described in Section 14.17, "SYSTem subsystem", on page 825.

How to:

- "To disable LAN access in general" on page 504
- "To disable LAN services individually" on page 504
- "To enable SMB version 1.0/2.0 client and server" on page 505

Common Services....498
└ LAN....498
└ LAN Services....498
Samba Services....499
└ SMB 1.0/2.0 Client....499
└ SMB 1.0/2.0 Server....500
Security Password....500
Accept....500

Common Services
Enables the LAN interface and supported LAN interface services.

LAN ← Common Services
Enables the LAN interface in general, and thus provides remote access over all unlocked services.

Remote command:
`:SYSTem:SECurity:NETWork[:STATe]` on page 845

LAN Services ← Common Services
Enables the supported LAN interface services individually.

"SCPI over LAN"
Access over LAN to control the instrument remotely, by using SCPI (Standard Commands for Programmable Instruments) commands.
See also "To set up the controller with R&S VISA" on page 554 and "To start remote control with R&S VISA" on page 557

Remote command:
`:SYSTem:SECurity:NETWork:SOE[:STATe]` on page 844

"VNC"
Access over VNC (Virtual Network Computing) interface, a graphical desktop sharing system that uses RFB protocol to control the instrument remotely.
See also Section 13.12, "To operate the instrument using VNC", on page 573.

Remote command:
`:SYSTem:SECurity:NETWork:VNC[:STATe]` on page 845

"SSH (SCP)" Access over SSH (Secure Shell), a network protocol for secure data communication.

Remote command:
:SYSTem:SECurity:NETWork:SSH[:STATe] on page 844

"Remote Support"
Remote support over SSH (SCP).
The service provides communication for service purposes only.

Remote command:
:SYSTem:SECurity:NETWork:REMSupport[:STATe]
on page 843

"HTTP" Access with HTTP (Hyper Text Transfer Protocol), the application protocol for hypermedia information systems.

Remote command:
:SYSTem:SECurity:NETWork:HTTP[:STATe] on page 843

"FTP" Access with FTP (File Transfer Protocol), used to transfer files from a host to the instrument and vice versa.
See also Section 11.10.2, "Accessing the file system using FTP", on page 442.

Remote command:
:SYSTem:SECurity:NETWork:FTP[:STATe] on page 842

"SMB (Samba)"
Access to SMB (Server Message Block), used for providing shared access to files, printers and serial ports of a network.
See also Section 11.10.3, "Accessing the R&S SMCV100B file system using SMB (Samba)", on page 443.

Remote command:
:SYSTem:SECurity:NETWork:SMB[:STATe] on page 844

"Avahi (Zeroconf)"
Avahi, a service for automatic configuration of the instrument in a network environment.

Remote command:
:SYSTem:SECurity:NETWork:AVAHi[:STATe] on page 842

"Software Update"
Allows updating the software.

Remote command:
:SYSTem:SECurity:NETWork:SWUPdate[:STATe] on page 845

Samba Services
Enables support of SMB client and SMB server version 1.0 and 2.0 of the SMB protocol.

Support of version 1.0 and 2.0 is additional to the current SMB protocol version supported in the firmware. This firmware supports SMB protocol up to version 3.1.1.

SMB 1.0/2.0 Client ← Samba Services
Enables support of the SMB client compatible with SMB protocol versions 1.0 and 2.0.

SMB 1.0/2.0 Server ← Samba Services
Enables support of the SMB server compatible with SMB protocol versions 1.0 and 2.0.

Security Password
Enters the password that is required to enable or to disable the settings protected by a security password. Default is *123456*.

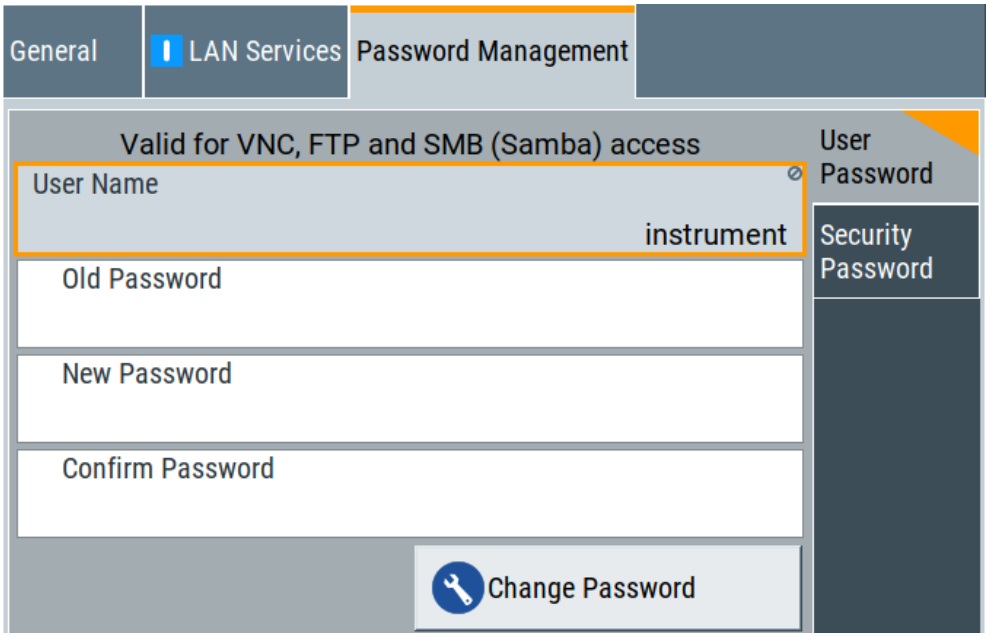
How to: "To change the security password" on page 503

Accept
Applies the modified settings, provided the security password is entered and correct.

12.6.4 Password management

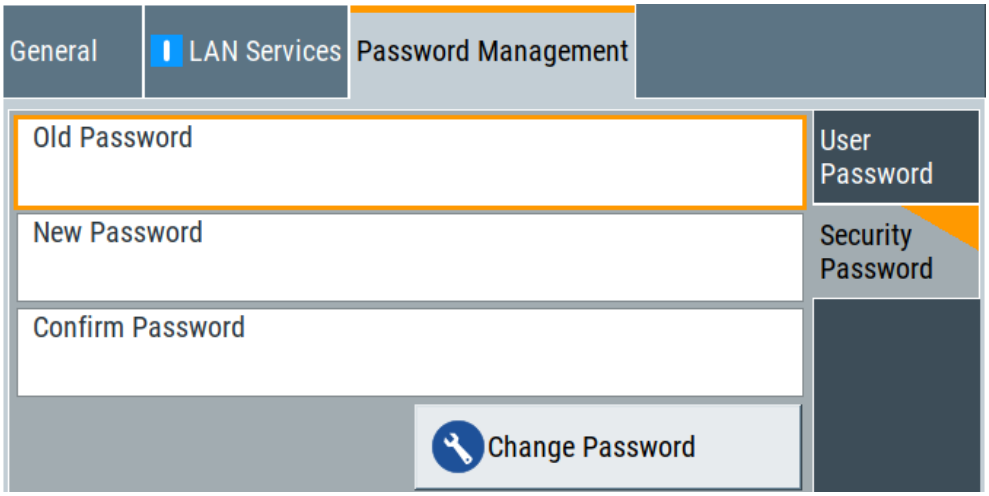
Access:

1. Select "System Config > Setup > Security > Security > Password Management > User Password".



   In this tab, you can assign the security and a user-defined password.

2. Select "System Config > Setup > Security > Security > Password Management > Security Password".



How to:

- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

Settings:

User Name....501
User Password....501
└ Old Password....501
└ New Password....502
└ Confirm Password....502
└ Change Password....502
Security Password....502
└ Old Password....502
└ New Password....502
└ Confirm Password....502
└ Change Password....503

User Name
Indicates the user name used for access to the Linux operating system and valid for VNC, FTP and SMB (Samba) access.

User Password
Access: select "System Config > Setup > Security > Security > Password Management > User Password".

Allows you to change and confirm the user password.

Old Password ← User Password
Enters the current user password. The default password is "instrument".

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:

- "To change the user password of the instrument" on page 503.

- "To change the security password" on page 503.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Section 15.10, "Contacting customer support", on page 876.

New Password ← User Password
Enters the new user password.

The security password can contain decimal characters only.

Confirm Password ← User Password
Confirms the new user password by repeating.

How to:
- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

Change Password ← User Password
Changes the user password accordingly.

Security Password
Access: select "System Config > Setup > Security > Security > Password Management > Security Password".

Enables you to change and confirm the security password.

Old Password ← Security Password
Enters the currently used security password. The default password is '123456'.

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

The security password is required when changing the status of the USB and LAN interface or other security settings.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Section 15.10, "Contacting customer support", on page 876.

New Password ← Security Password
Enters the new security password.

The security password can contain decimal characters only.

Confirm Password ← Security Password
Confirms the new security password by repeating.

How to:
- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

Change Password ← Security Password
Changes the password accordingly.

12.6.5 Preventing unauthorized access

The default computer name and user password are *instrument*. The user password is the password required for VNC, FTP and SMB (samba) connections. If for example, the VNC service or FTP are enabled, anyone in the network who knows the computer name and user password of the instrument can access it.

The default security password is *123456*. The security password is required when changing the status of the USB and LAN interfaces.

To prevent unauthorized access, use the following configurations exclusively or complementary:

- "To change the user password of the instrument" on page 503
- "To change the security password" on page 503
- "To disable LAN access in general" on page 504
- "To disable LAN services individually" on page 504
- "To enable SMB version 1.0/2.0 client and server" on page 505
- "To disable frequency and level indication in the status bar" on page 506
- "To disable the user interface" on page 506

If security is a concern, see the document instrument security procedures for comprehensive description.

To change the user password of the instrument

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

a) Select "System Config > Setup > Security > Security > Password Management > User Password".
b) Enter the current password in the "Old Password" field.
c) Enter the new password in the "New Password" and "Confirm Password" fields.
d) Select "Change Password".

The user password is changed; the user name is displayed ("Security > Password Management > User Password > User Name").

To change the security password

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 503.

- "To change the security password" on page 503.

a) Select "System Config > Setup > Security > Security > Password Management > Security Password".
b) Enter the current password in the "Old Password" field.
The default password is *123456*.
c) Enter the new password in the "New Password" and "Confirm Password" fields.
d) Select "Change Password".

To disable LAN access in general

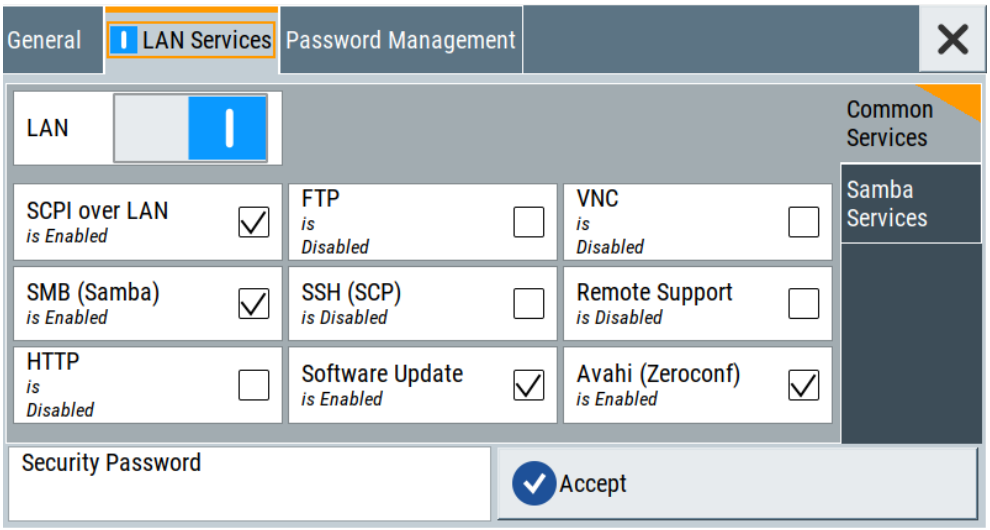
1. **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or certain services lock the remote access to the instrument.
The following services lock the remote access when disabled: "LAN", "SCPI over LAN", "VNC" and "HTTP".

   If you have locked the access accidentally, you have the following options:
   - Update the instrument firmware using ISO image (`<instrument>_<version-number>.iso`).
     Note: A firmware update with the ISO image resets the instrument. The instrument reset dismisses user-specific configurations and deletes user data.
     Contact the Rohde & Schwarz (https://www.rohde-schwarz.com/support) to get the ISO image.
   - Ship the instrument to your local service department. The service center experts can enable the remote access over LAN without loosing user-specific settings and data.
     See www.services.rohde-schwarz.com.
2. Select "System Config > Setup > Security > Security".
3. Select "LAN Services > Common Services".
4. Disable "LAN" state.
5. Enter the Security Password.
6. Select "Accept".

   All LAN connections are blocked, including the LAN services. Communication over LAN is not possible.

To disable LAN services individually

1. Select "System Config > Setup > Security > Security".
2. Select "LAN Services > Common Services".
3. Uncheck all services you want to block, for example "FTP > Off" or "VNC > Off".



4. Uncheck the services you want to block, for example "FTP" and "VNC".
5. Enable "LAN" state, if disabled.
6. Enter the Security Password.
7. Select "Accept".

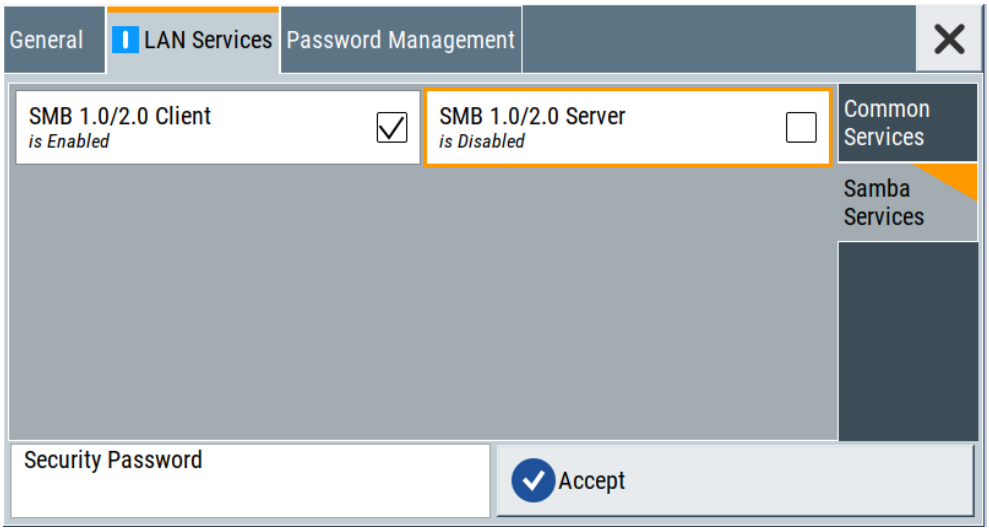
   Communication over LAN is possible for the enabled services only.

To enable SMB version 1.0/2.0 client and server

By default, support of SMB client and SMB server of the SMB protocol versions 1.0 and 2.0 is disabled.

Activate support only, if needed:

1. Select "System Config > Setup > Security > Security".
2. Select "LAN Services > Samba Services".



3. For example, check "SMB 1.0/2.0 Client".
4. Select "SMB 1.0/2.0 Client > On" and "SMB 1.0/2.0 Server > On".
5. Enter the Security Password.
6. Select "Accept".

   Enables the access for the SMB Samba client, the access for the SMB Samba server remains blocked.

To disable frequency and level indication in the status bar

These settings are useful to prevent unauthorized personnel from reading the display, when you remotely control the instrument from a different location.

1. Select "System Config > Setup > Security > General > Manual Operation".
2. Select "Annotation Frequency > Off" or "Annotation Amplitude > Off".
3. Enter the Security Password.
4. Select "Accept".

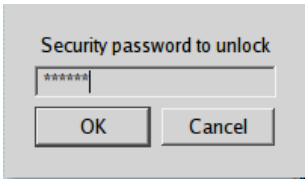
To disable the user interface

1. Select "System Config > Setup > Security > General > Manual Operation".
2. Select "User Interface > Disabled".
3. Enter the Security Password.
4. Select "Accept".

   The screen shuts off and displays a padlock symbol instead.
   There are further possible configurations. For details, see "User Interface" on page 495.

Unlocking (reactivating) the user interface for manual operation

1. In manual operation:
   a) On the instrument's keypad or external keyboard, press any key.
   The instrument prompts you to enter the security password for unlocking.

   If you press the character of the first key, the input field accepts the character immediately.
   b) Delete the entry before inserting the password.
   Enter the security password *123456*.
2. In remote control mode:

a) Send the command `SYST:ULOC ENABled` to release all locks at once.
b) Send the command `SYST:KLOC OFF` to unlock the keyboard and touchscreen.
c) Send the command `SYST:DLOC OFF` to release all locks.

Via remote control, there is no password required.

12.7 Undoing or restoring actions

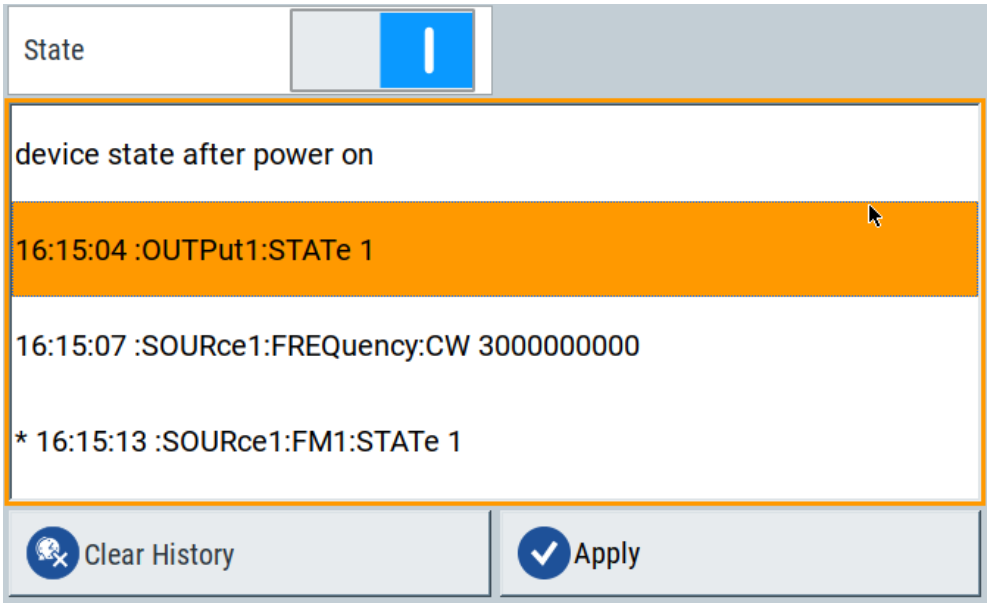
"Undo" is a function that removes the effect of the last action on the instrument and reverts it to an older state. Conversely, "Redo" restores a previously undone action.

You can "Undo/Redo" actions according to two criteria:

- Step by step
  Gradually undo/redo the actions in reverse order as previously performed. Depending on the available memory the "Undo/Redo" steps may restore all actions.
- Multiple steps at once
  Select any specific action in the history list to "Undo/Redo" multiple actions in a single step.
  Note: This mode requires a system restoration file on the instrument.

Access:

► Select "Setup > Settings > Undo/Redo".



The dialog contains all functions for enabling the "Undo/Redo" functionality.

Settings:

State....508
History List....508
Clear History....508
Apply....508

State
Enables the recording of the performed actions.

History List
Lists the performed actions, provided "Undo/Redo" state is "On".

Clear History
Deletes the recorded list of the performed steps.

Apply
Performs the "Undo/Redo".

If you select a previously performed action of the list, all subsequent actions are undone. The list entries remain.

If you select a subsequently executed action, you can restore all the actions undone up to this state.

12.8 Shutting down and rebooting the instrument

On the front panel, the [On/Standby] key switches the instrument from the standby to the ready state or vice versa. In remote operation from a remote computer or in manual control, there is another possibility to shut down the instrument or to reboot the system.

Access:

► Select "System Config > Setup > Maintenance > Shut down".



Remote control commands:

- `:SYSTem:REBoot` on page 852
- `:SYSTem:SHUTdown` on page 853

13 Network operation and remote control

As an alternative to the interactive operation directly at the instrument, you can operate the R&S SMCV100B also from a remote location.

The various interfaces provide flexible access to the instrument, such as *remote control*, *remote operation* or *remote file access*. These remote access modes are fundamentally different, although they are often considered interchangeable, as described in Overview of remote access modes.

Figure 13-1 shows the possibilities of the physical connection (interfaces) for remote access.

The following descriptions provide information required for operating the R&S SMCV100B 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

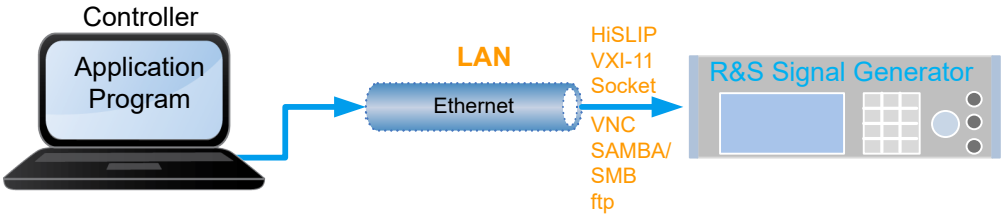


Figure 13-1: Supported remote connections

- Overview of remote access modes 510
- Remote control interfaces and protocols 511
- Remote control programs and libraries 514
- Status reporting system 517
- Remote access settings 520
- LXI settings 541
- To configure the instrument for remote access 548
- To establish a remote control session over LAN 553
- To trace messages with the LXI web browser interface 560
- To return to manual operation 561
- To automate tasks with remote command scripts 561
- To operate the instrument using VNC 573
- References 579

13.1 Overview of remote access modes

This section outlines the possible access modes and their major characteristics.

Remote control (SCPI)

- A remote PC controls the instrument, usually via VISA (Virtual Instrument Software Architecture) interfaces.
- Remote control disables the manual operation of the instrument; you can set different lock states.
- The GUI is not visible.
- Remote control commands (SCPI) perform the settings, either individually or in sequences (SCPI programs).
- Using SCPI programs is faster than the manual operation, since they automate repeating applications.

Remote operation (VNC)

- A remote device accesses the instrument via the common platform technology VNC (Virtual Network Computing).
- The protocol allows simultaneous operation from several remote devices and the instrument nevertheless remains locally operable.
- The GUI is visible.
- To perform the settings, you can operate the instrument as with the manual control.
- During remote operation via VNC, the direct control of the instrument is not disabled.
  You can control the instrument from the front panel and via the remote computer alternately.
- Clients supporting remote operation depend on the used remote device, see Table 13-1.
- How to: see Section 13.12, "To operate the instrument using VNC", on page 573.

Table 13-1: Supported VNC operation modes

Remote device	VNC client	Requirements	Characteristics
Desktop (Windows, Linux, Mac™OS)	• Ultr@VNC • Other dedicated client software	*Ultr@VNC or Client Software* must be installed.	Fast, supports several options like full screen mode or auto-login.
	• Any web browser	*Java Runtime* must be installed and activated in the browser settings.	Fast and convenient - only the instrument address required. Java runtime is sometimes considered as security concern.
	• Web browser with HTML5	*Web sockets* must be supported.	Slower than the other modes. No additional installation or activation required. No security concern.

Remote device	VNC client	Requirements	Characteristics
Smart device (Tablet/ smartphone)	• Dedicated client App	*App* must be installed.	Fast, supports several options like full screen mode or auto-login.
	• Web browser with HTML5	*Web sockets* must be supported.	Support of QR code scanning Slower than a dedicated App.

Remote file access (FTP, SAMBA/SMB)

- A remote client accesses the instrument's file system, using the protocols FTP (file transfer protocol) and SAMBA/SMB (server message block).
- The protocols enable you to transfer files from or to the instrument and to get direct access to its file sharing directory `share`.

How to:

Section 11.10.2, "Accessing the file system using FTP", on page 442.

Section 11.10.3, "Accessing the R&S SMCV100B file system using SMB (Samba)", on page 443

"To enable SMB version 1.0/2.0 client and server" on page 505

13.2 Remote control interfaces and protocols

The instrument supports various interfaces for remote control. Table 13-2 gives an overview on the connectivity:

Table 13-2: Remote control interfaces and protocols

Interface	Protocols, VISA*) address string and library	Remarks

Local area network (LAN)	• **HiSLIP** High-Speed LAN Instrument Protocol (IVI-6.1)
	`TCPIP::host address::hislip0[::INSTR]`
	VISA
	• **VXI-11**
	`TCPIP::host address[::LAN device name][::INSTR]`
	VISA
	• **Socket communication** (Raw Ethernet, simple Telnet)
	`TCPIP::host address[::LAN device name]::<port>::SOCKET`
	VISA or socket controller
		The LAN connector is at the rear panel of the instrument.
		The interface is based on TCP/IP, see Section 13.2.1, "LAN interface", on page 512 for details on the address information.

*) VISA (Virtual Instrument Software Architecture) is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is prerequisite for remote control over LAN (when using VXI-11 or HiSLIP protocol). With socket communication, VISA installation is optional. For basic information, see Remote control via SCPI.		

www.rohde-schwarz.com/rsvisa provides the standardized I/O software library R&S VISA for download at the Rohde & Schwarz website www.rohde-schwarz.com/rsvisa.

How to: Section 13.8, "To establish a remote control session over LAN", on page 553 describes how to configure the remote control interfaces.

- LAN interface 512
- LXI browser interface 513

13.2.1 LAN interface

The LAN interface of the instrument consists of a connector, a network interface card and protocols.

For remote control, the instrument and the controller PC must be connected to a common network with TCP/IP network protocol.

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

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

How to: Section 3.1.7, "Connecting to LAN", on page 27

Identifying instruments in a network

If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by the resource string.

VISA resource strings

The VISA resource string is required to establish a communication session between the controller and the instrument in the LAN. The resource string is a unique identifier, composed of the specific IP address of the instrument and some network and VISA-specific keywords.

TCPIP::<host address>[::<LAN device name>][::INSTR]

TCPIP	= designates the network protocol
host address	= designates the IP address or hostname of the instrument
[::LAN device name]	= defines the protocol and the instance number of a subinstrument
[::INSTR]	= indicates the instrument resource class (optional)

The **IP address** (host address/computer name) is used by the programs to identify and control the instrument. It is automatically assigned by the DHCP server the first time the device is registered in the network. Optionally, you can also assign its **LAN device name**.

If assigned, the IP address is displayed in the block diagram.

The following section lists the characteristics of the VISA resource strings for the corresponding interface protocols. The emphasized characters determine the protocol.

For description of the interface protocols, control commands and messages, refer to Remote control via SCPI.

HiSLIP

TCPIP::<host address>::hislip0[::INSTR]

hislip0 = HiSLIP device name, designates that the interface protocol HiSLIP is used (mandatory)

hislip0 is composed of `[::HiSLIP device name[,HiSLIP port]]` and must be assigned.

Example:

```
TCPIP::192.1.2.3::hislip0
```

VXI-11

TCPIP::<host address>[::inst0][::INSTR]

[::inst0] = LAN device name, indicates that the VXI-11 protocol is used (optional)

inst0 currently selects the VXI-11 protocol by default and can be omitted.

Example:

```
TCPIP::192.1.2.3::INSTR
```

Socket communication

TCPIP::<host address>::<port>::SOCKET

port = determines the used port number
SOCKET = indicates the raw network socket resource class

Socket communication requires the specification of the port (commonly referred to as port number) and of "SOCKET" to complete the resource string.

Basically, instruments from Rohde & Schwarz use port number 5025 for socket communication.

Example:

```
TCPIP::192.1.2.3::5025::SOCKET
```

13.2.2 LXI browser interface

The LXI browser interface allows easy configuration of the LAN and remote control of the R&S SMCV100B without additional installation requirements. The instrument's LXI browser interface works correctly with all W3C compliant browsers.

See Section 13.13.1, "LXI functionality", on page 579 for more about LXI.

The LAN settings are configured using the instrument's LXI browser interface described in Section 13.6.2.1, "LAN configuration", on page 544.

For LXI status information in the R&S SMCV100B, see Section 13.6.1, "LXI status settings", on page 541.

13.3 Remote control programs and libraries

This section shows how the remote-control programs access the instrument, and the libraries they require for the corresponding interface protocols.

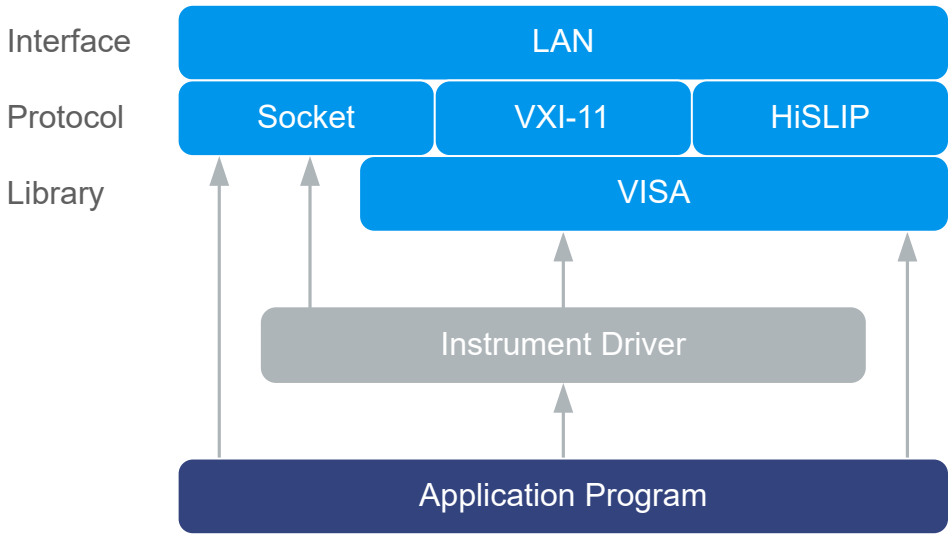


Figure 13-2: Overview of remote control interfaces, protocols and libraries

Possible setups and access functions

The following examples give an overview of dependencies between the available libraries, the possible interfaces and protocols, and whether an instrument driver is provided. For detailed information, see the application note 1GP72.

Example: Remote control (application) program using VISA

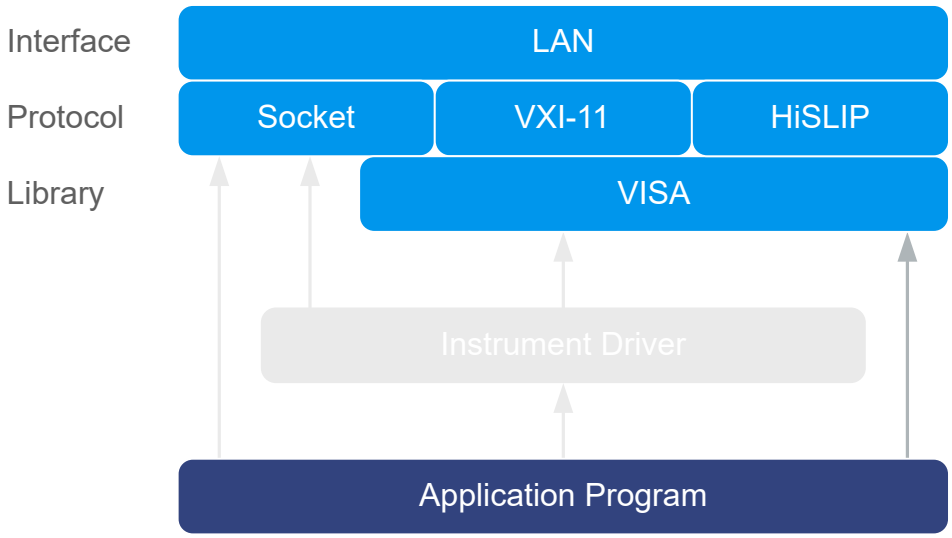


Figure 13-3: Application program using VISA

Protocol	Remote control program
Socket	`viOpen (..., "TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
VXI-11	`viOpen (..., "TCPIP:SMCV100B-102030::inst0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
HiSLIP	`viOpen (..., "TCPIP:SMCV100B-102030::hislip0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`

Example: Remote control program using instrument driver (VISA available)

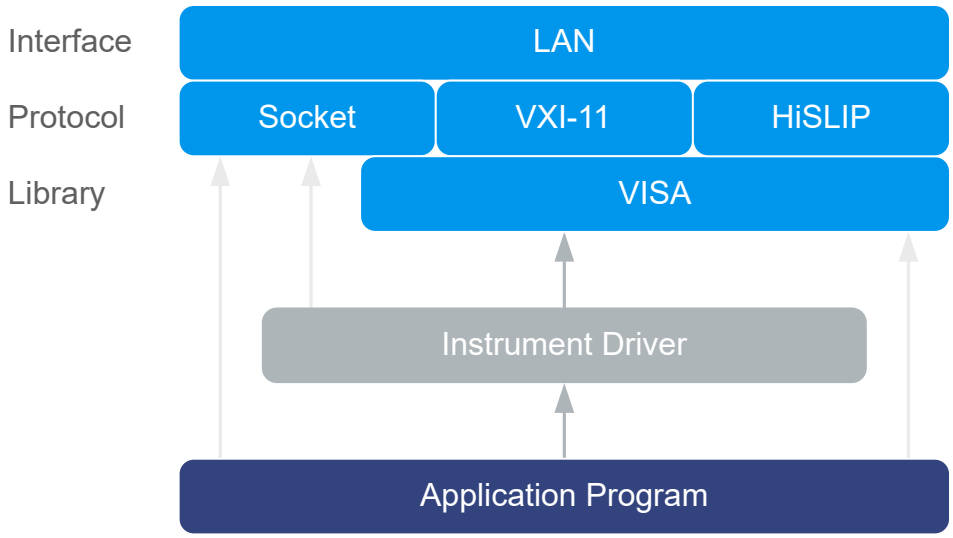


Figure 13-4: Application using instrument driver (VISA available)

Protocol	Remote control program
Socket	`rssmcv_init ("TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `rssmcv_SetFrequency (..., 2e9)`
VXI-11	`rssmcv_init ("TCPIP:SMCV100B-102030::inst0::INSTR", ...)` `rssmcv_SetFrequency (..., 2e9)`
HiSLIP	`rssmcv_init ("TCPIP:SMCV100B-102030::hislip0::INSTR", ...)` `rssmcv_SetFrequency (..., 2e9)`

Example: Remote control program using instrument driver (VISA not available)

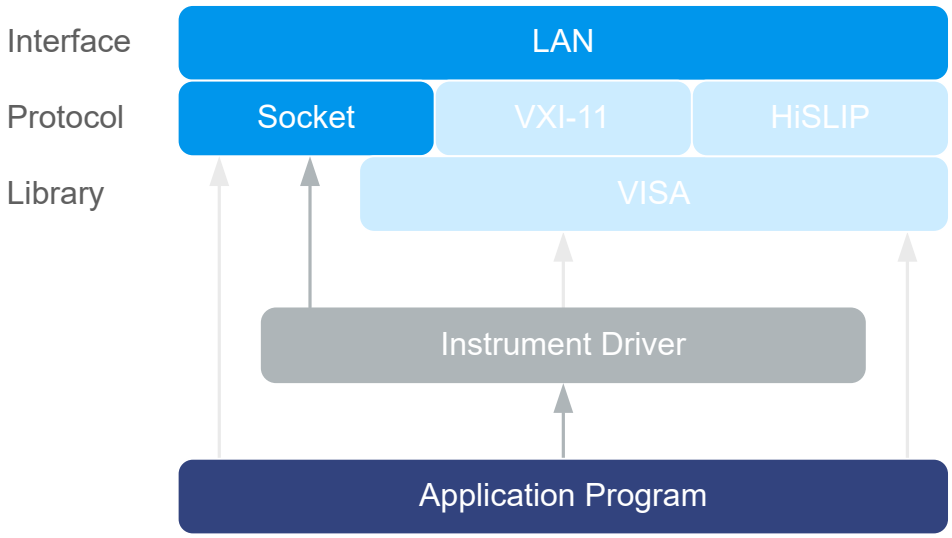


Figure 13-5: Remote control program using instrument driver (VISA not available)

Protocol	Remote control program
Socket	`rssmcv_init ("TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `rssmcv_SetFrequency (..., 2e9)`

13.4 Status reporting system

The status reporting system stores all information on the current operating state of the instrument and on errors which have occurred. This information is stored in the status registers and in the error queue. You can query the status of the registers with the remote commands of the Section 14.18, "STATus subsystem", on page 853.

13.4.1 Overview of the status registers

The Figure 13-6 shows the hierarchical structure of information in the status registers (ascending from left to right).

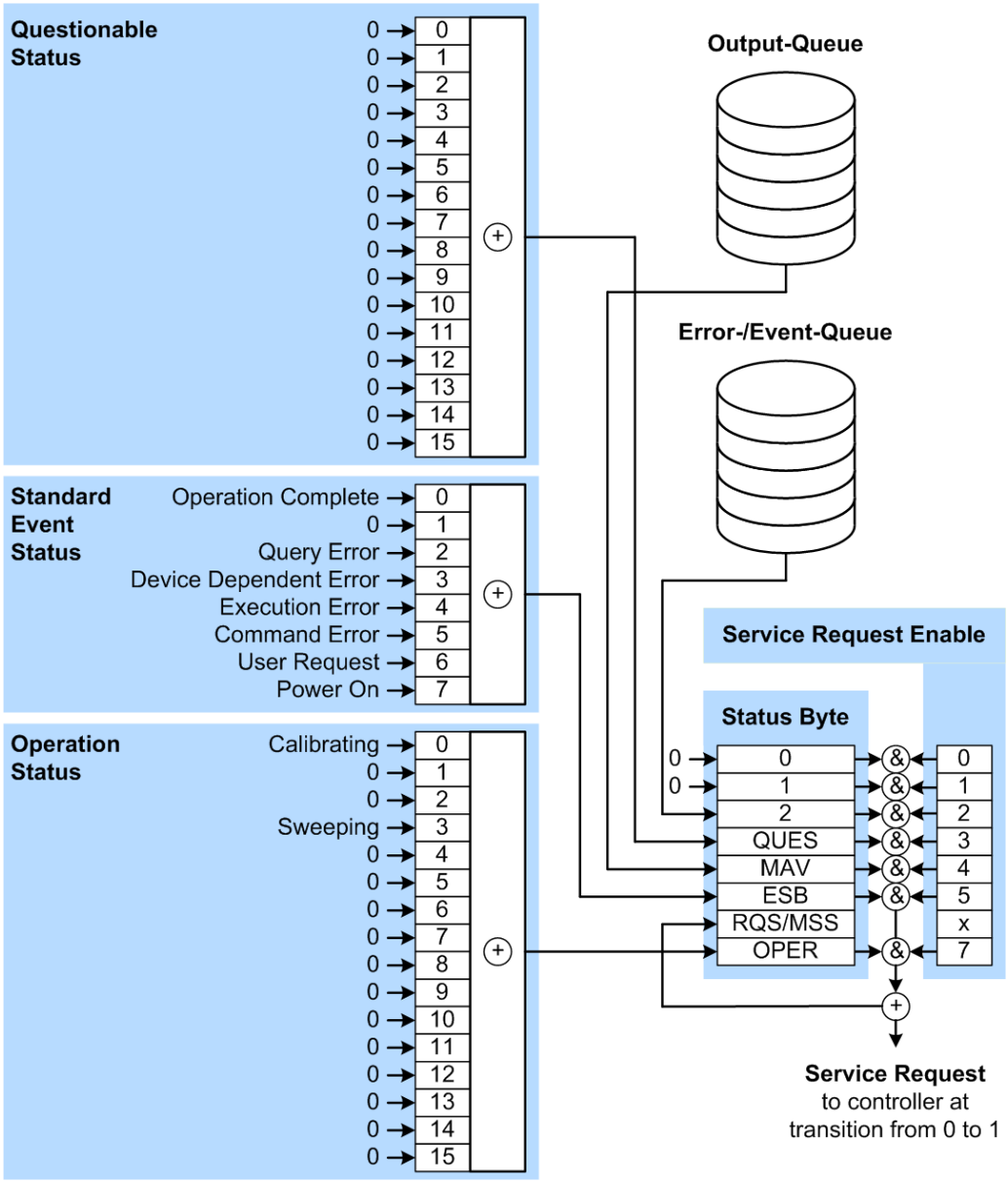


Figure 13-6: Graphical overview of the status registers hierarchy

OPER = Operation Status Summary Bit
RQS/MSS = Service Request Generation
ESB = Standard Event Status Summary Bit
MAV = Message Available in Output Queue
QUES = Questionable Status Summary Bit
2 = Error- /Event-Queue
1, 0 = not used

The following sections describe the instrument-specific bit assignments of the operation status and the questionable status registers.

For more information, see:

- Remote control via SCPI: provides general information on the status reporting system of Rohde & Schwarz instruments. This document also provides information on the standard event status register and the error queue.
- SCPI standard documentation for comprehensive information on the standard

13.4.2 Instrument-specific status operation register

The condition part contains information on currently executed actions. The event part covers information on the actions performed since the last readout of the register.

To read the register, use the query commands `:STATus:OPERation:CONDition?` on page 854 and `:STATus:OPERation[:EVENt]` on page 854.

The remote commands for the status questionable register are described in Section 14.18, "STATus subsystem", on page 853.

Table 13-3: Assignment of the bits used in the operation status register

Bit No.	Meaning
0	Calibrating The bit is set during the calibration phase.
1–2	Not used
3	Sweeping This bit is set during a sweep in automatic or single mode.
4–15	Not used

13.4.3 Instrument-specific status questionable register

This status register contains information on questionable instrument states. Questionable states occur when the instrument is not operated in compliance with its specifications.

To read the register, use the query commands `:STATus:QUEStionable:CONDition` on page 855 or `:STATus:QUEStionable[:EVENt]` on page 856.

The remote commands for the status questionable register are described in Section 14.18, "STATus subsystem", on page 853.

Table 13-4: Assignment of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

13.4.4 Reset values of the status reporting system

The following table contains the different commands and events causing the status reporting system to be reset. None of the commands, except for `*RST` and `SYSTem:PRESet` affect the functional instrument settings. In particular, `DCL` does not change the instrument settings.

Table 13-5: Resetting the status reporting system

Event	**Switching on supply voltage** **Power-On-Status-Clear**		`DCL`, `SDC` **(Device Clear, Selected Device Clear)**	`*RST` **or** `SYSTem:PRESet`	`STATus:PRESet`	`*CLS`
Effect	**0**	**1**				
Clear STB, ESR	-	Yes	-	-	-	Yes
Clear SRE, ESE	-	Yes	-	-	-	-
Clear PPE	-	Yes	-	-	-	-
Clear error queue	Yes	Yes	-	-	-	Yes
Clear output buffer	Yes	Yes	Yes	1)	1)	1)
Clear command processing and input buffer	Yes	Yes	Yes	-	-	-
1) The first command in a command line that immediately follows a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.						

13.5 Remote access settings

This section outlines the settings required for accessing and configuring the provided remote control interfaces. It includes network settings, access addresses, emulation settings for using the command sets of other generators, and the access with smart devices.

About instrument emulations

You can remotely control the R&S SMCV100B using the command set of another signal generator. With this function you can, for example, replace a signal generator with an R&S SMCV100B in an automated test setup, without adjusting the command scripts used.

The R&S SMCV100B also covers command sets of Rohde & Schwarz signal generators, such as the R&S SFE and R&S SFE100. To achieve optimal compatibility when replacing an instrument, we recommend that you select the emulation command set for the corresponding signal generator.

You find the remote control command sets supported by the R&S SMCV100B in a selection list.

The selected instrument also defines the identification string that is retrieved with query `*IDN?`. If necessary, use the parameter Mode and IDN String to change this string.

As any other parameter, the remote control command set can also be changed remotely by the command `:SYSTem:LANGuage`.

While working in an emulation mode, the R&S SMCV100B specific command set is disabled and the SCPI command `:SYSTem:LANGuage` is discarded.

To return to the SCPI command set of the R&S SMCV100B, use the corresponding command of the selected command set.

If for example the R&S SFE/R&S SFE100 is emulated, the R&S SFE/R&S SFE100 command returns the corresponding R&S SMCV100B-specific command.

About health and utilization monitoring system (HUMS)

The R&S SMCV100B comes with a health and utilization monitoring system (HUMS) providing information about the R&S SMCV100B. Aim is to increase the overall utilization, to avoid downtime and to increase the overall security level of a fleet of instruments.

HUMS provides, for example, information about:

- Instrument identification, hardware components, software packages, licenses
- Usage of remote control, usage via keyboard / mouse, usage of test applications
- Hardware utilization and status, including S.M.A.R.T. data of the system drive
- User-defined static information, for example, an inventory code

Interfaces and protocols

The HUMS installation on the R&S SMCV100B includes an SNMP agent and a REST service with HTTP endpoints. So you can access the health and usage information via LAN, using the SNMP protocol or the REST protocol. Accessing the data does not interfere with remote control via SCPI commands or with measurement execution.

Reference information for both protocols is available on the R&S SMCV100B at the address *http://<instrument>/api/hums/v1/documents?name=<interface>*.

For *<instrument>*, enter the hostname (e.g. *SMCV100B-102030*) or the IP address (e.g. *10.121.0.34*) of your instrument, as for access to the GUI.

For *<interface>* = *snmp*, you get a `.zip` file containing the MIB files for SNMP. For *<interface>* = *rest*, you get a web page with the OpenAPI specification of the REST API.

Address example: *http://SMCV100B-102030/api/hums/v1/documents?name=snmp*.

The following table lists the REST endpoints and the SNMP MIB file names.

REST endpoint /api/hums/v1/...	SNMP MIB	Description	Typical data
documents	---	developer information	SNMP MIB files, swagger specification of HUMS REST endpoints
greetings	RS-GREETINGS-MIB	identity information	manufacturer, model, serial number, version
equipment/bios	RS-BIOS-INFO-MIB	BIOS information	BIOS manufacturer, version and release date
date-time	RS-TIME-DATE-MIB	time and date information	UTC and local time, timezone, dst (daylight savings time)
device-history	RS-DEVICE-HISTORY-MIB	history events	instrument-specific event information and notifications
device-tags	RS-DEVICE-TAGS-MIB	customer information	user-definable key information, associated with the instrument, e.g. asset number, owner, location
equipment	RS-EQUIPMENT-MIB	footprint information	hardware and software configuration, licenses
hums-info	RS-HUMS-INFO-MIB	basic information on the HUMS service	HUMS version, counter of SNMP and REST requests, amount of collected data, HUMS database size
storage	RS-STORAGE-MIB	S.M.A.R.T. data of drive	system drive temperature, drive health
system-info	RS-SYSTEM-INFO-MIB	a system overview	OS and BIOS version, IP address, locale
system-status	RS-SYSTEM-STATUS-MIB	system status information	global system status, static notifications
utilization	RS-UTILIZATION-MIB	utilization information	instrument activity, e.g., power on time, RF on time, option utilization, remote interface traffic

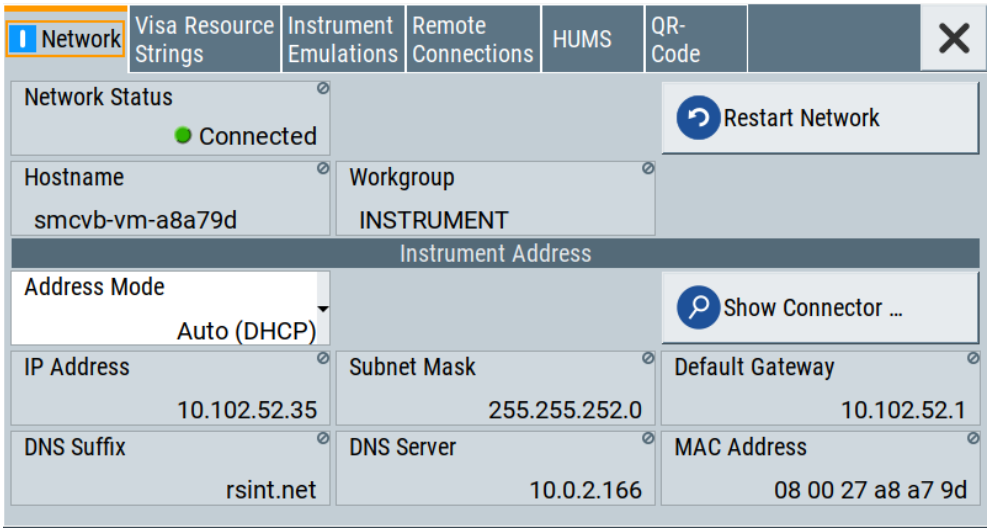
For detailed information about HUMS and its applications, refer to:

- The R&S®HUMS Health and Utilization Monitoring Service user manual, available on the Rohde & Schwarz website.
- The application note GFM336

13.5.1 Network settings

Access:

► Select "System Config" > "Remote Access" > "Network".



The "Network" dialog provides settings of the general network environment, and specific identification parameters of the instrument in the network. If necessary, you can configure the instrument address settings manually.
How to: "To assign the instrument address manually" on page 550.

The remote commands required to configure the network remotely are described in Section 14.17, "SYSTem subsystem", on page 825.

Settings:

Network Status....523
Restart Network....523
Hostname....524
Workgroup....524
Address Mode....524
IP Address....524
Subnet Mask....524
Default Gateway....525
DNS Suffix....525
DNS Server....525
MAC Address....525

Network Status
Indicates that the instrument is connected to the network.

Remote command:
`:SYSTem:COMMunicate:NETWork:STATus?` on page 838

Restart Network
Terminates the network connection of the instrument and sets it up again. You can use this function to fix network problems.

Note: This function restarts only the connection of the instrument to the network. It does not impact the network itself.

Remote command:
:SYSTem:COMMunicate:NETWork:RESTart on page 838

Hostname
Displays the hostname.

Each instrument is delivered with an assigned hostname, a logical name which can be used instead of the IP address. With the default network settings, the IP address is allocated by the DHCP server. This address can change each time the instrument is reconnected. Unlike the IP address, the hostname name does not change.

Note:
This function is password-protected. Unlock the protection level 1 to access it.

- We recommend that you do not change the default network settings or the hostname to avoid problems with the network connection.
  If you change the hostname, be sure to use a unique name.

Remote command:
:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname on page 838

Workgroup
Sets the individual windows workgroup name of the R&S SMCV100B. This parameter is required in case the instrument is integrated in a windows network.

This function is password-protected. Unlock the protection level 1 to access it.

Remote command:
:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup on page 839

Address Mode
Selects the mode for assigning the IP address.

"Auto (DHCP)"
Assigns the IP address automatically, provided the network supports DHCP (Dynamic Host Configuration Protocol).

"Static" Enables you to assign the IP address manually.

Remote command:
:SYSTem:COMMunicate:NETWork:IPADdress:MODE on page 837

IP Address
Displays the IP address of the instrument in the network.

To assign the IP address manually, see "To assign the instrument address manually" on page 550.

Remote command:
:SYSTem:COMMunicate:NETWork:IPADdress on page 837

Subnet Mask
Displays the bit group of the subnet in the host identifier.

The TCP/IP protocol is preinstalled with the subnet mask 255.255.255.0. If the DHCP server is available Address Mode A AUTO (DHCP), the setting is read-only. The subnet mask consists of four number blocks separated by dots. Each block contains 3 numbers in maximum (e.g. 100.100.100.100), but also one or two numbers are allowed in a block (as an example see the preinstalled address).

To assign the subnet mask manually, select Address Mode > Static.

Note: When assigning the subnet mask manually, make sure that the address matches with the subnet mask of the controlling host interface.

How to: "To assign the instrument address manually" on page 550.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 839

Default Gateway
Displays the gateway address.

This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

To assign the gateway address manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway` on page 839

DNS Suffix
Displays the primary DNS (Domain Name System) suffix, that means the DNS name without the hostname part.

The DNS system uses the suffix for registration and name resolution for unique identification of the instrument in the entire network.

To assign the DNS suffix manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain` on page 838

DNS Server
Determines the preferred server for name resolution. The DNS server contains the underlying numerical values that are required for name resolution of the hostname as part of the IP address.

To select the DNS server manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS` on page 839

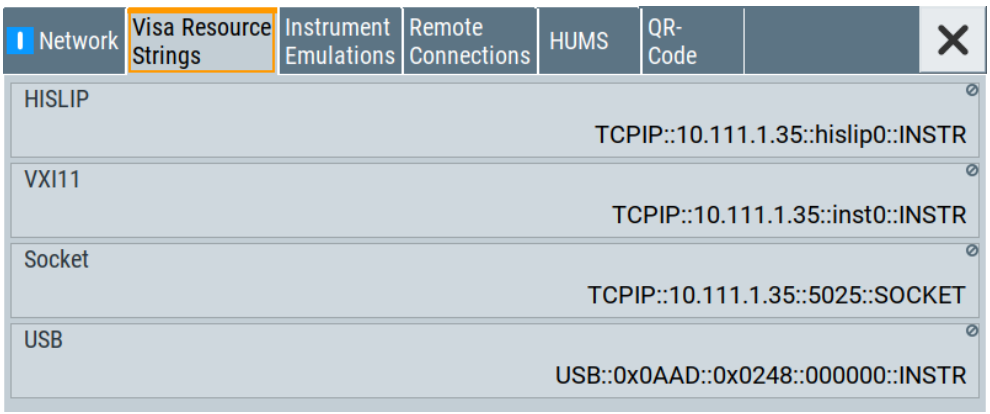
MAC Address
Indicates the MAC (Media Access Control) address, a unique identifier of the network adapter in the R&S SMCV100B.

Remote command:
`:SYSTem:COMMunicate:NETWork:MACaddress` on page 837

13.5.2 VISA resource strings

Access:

► Select "System Config > Remote Access > Visa Resource Strings".



The "Visa Resource String" dialog displays the VISA resource strings provided for remote control over the different interfaces.

The remote commands required to query the address information remotely are described in Section 14.17, "SYSTem subsystem", on page 825.

Settings:

HISLIP....526
VXI11....526
Socket....526

HISLIP
Displays the visa resource string for remote control with HiSLIP protocol.

See also Section 13.2.1, "LAN interface", on page 512.

Remote command:
`:SYSTem:COMMunicate:HISLip:RESource?` on page 836

VXI11
Displays the visa resource string for remote control over LAN.

See also Section 13.2.1, "LAN interface", on page 512.

Remote command:
`:SYSTem:COMMunicate:NETWork:RESource?` on page 837

Socket
Displays the visa resource string for remote control over LAN, using the socket communication protocol.

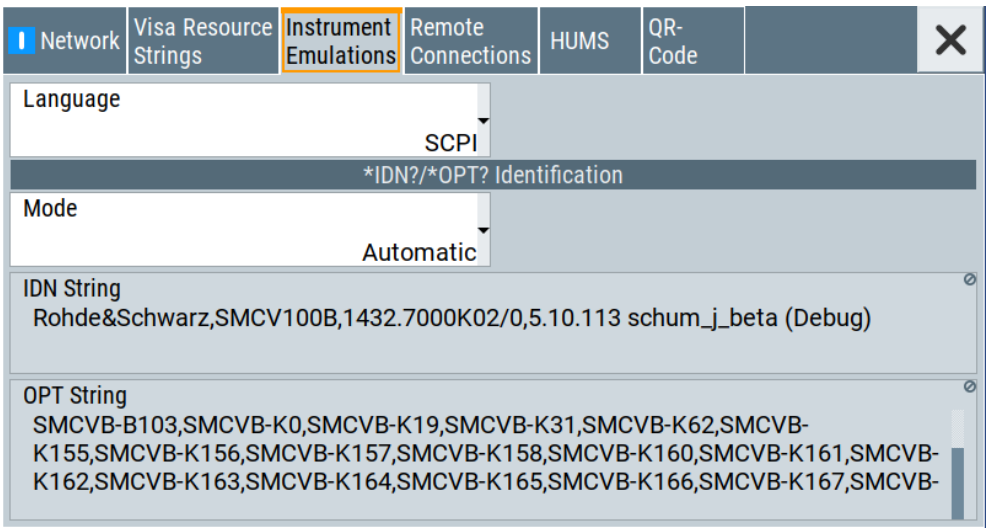
See also Section 13.2.1, "LAN interface", on page 512.

Remote command:
`:SYSTem:COMMunicate:SOCKet:RESource?` on page 839

13.5.3 Instrument emulations settings

Access:

► Select "System Config > Remote Access > Instrument Emulations".



The "Instrument Emulations" dialog enables you to emulate a remote control command set of another signal generator.

The remote commands required to configure the emulation settings remotely are described in Section 14.17, "SYSTem subsystem", on page 825.

Settings:

Language
Selects the instrument whose remote command set is emulated by the R&S SMCV100B.

Remote command:
`:SYSTem:LANGuage` on page 842

Mode
Selects the way the instrument identification is performed.

"Automatic" Sets the "IDN String" and the "OPT String" automatically for the instrument selected with the parameter Language.

"User Defined" Enables you to define the "IDN String" and the "OPT String".

Remote command:
`:SYSTem:IDENtification` on page 840

Set to Default
In "Mode > User Defined", resets the `*IDN` and `*OPT` strings.

Remote command:
`:SYSTem:IDENtification:PRESet` on page 841

IDN String
Indicates the identification string of the instrument when queried with the common command `*IDN?`.

In addition to the preset values, you can define your own identification string so that each generator uses an individual identification, like `My_SigGen` for instance, see Mode .

Remote command:
`*IDN?` on page 585
`:SYSTem:IRESponse` on page 841

OPT String
Indicates the option string of the instrument as queried with common command `*OPT?`.

In Mode > "User Defined", you can define your own option string. A query responds with this option string instead of the automatically created option string.

Remote command:
`*OPT?` on page 585
`:SYSTem:ORESponse` on page 841

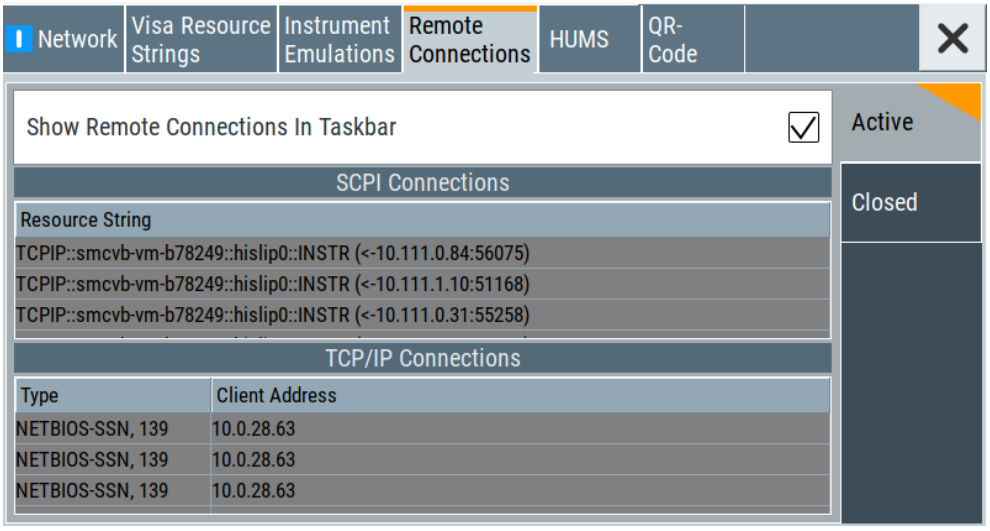
13.5.4 Remote connections settings

The "Remote Connections" dialog covers the active SCPI and TCP/IP connections, and a history list of the connections that have accessed the instrument before.

13.5.4.1 Active connections

Access:

► Select "System Config > Remote Access > Remote Connections > Active".



The "Active" tab shows the currently active remote connections, and you can enable the display of the active connections in the task bar.

Settings:

Show Remote Connections in Taskbar 529
SCPI Connections 529
TCP/IP Connections 529

Show Remote Connections in Taskbar
Displays the currently active connections in the taskbar.

SCPI Connections
Displays the VISA resources strings of the remote connections currently controlling the instrument via the LAN interface.

Remote command:
n.a.

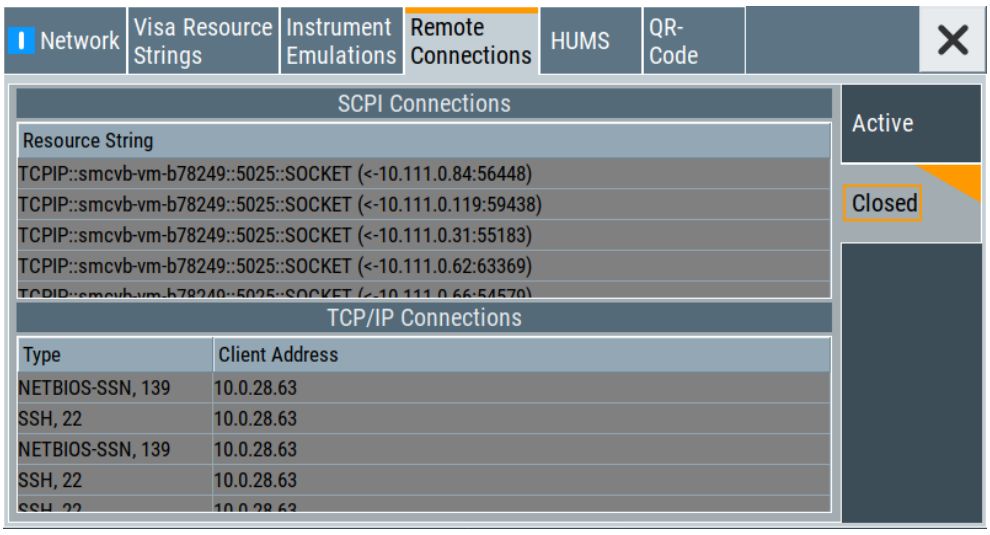
TCP/IP Connections
Displays the types and client addresses of the remote connections currently controlling the instrument via the LAN interface.

Remote command:
n.a.

13.5.4.2 Closed connections

Access:

► Select "System Config > Remote Access > Remote Connections > Closed".



The "Closed" tab shows the currently active remote connections, and you can enable the display of the active connections in the task bar.

Settings:

SCPI Connections.....530
TCP/IP Connections.....530

SCPI Connections
Lists the VISA resource strings of the last remote connections that have accessed the instrument via the LAN interface before.

Remote command:
n.a.

TCP/IP Connections
Lists the types and client addresses of the last remote connections that had accessed the instrument via the LAN interface before.

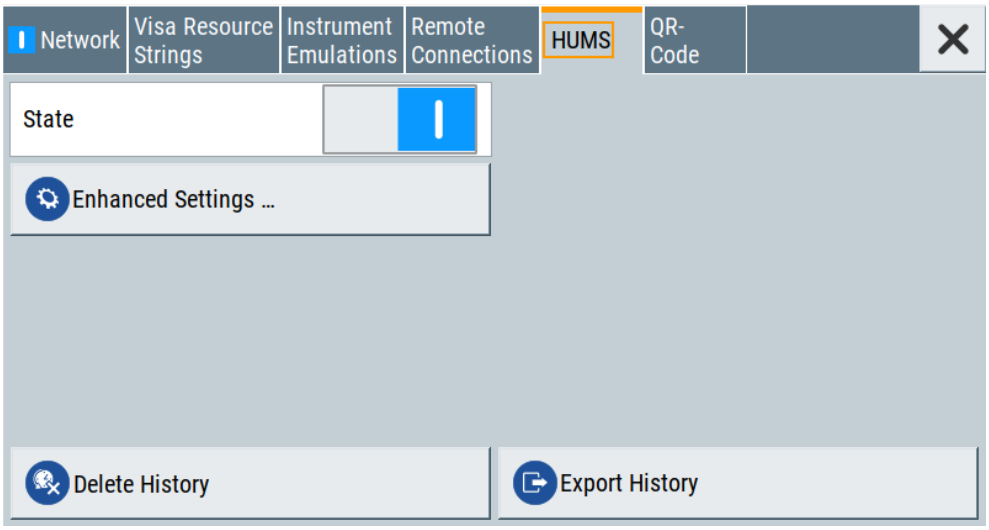
Remote command:
n.a.

13.5.5 HUMS settings

Requires R&S SMCVB-K980.

Access:

► Select "System Config > Remote Access > HUMS".



The dialog provides settings to configure the health and utilization monitoring system (HUMS) of the R&S SMCV100B.

The remote commands required to define these settings are described in Section 14.8, "HUMS remote control commands", on page 609.

Settings:

State....531
Enhanced Settings....531
Delete History....531
Export History....531

State
Activates HUMS.

Data is only recorded if HUMS is enabled. If disabled, already recorded data can still be retrieved.

The setting is reset by a factory preset to "off".

Remote command:
`DIAGnostic:HUMS:STATe` on page 612

Enhanced Settings
Opens a dialog for configuring enhanced protocol settings, see Section 13.5.6, "HUMS enhanced settings", on page 531.

Access is only available, when HUMS is enabled, see State.

Delete History
Deletes all information from the HUMS service including the device history.

Note: Regarding the instrument security, the sanitization procedure also deletes the history of the HUMS service, see Section 12.6.2.1, "Disk & memory security settings", on page 492.

Remote command:
`DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL` on page 611

Export History
Triggers an export of the logged data of the HUMS service into a `*.zip` file.

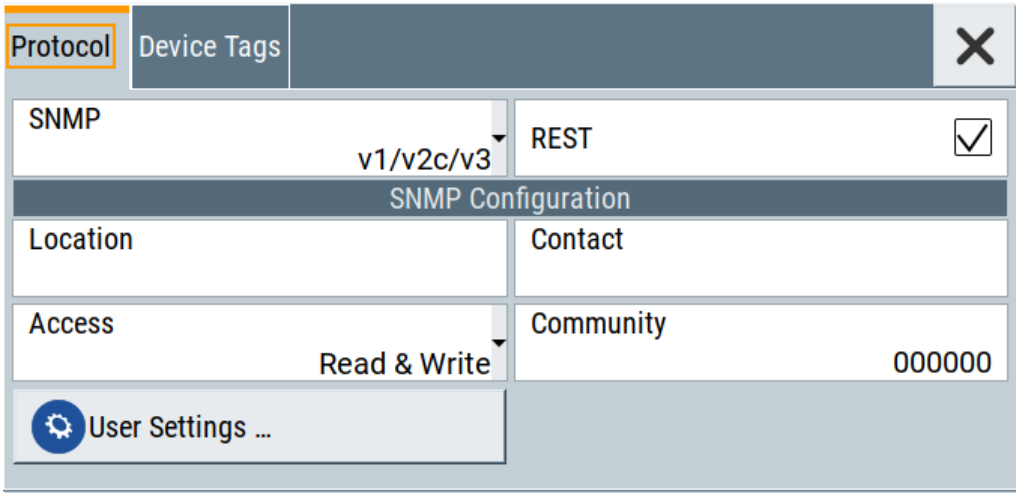
A standard file dialog opens, to save the log file. By default, the file is saved to the directory /var/user/.

Remote command:
`DIAGnostic:HUMS:DEVice:HISTory?` on page 610
`DIAGnostic:HUMS:SAVE` on page 611

13.5.6 HUMS enhanced settings

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".



The dialog provides enhanced settings for configuring protocol settings and device tags.

The remote commands required to define these settings are described in Section 14.8, "HUMS remote control commands", on page 609.

- Protocol settings....532
- SNMP user settings....534
- Device tag settings....538

13.5.6.1 Protocol settings

The "Protocol" tab of the "Enhanced HUMS Settings" dialog provides protocol settings for SNMP or REST protocol.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".
4. Select "Protocol".

   The dialog provides enhanced settings for configuring protocol settings and device tags.

Settings:

SNMP....533
REST....533
SNMP Configuration....533
  └ Location....533
  └ Contact....533

└ Access 533
└ Community 534
User Settings 534

SNMP
Enables the SNMP agent and selects the supported SNMP version to communicate with the service.

The setting is reset by a factory preset to "v1/v2c".

"Off"	The SNMP agent is disabled.
"v1/v2c"	Selects SNMP version 2, which also enables version v1.
"v1/v2c/v3"	Selects all SNMP version v1, v2c and v3.
"v3"	Selects SNMP version v3.

Remote command:
`SYSTem:COMMunicate:SNMP:VERSion` on page 616

REST
Enables the REST API protocol.

The setting is reset by a factory preset to "On".

Remote command:
`SYSTem:COMMunicate:REST:ENABle` on page 613

SNMP Configuration
For SNMPv1 and SNMPv2c authentication, you can define "Access" and "Community". For SNMPv3 authentication, you can define "User" profiles.

Location ← SNMP Configuration
Defines the SNMP location information. This information complies with the server's physical location and is used for identification of the SNMP server. By default, this input field is empty.

Remote command:
`SYSTem:COMMunicate:SNMP:LOCation` on page 614

Contact ← SNMP Configuration
Sets the SNMP contact information. This information complies with the person who manages the SNMP server and is used for identification of the SNMP server. By default, this input field is empty.

Remote command:
`SYSTem:COMMunicate:SNMP:CONTact` on page 614

Access ← SNMP Configuration
Defines the access type for SNMP community string.

For read access, you can use "Read" or "Read & Write". For write access, use "Read & Write".

The setting is reset by a factory preset to "Read & Write".

Remote command:
SYSTem:COMMunicate:SNMP:COMMunity:RO on page 613
SYSTem:COMMunicate:SNMP:COMMunity:RW on page 614

Community ← SNMP Configuration
Defines the SNMP community string that can be a group of instruments with SNMP version v2 support.

The setting is reset by a factory preset to the "<serial number>" of the instrument.

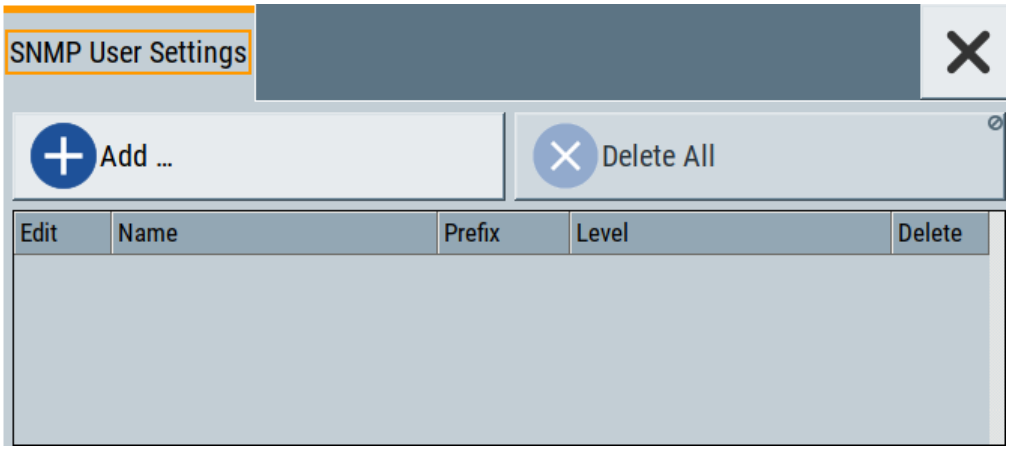
User Settings
Accesses the "Configure SNMP Users for HUMS" dialog.

13.5.6.2 SNMP user settings

For SNMPv3 authentication, you can define user profiles.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".
4. In the protocol tab, select SNMP communication with SNMPv3, e.g. "SNMP > v1/v2c/v3".
5. Select "User Settings".



The "Configure SNMP User for HUMS" dialog provides an overview of all defined SNMP users and their profiles. With the "Add" and "Delete All" controls, you can add or remove users.

Settings:

Add....535
Delete All....535
User table....535

└ Edit....535
└ Name....536
└ Prefix....536
└ Level....536
└ Delete....536
Add SNMP User for HUMS....536
└ SNMP User Name....537
└ SNMP User Prefix....537
└ SNMP User Level....537
└ SNMP User Public Passphrase....538
└ SNMP User Encrypted Passphrase....538
└ Add / Update....538

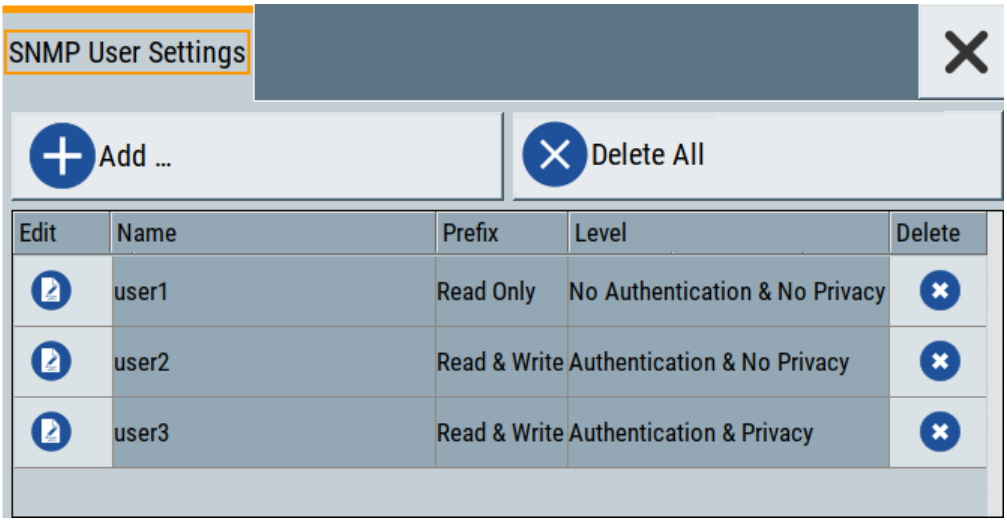
Add
Accesses the "Add SNMP User for HUMS" dialog.

In this dialog, you can define a user and its profile, see "Add SNMP User for HUMS" on page 536.

Delete All
Removes all users from the list.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL` on page 616

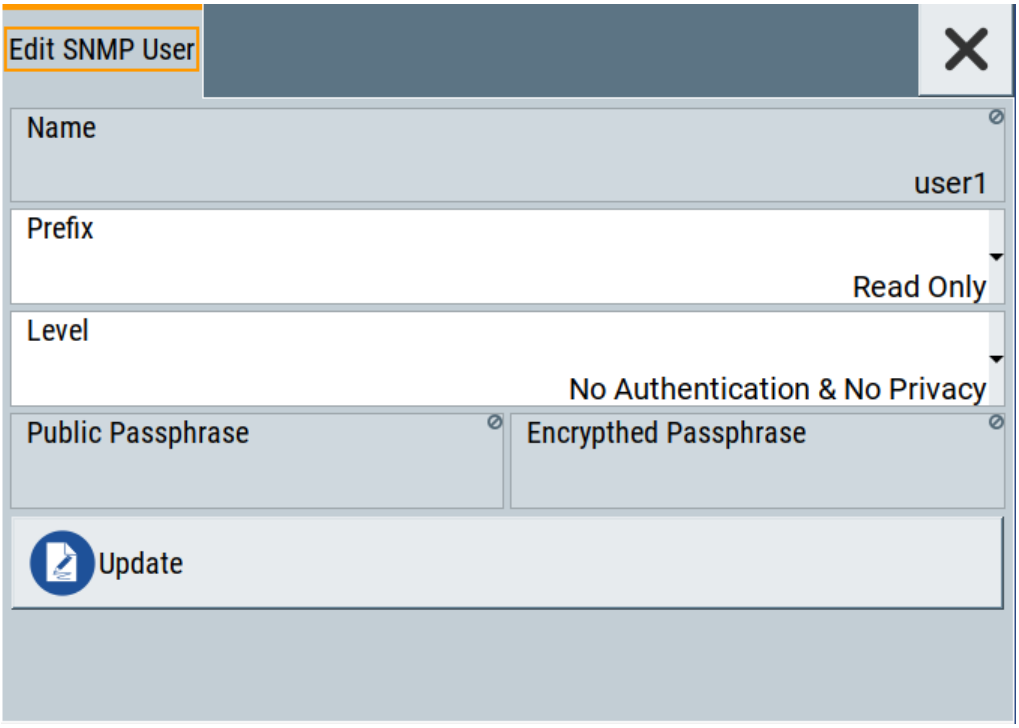
User table
Lists all defined SNMP users.



The table informs on the user name and its specified user profile.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:ALL?` on page 615

Edit ← User table
Accesses the "Edit SNMP Users for HUMS" dialog, where you can modify an already defined user profile.



For description on the entry fields, see Add SNMP User for HUMS.

Name ← User table
Shows the user name of the user who should have specific user rights.

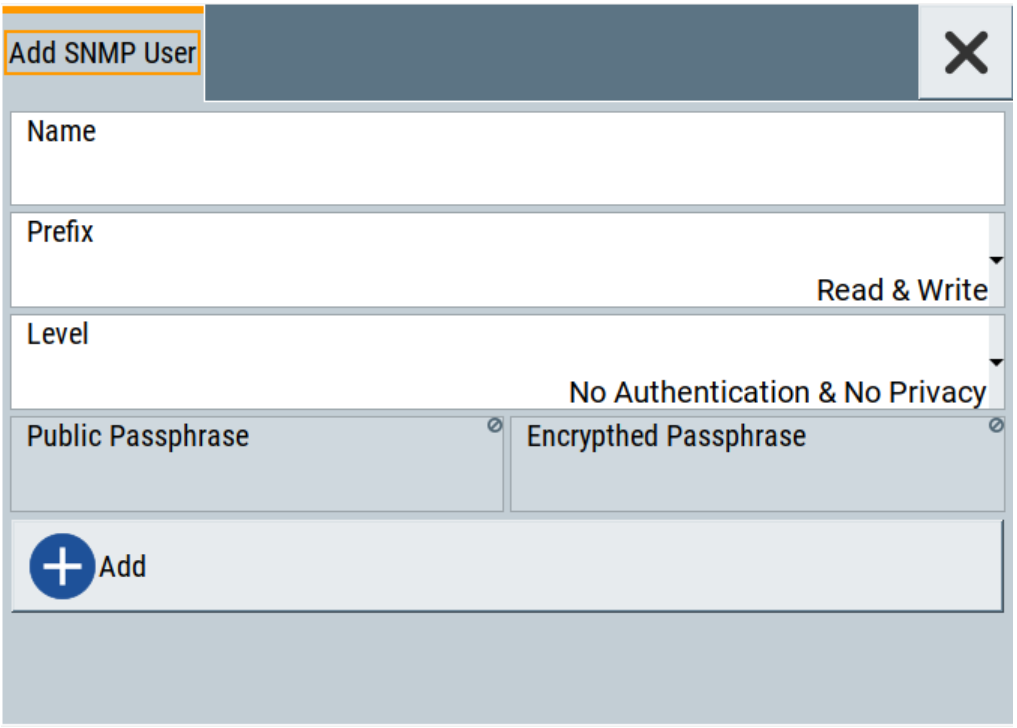
Prefix ← User table
Shows the access right of the selected user.

Level ← User table
Shows the security level of the selected user.

Delete ← User table
Removes the selected user from the list.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:DELete` on page 616

Add SNMP User for HUMS
Configuration dialog for defining SNMP users and their profiles.



Remote command:
SYSTem:COMMunicate:SNMP:USM:USER on page 615

SNMP User Name ← Add SNMP User for HUMS
Defines the name of the user for assigning specific user rights. Entering a user name is mandatory.

SNMP User Prefix ← Add SNMP User for HUMS
Defines the access right for a user.

"Read Only" Allows the user to only read information.

"Read & Write" Allows the user to read and modify information.

SNMP User Level ← Add SNMP User for HUMS
Defines the security level of the SNMP user. Depending on the security level, the service requests user name and passphrases for authentication and encryption.

"No Authentication & No Privacy"
Low security level. Using this level, the service queries the user name only. Password authentication and password for encrypted data transfer is not requested.
See "SNMP User Public Passphrase" on page 538 and "SNMP User Encrypted Passphrase" on page 538 for data transfer is not requested.

"Authentication & No Privacy"
Medium security level: Requests the user name and password authentication, but no data transfer encryption.

"Authentication & Privacy"
High security level: Requests the user name, and both, the password authentication and the password for data transfer encryption.

SNMP User Public Passphrase ← Add SNMP User for HUMS
Defines the password for authentication. The password must have of 8 to 12 characters with any combination of ASCII characters.

SNMP User Encrypted Passphrase ← Add SNMP User for HUMS
Defines the password for encryption. This password must have at least 8 characters with any combination of ASCII characters. When encryption is defined, the R&S SMCV100B supports the DES (directed enhanced services) protocol.

Add / Update ← Add SNMP User for HUMS
Assigns the defined user with its profile to the list.

If you change an already defined user profile, the instrument provides the "Update" button to apply the modifications.

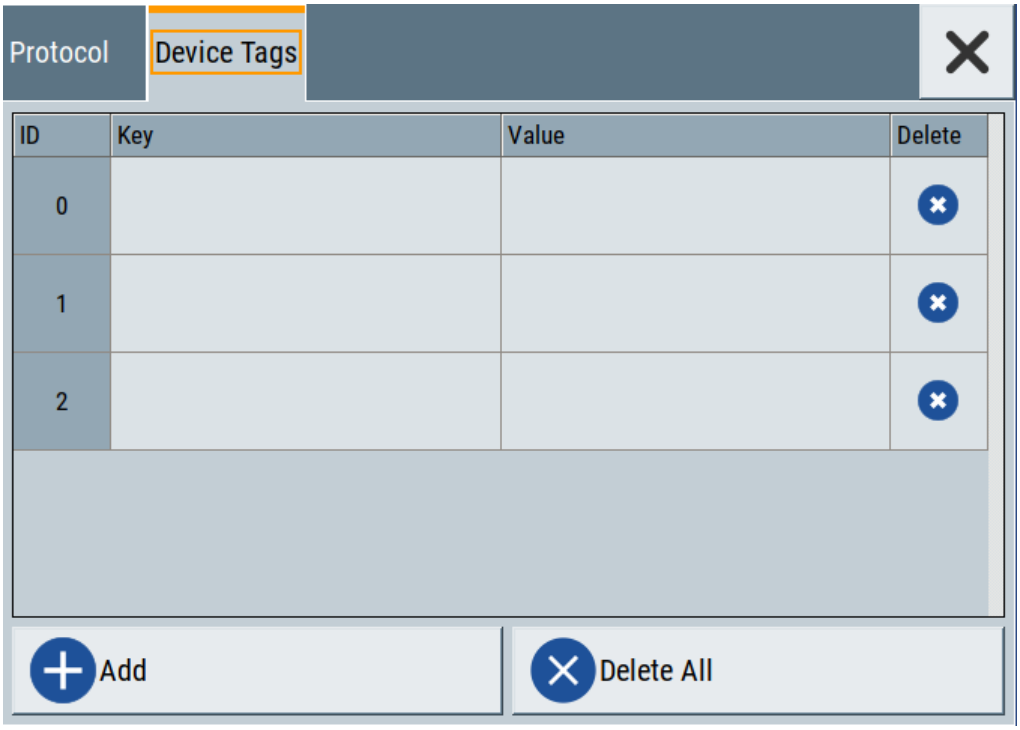
13.5.6.3 Device tag settings

The "Device Tags" tab of the "Enhanced HUMS Settings" dialogs displays the defined device tags. You can also add or delete device tags here.

A device tag is a label to assign to your instrument. You can create any device tag for your instrument and define it by a specific key and value.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".



Configures device tags for tagging user-defined information of the instrument in a table. You can define up to 32 device tags, e.g., for HUMS history evaluation.
To add a device tag, define "Key" and "Value" of the device tag in the table. Click "Add" to add all device tags of the table to the HUMS history.

Settings:

ID....539
Key....539
Value....539
Delete....540
Add....540
Delete All....540

ID
Identification count of a device tag entry.

Key
Sets the identification key of a device tag.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 613

Value
Sets the value of the identification key of a device tag.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 613

Delete
Deletes the selected device tag from the HUMS history.

Remote command:
`DIAGnostic:HUMS:TAGS:DELete` on page 612

Add
Adds a new device tag to the HUMS service.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 613
`DIAGnostic:HUMS:TAGS:ALL?` on page 612

Delete All
Removes all device tags from the HUMS history.

Remote command:
`DIAGnostic:HUMS:TAGS:DELete:ALL` on page 613

13.5.7 QR code

Access:

► Select "System Config > Remote Access > QR Code".



The "QR Code" dialog shows the current instrument address (IP address) in quick response (QR) format.

This functionality provides fast access to the instrument via VNC with, for example, a smartphone or a tablet.

See Section 13.12.3, "How to set up remote operation from a smart device", on page 576.

13.6 LXI settings

On the R&S SMCV100B, an LXI functionality is already installed and enabled. Thus, you can access he instrument using any web browser.

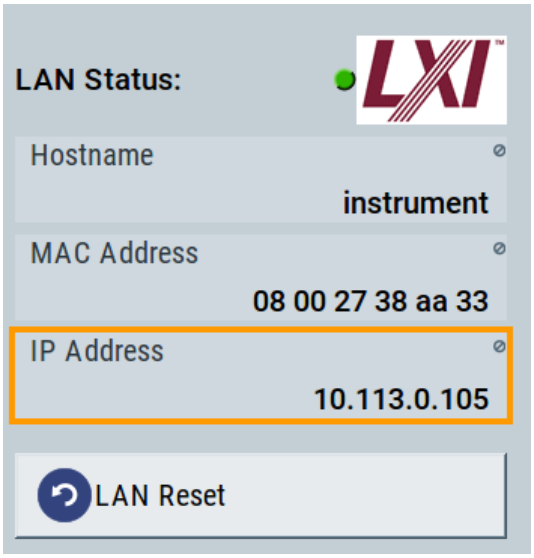
13.6.1 LXI status settings

On the R&S SMCV100B, an LXI functionality is already installed and enabled. Thus, you can access he instrument using any web browser.

See Section 13.6.2, "LXI browser settings", on page 542.

Access:

► Select "System Config > Setup > Remote Access > LXI Status".



The LXI "LAN Status" dialog shows the parameters of the LAN connection.

Alternatively, you can change the LAN settings using the LXI web browser interface, see Section 13.6.2.1, "LAN configuration", on page 544.

Settings:

LAN Status....541
Hostname / MAC Address / IP Address....542
LAN Reset....542

LAN Status
The LED indicates the LXI status.

"green" Normal operation

"green (flashing)" Device identification

"red" LAN fault

Hostname / MAC Address / IP Address
See "Hostname" on page 524.

LAN Reset
Initiates the network configuration reset mechanism for the instrument and resets the hostname, MAC address, and IP address.

According to the LXI standard, a LAN reset must set the following network parameters to a default state:

Parameter	Value
TCP/IP mode	DHCP + Auto IP address
Dynamic DNS	Enabled
ICMP ping	Enabled
Password for LAN configuration	LxiWebIfc

The LAN reset also resets the following parameters for the R&S SMCV100B:

Parameter	
Hostname	`Instrument-specific hostname`
Description	vector signal generator
Negotiation	Auto detect
VXI-11 discovery	Enabled

13.6.2 LXI browser settings

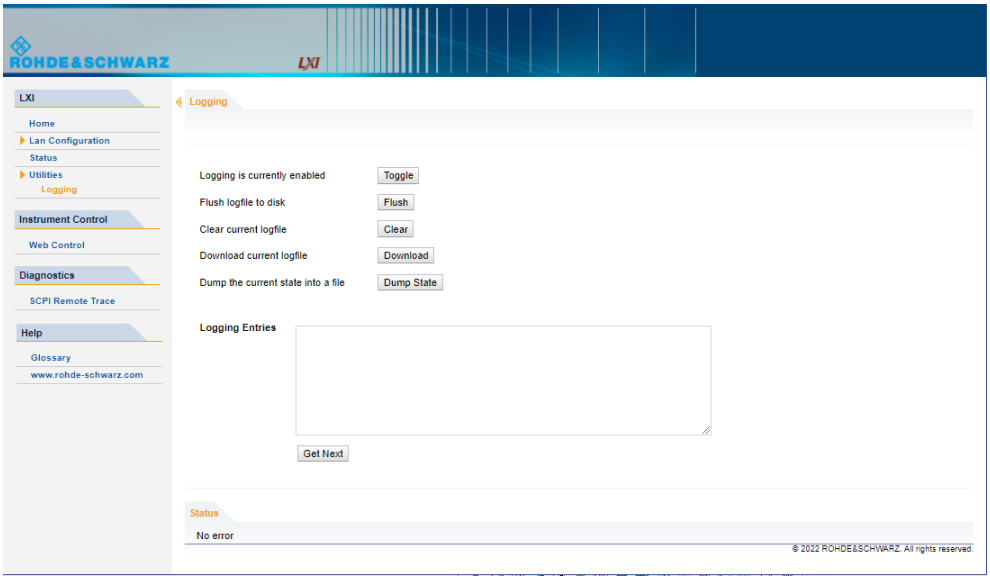
Accessing the R&S SMCV100B over the LXI browser inerface, you can perform the following tasks:

- Modifying network configurations, see Section 13.6.2.1, "LAN configuration", on page 544.
- Accessing the instrument remotely
- Analyzing SCPI remote diagnostics
- Monitoring the use and status of the instrument
  This service requires option R&S SMCVB-K980 "Health and utilzation monitoring service (HUMS)".

Access:

► In the address field of the browser, enter the URL address, composed of the instrument's IP address or host name, for example *http://10.113.1.151*.
Note: Do not add the missing zeros in the IP address, while opening the instrument homepage.

The instrument homepage (welcome page) opens.



The navigation pane of the browser interface contains the following elements:

- "LXI"
  - "Home" opens the instrument homepage.
    The homepage displays the device information required by the LXI standard, including the VISA resource string in read-only format.
  - "Device Indicator" activates or deactivates the LXI status indication.
    When activated, the LXI LED flashes. A green LXI status symbol indicates that a LAN connection has been established; a red symbol indicates that no LAN cable is connected.
  - "Lan Configuration" allows you to configure LAN parameters and to initiate a ping, see "Ping client" on page 546.
  - "Status" displays information about the LXI status of the instrument.
  - "Utilities" provides access to the LXI event logging functionality required by the LXI standard.
- "Instrument Control"
  "Web Control" provides remote access to the instrument.
  See "To start remote control with the LXI browser" on page 553.
- "Diagnostics"
  - "SCPI Remote Trace" records messages exchanged via the remote control interface, see Section 13.6.2.2, "SCPI remote trace", on page 546.
  - "Health & Utilization" (option: R&S SMCVB-K980) enables you to monitor the use and status of an instrument, see Section 13.6.2.3, "Health and utilization", on page 548.
- "Help"
  - "Glossary" explains terms related to the LXI standard.
  - www.rohde-schwarz.com opens the Rohde & Schwarz homepage.

13.6.2.1 LAN configuration

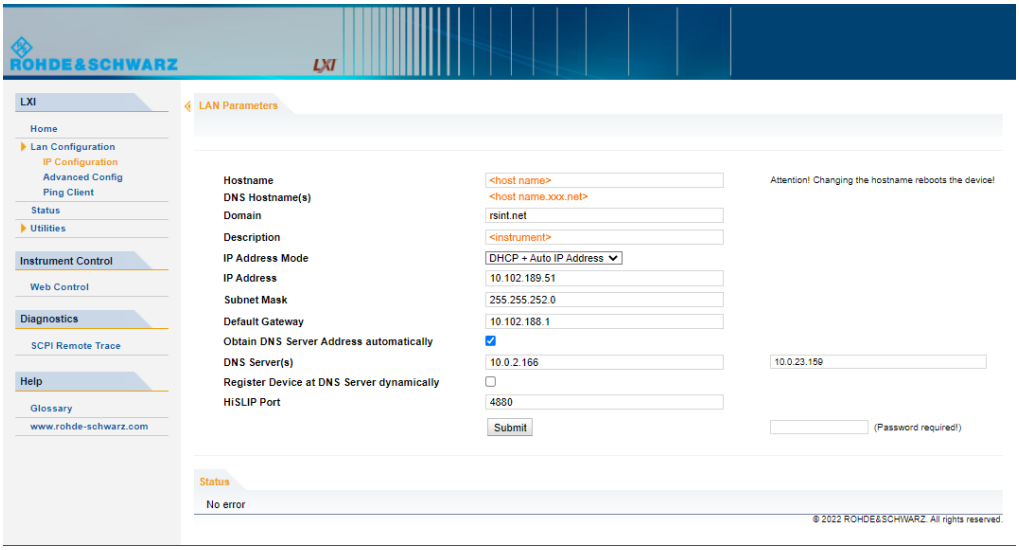
The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

- IP configuration 544
- Advanced config 545
- Ping client 546

IP configuration

The "IP configuration" web page displays all mandatory LAN parameters and allows their modification.



The "IP Address Mode" selects a configuration mode for the IP address of the instrument. With static configuration, the entered IP address, subnet mask, and default gateway are used. With dynamic configuration, DHCP or dynamic link local addressing (automatic IP) is used to obtain the instrument IP address.

Changing the LAN configuration

This function is password-protected. Unlock the protection level 1 to access it.

Note: We recommend that you change the default password before connecting the instrument to a network.

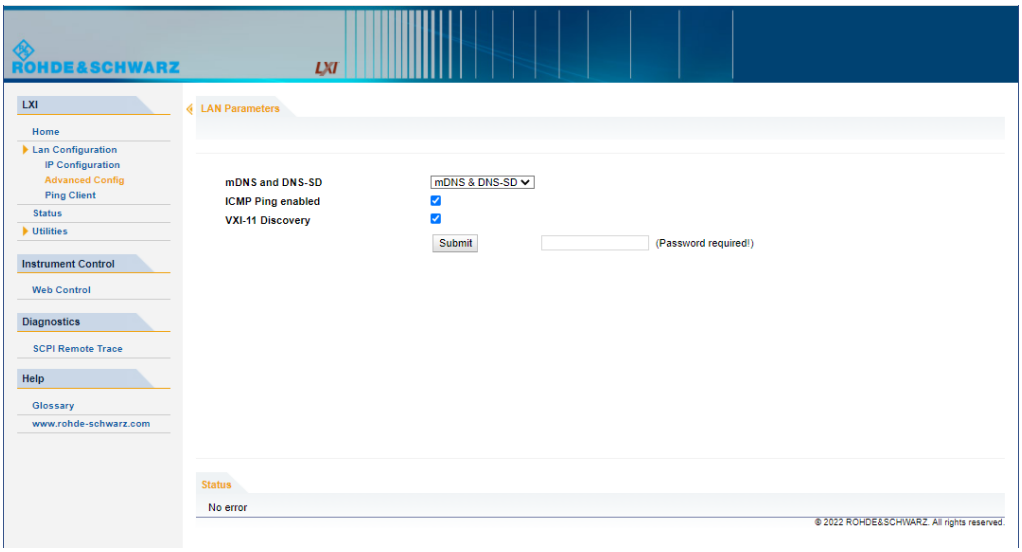
How to:

- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

See Section 12.6.4, "Password management", on page 500.

Advanced config

The "Advanced Config" web page provides LAN settings that are not declared mandatory by the LXI standard.



The following advanced parameters are available:

- "mDNS and DNS-SD": The additional protocols "multicast DNS" and "DNS service discovery" are used for device communication in zero configuration networks, working without DNS and DHCP.
- "ICMP Ping": Must be enabled to use the ping utility.
  If you disable this setting, the instrument does not answer ping requests. The setting does not affect the LXI ping client. You can ping other hosts from the instrument, even if the setting is disabled.
- "VXI-11 Discovery": Must be enabled to detect the instrument in the LAN.
  If you disable this setting, the instrument cannot be detected by the VXI-11 discovery protocol mechanism. The setting does not affect other detection mechanisms. Setting up a VXI-11 connection via the IP address or the host name is independent of this setting.

Changing the LAN configuration

This function is password-protected. Unlock the protection level 1 to access it.

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:

- "To change the user password of the instrument" on page 503.
- "To change the security password" on page 503.

See Section 12.6.4, "Password management", on page 500.

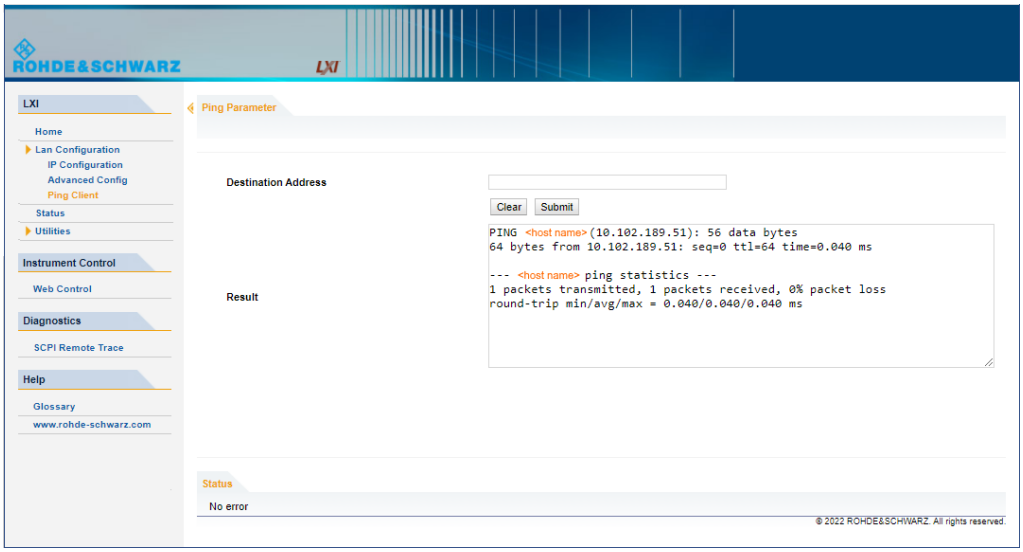
Ping client

The "Ping Client" page provides the ping utility to verify the connection between the LXI-compliant instrument and another device.

The ping is initiated from the instrument. Using the `ICMP` echo request and echo reply packets, this function checks whether the communication with a device via LAN is working. Ping is useful for the diagnosis of IP network or router failures.

To initiate a ping at the instrument:

1. On the "Ping Client" page, enter the IP address of the host in the "Destination Address" field (for example 10.113.1.151).
2. Select "Submit".



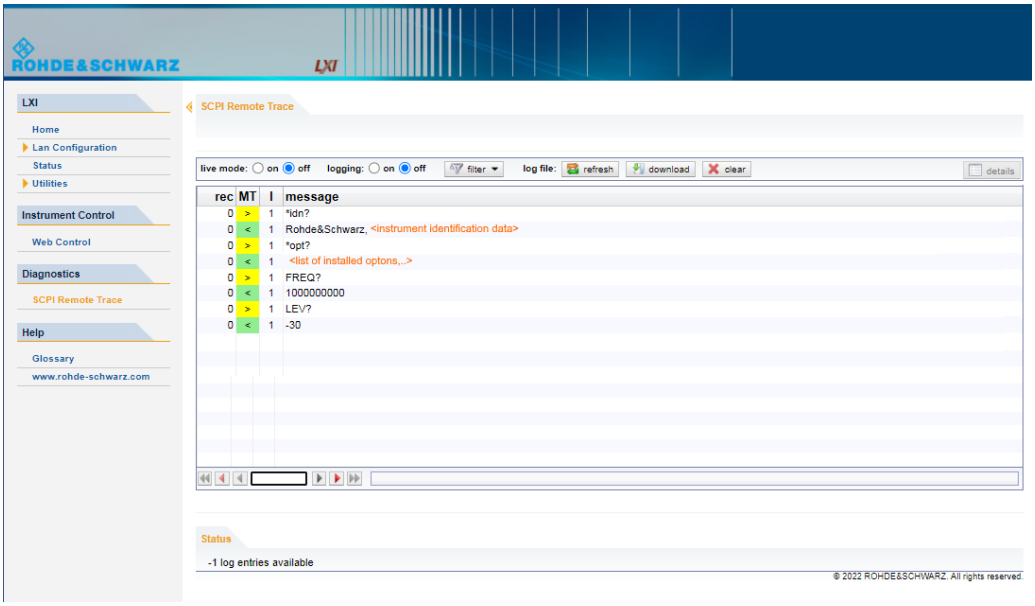
13.6.2.2 SCPI remote trace

The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SMCV100B.

See Section 13.9, "To trace messages with the LXI web browser interface", on page 560.

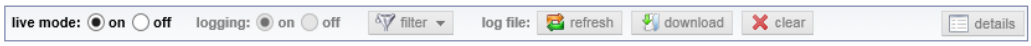
A recorded trace (message log) can be evaluated directly in the dialog. Use the highlighting and navigation functions provided by the lower toolbar to locate error messages and messages containing arbitrary search strings. You can also export the message log to a `*.csv` file and evaluate the file using a suitable program.

To trace and display messages, switch on "logging" and "live mode" in the toolbar.



Toolbars

The toolbar at the top of the dialog provides basic settings and functions.



- "Live mode" / "logging": If logging is switched on, messages are traced. They are stored in an internal database and can be displayed upon request, using the refresh button (live mode off) or they can be displayed automatically (live mode on).
- "Filter": applies a filter to columns and/or rows when working (live mode off)
- "Refresh": reads the message log from the internal database and displays it
- "Download": stores the SCPI trace log to a `*.csv` file
- "Clear": deletes all message log entries in the database and at the screen
- "Details": displays details of the selected message, for example an SCPI command in hex format (also possible by double\-clicking a message)

Columns

The following columns are available if no column filter is applied:

- "Rec": record number of the message within the message log
- "MT": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, highlighted by red color
  - T = execution time, i.e. time required by the instrument to process the command internally.
- **I**: number of the subinstrument

- "message": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, denoted in red
  - T = execution time, i.e. time required by the instrument to process the command internally

13.6.2.3 Health and utilization

Option: R&S SMCVB-K980

The health and utilization monitoring service allows you to monitor the usage and status of the instrument, it's options, including S.M.A.R.T. data of the system drive. You can retrieve information on remote accesses over SCPI commands, web browsers or protocols, as for example SNMP or REST.

For detailed information on R&S HUMS, see the following documents, available on the Rohde & Schwarz website:

- User manual "R&S Health and Utilization Monitoring Service" , describing how to access and use the service.
- Application note GFM336, providing information on the SNMP and REST API, including a list of all SNMP variables and REST endpoints.

13.7 To configure the instrument for remote access

The R&S SMCV100B is equipped with a network interface and can be connected to an Ethernet LAN (local area network).

How to: Section 3.1.7, "Connecting to LAN", on page 27

For identification in the network, all devices require an IP address.

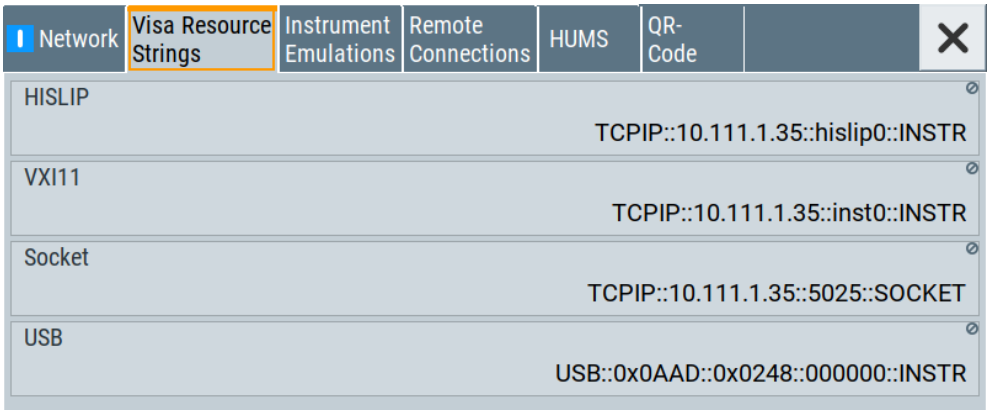
How to:

- To find the VISA resource string.....548
- To configure the access over LAN..... 549

13.7.1 To find the VISA resource string

To find the VISA resource string

► Select "System Config > Remote Access > VISA Resource Strings".



The dialog shows the VISA resource strings that enable you to access the instrument for remote control.

13.7.2 To configure the access over LAN

About network address information

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

- If the network supports dynamic TCP/IP configuration using the DHCP protocol, this service assigns all address information automatically.
- If the network does not support DHCP or if there is no server available, the instrument tries to obtain the IP address using the Zeroconf(Avahi) protocol.
  This protocol enables the instrument to self-configure an IP address and subnet mask. Zeroconf (Avahi) IP addresses start with the number blocks 169.254.*.*, with the subnet mask of 255.255.

The automatic address configuration establishes the physical connection to the LAN without any additional configuration.

- An IP address that is assigned with the Zeroconf protocol although the network requires an IP address assigned from the DHCP server can cause network connection failures.
- If the dynamic TCP/IP configuration does not succeed, or if the instrument is expected to use alternate TCP/IP configuration, you must set the address information manually.
  See "To assign the instrument address manually" on page 550.

13.7.2.1 How to assign the IP address

If necessary, you can assign the IP address manually. It is assumed that you have connected controller PC and the instrument.

To assign the instrument address manually

It is assumed that you have connected the instrument in the LAN.

1. Obtain the instrument address information for the R&S SMCV100B and the IP address for the local default gateway from your network administrator. If necessary, also obtain the name of your DNS domain and the IP addresses of the DNS server on your network.
   Obtain the IP address and subnet mask for the R&S SMCV100B and the IP address for the local default gateway from your network administrator. If necessary, also obtain the name of your DNS domain and the IP addresses of the DNS server on your network.
2. On the instrument, select "System Config > Remote Access > Network".
3. Select "Address Mode > Static".
4. Select the "IP Address".
5. Enter the IP address, for example *192.168.0.1.*

   The IP address consists of four number blocks separated by dots. Each block contains 3 numbers in maximum.
6. Select the "Subnet Mask" and enter the subnet mask, for example *255.255.255.0.*

   Note: The subnet mask must be the same for both, the R&S SMCV100B and the host interface, the instrument is connected to.
7. Enter the "Default Gateway", "DNS Suffix", and "DNS Server" if necessary.

To assign the IP address manually on the computer

► Obtain the necessary information from your network administrator. If you use more than one LAN connector, you need separate address information for each connector.
For information on how to configure the address information, see the documentation of the operating system the computer uses.

13.7.2.2 How to use the hostname

In a LAN that uses a DNS server, each computer or instrument connected in the LAN can be addressed with an unambiguous Hostname (also referred to as computer name) instead of the IP address. The DNS server translates the hostname to the IP address.

Using the hostname is useful in networks with dynamic TCP/IP and DHCP protocol services, that assign the address information automatically. Thus, it can be that the services assign a new IP address each time the instruments restarts, but they do not change the hostname.

Each instrument is delivered with an assigned hostname, that remains constant as long as it is not explicitly changed.

This function is password-protected. Unlock the protection level 1 to access it.

The default *hostname* name follows the syntax `<INST>-<Serial Number>`, where:

- `<INST>` is the short name of your instrument, as stated on the front panel.
- `<Serial Number>` is the individual serial number of the instrument.
  You can find the serial number at the rear panel of instrument. It is the third part of the device ID printed on the barcode sticker.



Example:

The default hostname of an R&S SMCV100B with a serial number 102030 is `SMCV100B-102030`.

To query and change the hostname

1. Select "System Config > Remote Access > Network".

   Section "Instrument Name" displays the assigned "Hostname".

   Note: This function is password-protected. Unlock the protection level 1 to access it.

2. Select "System Config > Setup > Security > Protection".
3. Enable the "Protection Level 1".
   The default protection level 1 password is *123456*.

   The parameter "Hostname" in the "Network" tab is now enabled for configuration.
4. Change the "Hostname".

13.7.2.3 How to configure LAN interface access and services

By default, the LAN interface and the supported LAN interface services are enabled.

For security reasons, for example to protect the instrument against unauthorized access, you can block either the LAN services individually, or the access over LAN in general.

To disable LAN access in general

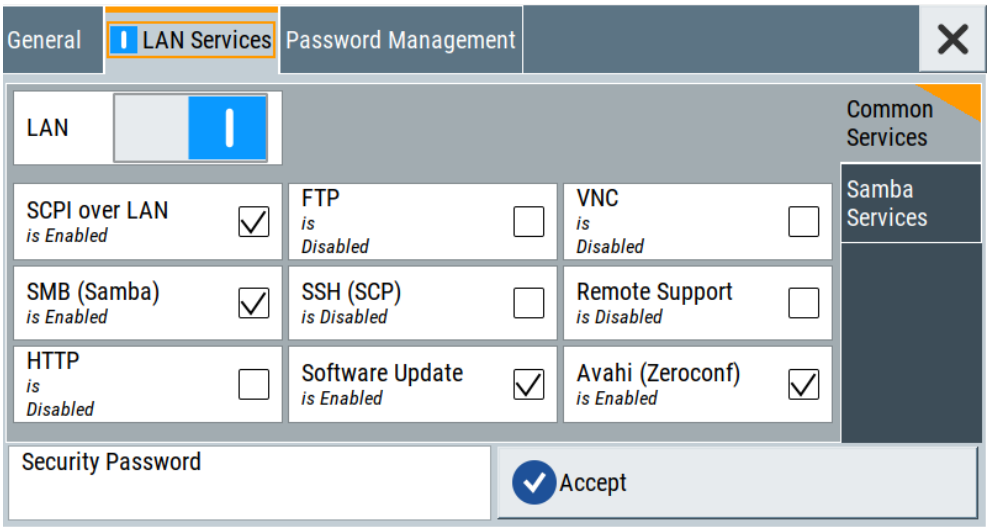
1. Select "System Config > Setup > Security".
2. Select "Security".
3. Select "LAN Services".
4. Disable "LAN" state.
5. Enter the Security Password.

6. Select "Accept".

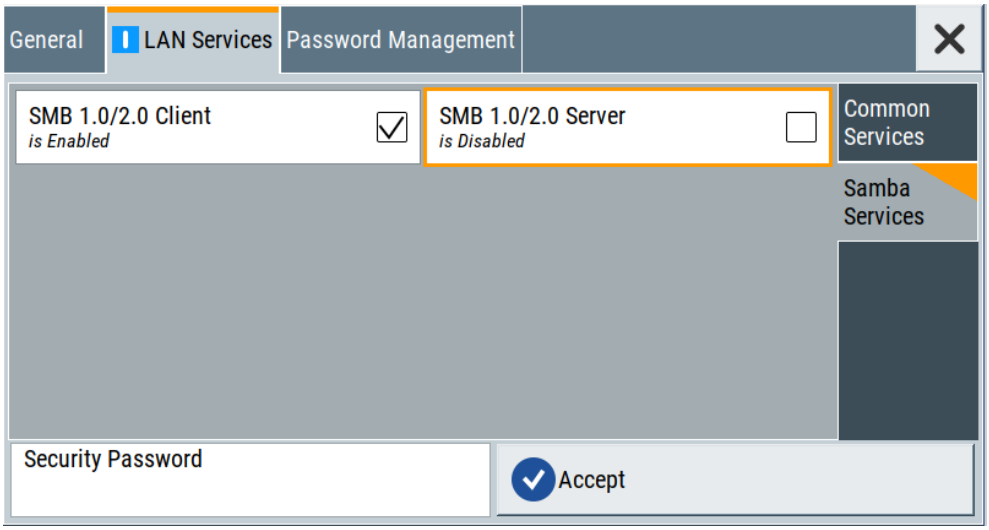
   When disabled, communication over the LAN connection is not possible.

To disable LAN services individually

1. Select "System Config > Setup > Security".
2. Select "Security".
3. Select "LAN Services".
4. Enable "LAN" state.
5. In the "Common Services" side tab, uncheck all services you want to block.



6. Select the "Samba Services" sidetab.



7. For example, uncheck "SMB 1.0/2.0 Server" to block the access for the SMB Samba server.

8. Enter the Security Password.
9. Select "Accept".

13.8 To establish a remote control session over LAN

This section shows you how to establish remote control connections over the available interfaces.

The following general prerequisites must be fulfilled:

- The instrument and the controller have to be connected over the corresponding interface with the suitable cable.
- The instrument and the controller must be switched on.
- To operate the instrument remotely, it must be addressed using the defined interface address.

  See:

  – Section 13.2.1, "LAN interface", on page 512
- A remote control program must open a connection to the instrument, before it can send commands to and receive device responses from the instrument.

If security is a concern, see:

- Document Instrument Security Procedures.
- Section 12.6.5, "Preventing unauthorized access", on page 503.

- To establish the connection with the LXI web browser..... 553
- To establish the connection using VXI-11 protocol.....554
- To establish the connection using socket communication..... 559

13.8.1 To establish the connection with the LXI web browser

Using the LXI browser interface you can access and control the R&S SMCV100B instrument remotely from another PC without additional installation. File upload and download between the instrument and the remote PC is also available.

It is assumed that the instrument is set up in the LAN, and the LAN service is enabled. See Section 12.6.3, "Configuring LAN services", on page 496.

To start remote control with the LXI browser

1. On the controller PC, start a browser that supports HTML5 (W3C compliant).
2. Enter the IP address of the R&S SMCV100B in the browser's address bar.

   The browser displays the R&S SMCV100B's welcome page.
3. In the navigation pane, select "Instrument Control" > "Web Control".

Remote access to the instrument requires the password. The default password is *instrument*.

4. Enter the password.
5. Confirm with [Enter].

   The current screen of the R&S SMCV100B appears in the browser window.
6. Use the mouse cursor and keyboard to access the functionality of the instrument as if you operate the instrument directly.

13.8.2 To establish the connection using VXI-11 protocol

In this example, the I/O software library R&S VISA from Rohde & Schwarz is used to set up a LAN remote control link and remotely control the R&S SMCV100B. R&S VISA is running on a controller PC with Windows operating system. When the connection is set up, you can send commands to the instrument and receive the responses.

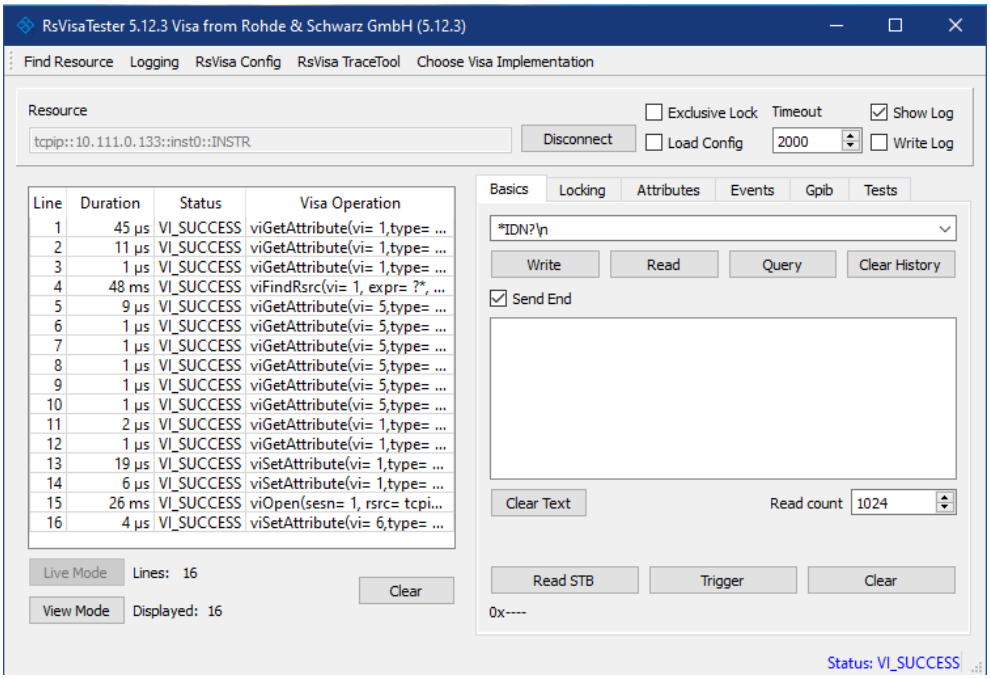
The remote control connection requires a VISA installation but no additional hardware on the controller PC. The LAN I/O channel is selected at initialization time using the VISA resource string (also referred to as "address string"). A VISA alias (short name) is used to replace the complete resource string. The host address is the R&S SMCV100B's hostname or its IP address.

See also Section 13.2.1, "LAN interface", on page 512.

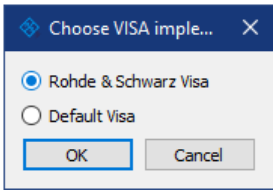
To set up the controller with R&S VISA

To remote control the R&S SMCV100B, we use the R&S VISA Tester application. The application communicates over the TCP/IP protocol.

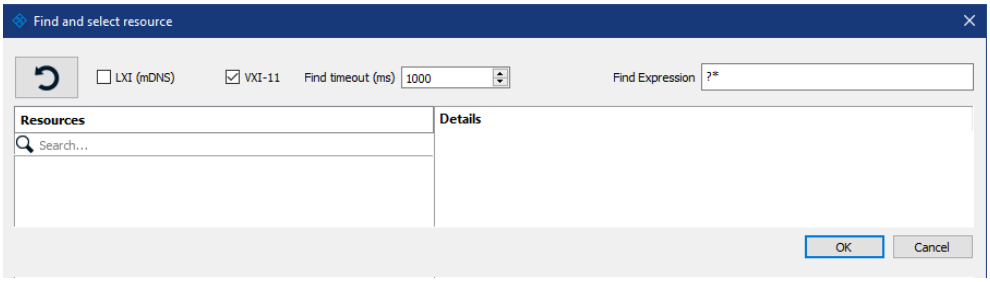
1. On the controller PC, install the R&S VISA program.
   See www.rohde-schwarz.com/rsvisa > "RS VISA release notes".
2. On the instrument, enable the LAN interface and "SCPI over LAN".
3. On the controller, start, e.g., "R&S VISA > Tester".



4. In the menu bar, select "Choose VISA Implementation > Rohde & Schwarz Visa"
5. Confirm with "OK".

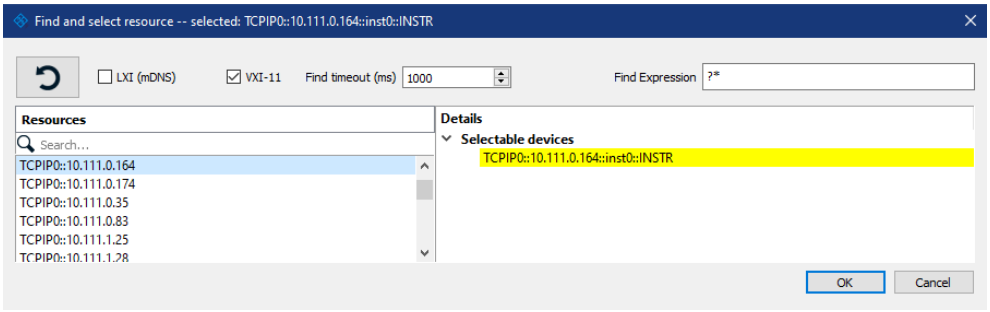


6. In the menu bar, select "Find Resource" to search for the instrument in the LAN.



7. Select "VXI-11".
8. Select the "refresh" button to start the search.

   R&S VISA scans the network for connected instruments and lists all detected instruments in the "Resource" list.
   Note: The search can take some time, particularly in large networks.
9. Select the required instrument.

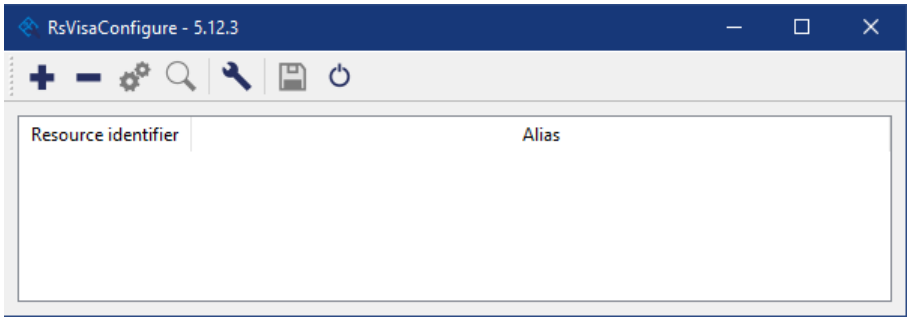


10. Confirm with "Ok".

    The "Find and select resource" dialog closes and R&S VISA indicates the IP address in the "Resource" field of the main application window.

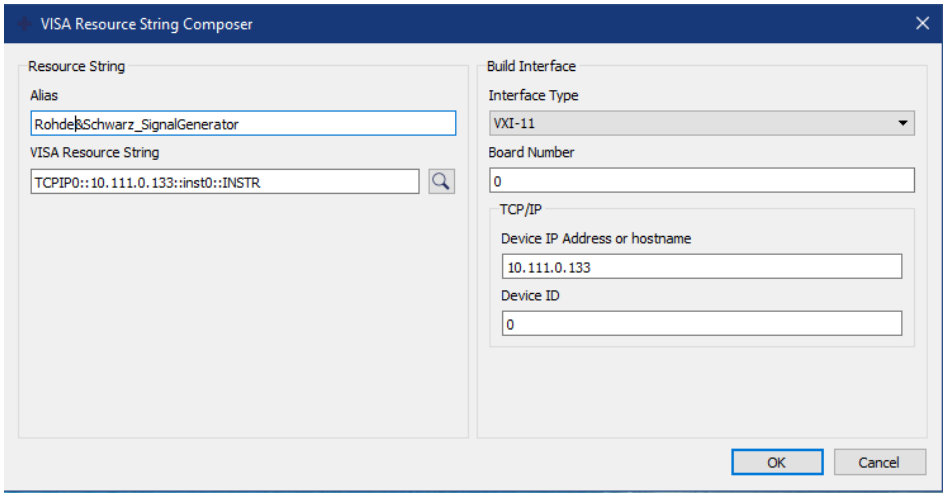
11. As an alternative to the IP address, you can assign an alias name to the R&S SMCV100B:

    a) In the menu bar, select "RsVisaConfig".

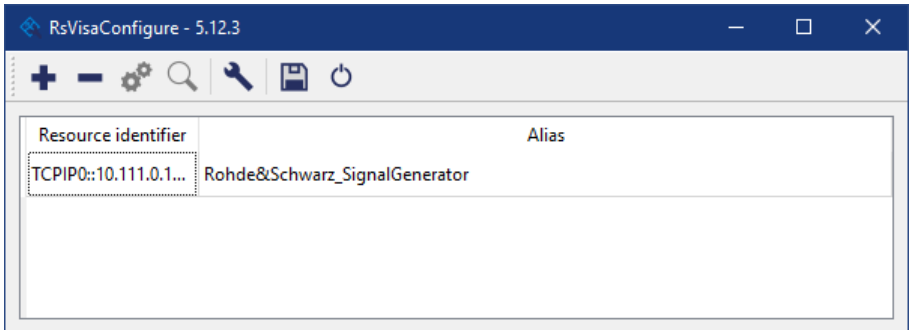


    b) In the toolbar, select "+" to access the "VISA Resource String Composer".

c) Fill in the "Alias" name, the "VISA Resource String" and the "Device IP Address or hostname" as shown in the figure.



R&S VISA indicates the assigned "Alias" name.



d) Confirm with "OK".
R&S VISA identifies the R&S SMCV100B and you can address it either with the resource string or the alias name.

12. In the main window, select "Connect".

    R&S VISA establishes the connection to the R&S SMCV100B.

    You can send settings to configure the instrument and receive its responses.

    Note: If the connection cannot be set up, R&S VISA displays an error in the log view.
    See also Section 15.5, "Resolving network connection failures", on page 869.

To start remote control with R&S VISA

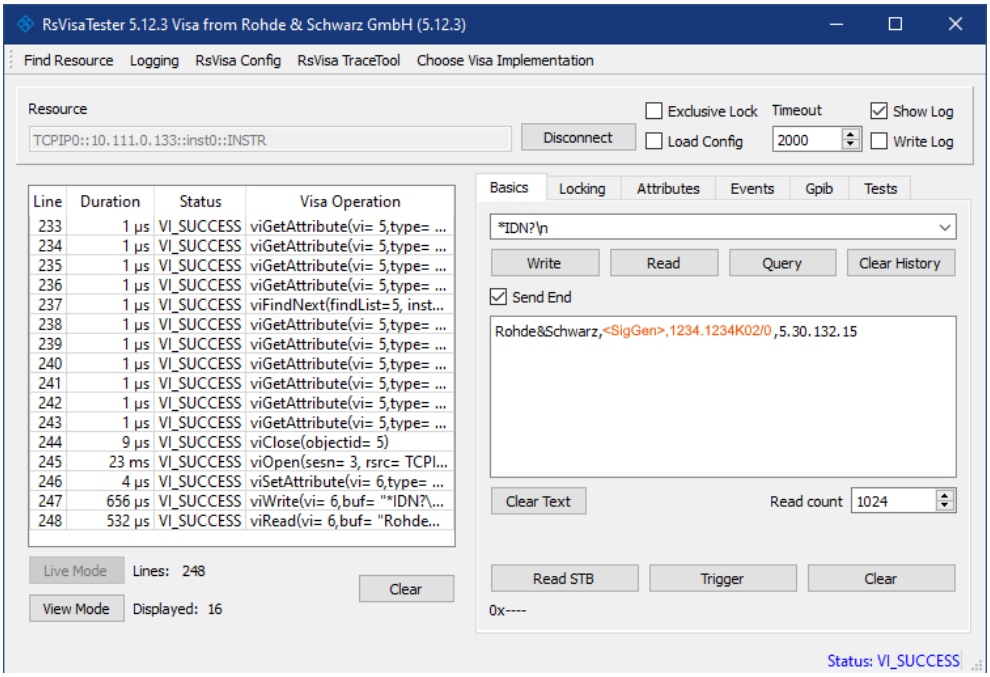
To set the instrument to remote control state, you can send any command from the controller.

1. Start the R&S VISA Tester.
   Establish the connection to the R&S SMCV100B.
   See "To set up the controller with R&S VISA" on page 554.
2. In the R&S VISA "Basics" tab, enter a SCPI command, e.g. `*IDN?`.

3. Confirm with "Query".

   The instrument switches to remote control when it receives a command from the controller.

4. Select "Read" to obtain the instrument response.



   The instrument returns the response.
   Remote control over R&S VISA is enabled.

To check remote control with VISA

You can check the communication by sending a setting command and querying the response:

1. Set, e.g. the frequency with the command:
2. Select "Write".
3. Enter the command `SOUR:FREQ?`.
4. Select "Query".

   If the R&S SMCV100B responses with the frequency value xyou entered, remote control works properly.

To monitor the remote control operation

1. Check the "Show Log" checkbox on the top right.

   R&S VISA displays each VISA operation in the log-view on the left.

2. Check the "Write Log" checkbox.

R&S VISA saves all log-view entries to a log file.

You can operate the log-view in two modes:
- "Live Mode": shows only the most recent messages
- "View Mode" allows you to scroll the history

13.8.3 To establish the connection using socket communication

This section provides an example on how to establish a remote control connection over Telnet client and a simple sockets-based program example that can be further developed.

The telnet client transmits information unencrypted. Therefore, for sensitive information we recommend that you use a client which supports secure protocols, like SSH.

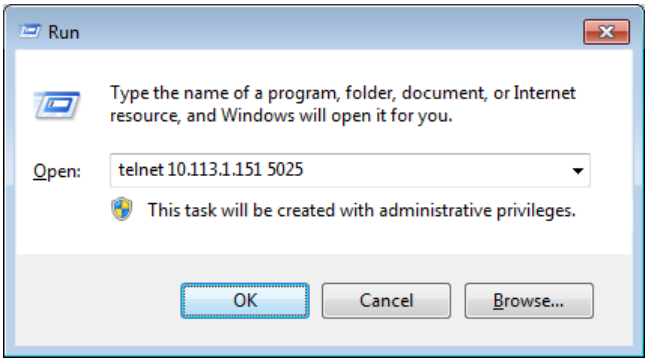
In the following example, we assume basic knowledge of programming and operation of the controller. You can find information on the interface commands in the corresponding manuals.

To set up a Telnet connection

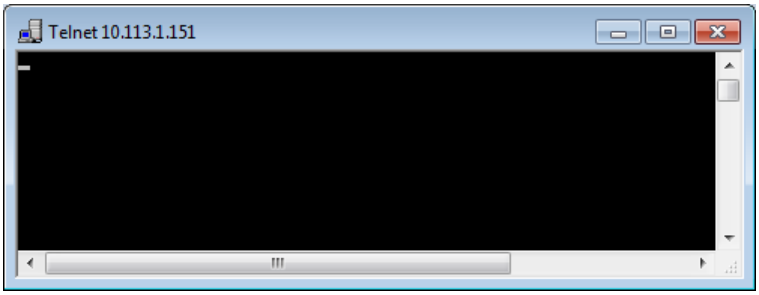
To control the software, only a Telnet program is required. The Telnet program is part of each operating system.

The controller PC and the instrument are connected in the same network.

1. On the instrument, enable the LAN interface and "SCPI over LAN".
   See Section 12.6.3, "Configuring LAN services", on page 496.
2. On the controller PC, start the Telnet program.
3. Enter the socket address.
   The socket address is a combination of the IP address or the hostname of the R&S SMCV100B and the number of the port configured for remote-control via Telnet.
   Tip: The R&S SMCV100B uses the port number 5025 for remote connection via Telnet.



The connection to the instrument is set up and you can send remote-control commands.



4. Telnet does not reflect your first entry.
   Insert a command, e.g. `*IDN` and confirm with "Enter".
5. Observe the screen.

   A response on the query confirms that the connection is working. The client displays all subsequent inputs and responses.
6. Even if the cursor is not visible on the screen, just enter a remote-control command. Confirm with Enter.

13.9 To trace messages with the LXI web browser interface

The remote trace functionality allows you to trace commands and messages exchanged via a remote control interface of the R&S SMCV100B.

To activate SCPI remote trace

The remote trace functionality allows you to trace SCPI commands and messages exchanged over the LAN of the R&S SMCV100B. To communicate with the instrument over SCPI, use a suitable remote control application.

1. Set up the remote control session as described under "To start remote control with the LXI browser" on page 553.
2. In the navigation pane, select "Diagnostics > SCPI Remote Trace".
3. In the toolbar bar of the "SCPI Remote Trace" page, select "live mode > on".
4. Using the remote control program, send your SCPI commands to the R&S SMCV100B.

   The "SCPI Remote Trace" tab displays all sent commands and responses.
5. Select "logging > on".
   (Live mode and logging exclude each other).

"logging > on" displays all commands and responses, and traces messages also.

The SCPI remote trace function records all sent commands, received responses and messages, and saves them in an internal database. If "live mode" is disabled, you can display the recent traces on request, using the "refresh" button. You can also save the log in a file.
Note: The diagnostics functionality is extended in later releases, e.g. to download or upload SCPI command files from / to the instrument.

13.10 To return to manual operation

Before returning to manual control, command processing must be completed. Otherwise, the instrument switches back to remote control immediately.

1. To return from "Remote" state to manual state, perform one of the following:
   - On the controller, use the command `&GTL`
     Note: If `&NREN` has been set before `&GTL` is locked. Use `&GTR` instead.
   - In the status bar, select the "Remote" icon.
   - In the block diagram, select "Context sensitive menu > Key Emulation > Local"
2. **Note:** In the local lockout state, the command `&GTL` is locked. You can unlock this state only over remote control.

   To return from "Remote LLO" state to manual or to "Remote" state, perform one of the following:
   - On the controller, use the command `&LOCS`.
     This command switches directly to manual operation.
   - Send the command `&REMS`.
     This command changes the remote control state from "Remote LLO" to "Remote".
   - Use the Visual Basic command `CALL IBLOC (generator%).`
     The command switches directly to manual operation.
   - VISA function `viGpibControlREN()`
     This function switches directly to manual operation.

13.11 To automate tasks with remote command scripts

To achieve fast configuration, make complex test setups or repeating measurements reproducible, you can automate the required settings with scripts. A script contains a series of SCPI commands corresponding to the settings. When completed, it is converted to an executable format, saved in a file and can be run whenever needed.

If you frequently need to load and run a script, assign the script to the [★ (User)], and you can quickly and easily perform the task.

See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

In contrast to "Recall Setup" over the [★ (User)] key, an assigned script execution does not close active dialogs and windows. Furthermore active window control (open / close) is possible.

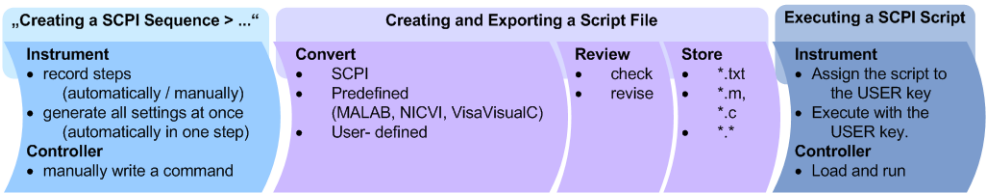


Figure 13-7: Steps for performing SCPI Scripts

The graph shows the main steps required to create and execute a SCPI script.

Creating a SCPI list

Using the SCPI recorder functions, you can create a SCPI command list directly on the instrument and then export the list for use on the controller PC. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, you can retrieve the command corresponding to a setting directly on the instrument.

Directly in the instrument, you can create a SCPI list at any time of operation, in the following ways:

- Recording steps

  Both, automatic and manual SCPI recording of settings is possible. You can start, stop and resume automatic recording, and also record individual commands manually.

  – Manually record the steps selectively
  In manual recording mode, you can deliberately record a SCPI command with the "Add CPI Command to Recording List" function.
  See "To record settings manually" on page 567.

  – Automatically record all performed steps
  The instrument records the SCPI command and settings value of each step you perform, and then writes the commands to the file system.
  See "To record settings automatically" on page 567.
  You can also add a SCPI command manually to the recording list during automatic SCPI recording.

  Note: The vector signal generator clears the SCPI list after booting automatically.

- Generating all settings at once
  Generates the SCPI commands of the current instrument settings in one step, and writes the command list in a temporary list.
  See "To generate a SCPI command list of all settings in one step" on page 568.
  Note: This function lists all commands in alphabetical order, in contrast to the recording or manual creation, which consider the order the settings are configured.

Using this function can slow down the runtime or cause errors during execution. Therefore, always check and revise a script if necessary, see "How to check a SCPI list" on page 569.

- Manually create a command script with "Copy" and paste
  "Show SCPI command" enables you to copy the SCPI command and the current setting and paste it into any suitable editor.
  See "To copy and paste SCPI commands" on page 569.

Some parameters cannot be set by a SCPI command.

If so, *no SCPI command found* is entered instead of a command when you record or generate all settings at once.

The difference between Show SCPI Command and the provided cross-reference

If you want to enter your settings in a script, or use a remote control program, you must know the corresponding SCPI command and the exact syntax.

If you need to look up the SCPI command, the instrument offers two ways to figure it out quickly.

- "Show SCPI command" (context-sensitive menu)
  Displays the SCPI command syntax of a selected parameter including the current setting value, see "Finding out the SCPI command with the "Show SCPI Command" function" on page 572.
  The "Copy" function enables you to write a SCPI script conveniently by hand.
- Instrument help ([Help] key)
  Opens a help topic that describes the selected parameter or instrument function, including a cross-reference to the corresponding SCPI command. The reference leads you to the description of the SCPI command comprising the complete SCPI syntax, all available setting values, value ranges, etc.
  See "Finding out the SCPI command using the online help" on page 572.

Creating and exporting a script file

When the script list is completed, a code generator translates the SCPI commands into the source code of a proprietary programming language, using a code template. Therefore, each language requires an appropriate code template. When converted, you can save the script in a file with an extension corresponding to the programming language.

The R&S SMCV100B provides the following predefined code templates by default:

- Plain SCPI
  Represents SCPI base format, that is ASCII format, saved as text file (`*.txt`).
- MATLAB
  A programming environment, frequently used in signal processing and test and measurement applications (`*.m`).
  You can directly use this format with MATLAB(c) Toolkit. For comprehensive information on this topic, refer to the application note 1GP60.
- NICVI
  An ANSI C programming environment designed for measurements and tests (`*.c`).
  You can directly use this format with National Instruments LabWindows CVI.

- Python3
  A general-purpose and high-level programming language (`*.py`).

You can also convert a script to a user-specific format. In this case, you need a code template with the extension `*.expcodetmpl`.

For information on how to select the code template and save the script in a file, see Section 13.11.3, "SCPI recording export settings", on page 565.

Executing a SCPI script

A SCPI script primarily runs on the controller PC. In addition, you can execute a script directly on the instrument, by assigning the script to the [★ (User)] key.

See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

13.11.1 Show SCPI command settings

Access:

1. Select the parameter.
2. Open the context-sensitive menu.
3. Select "Show SCPI Command".

This function provides the syntax of the remote command with the current setting.

Setttings:

Copy....564
Close....564

Copy
Copies the command and the current setting.

Close
Exits the "SCPI Command" dialog.

13.11.2 Displaying a SCPI list

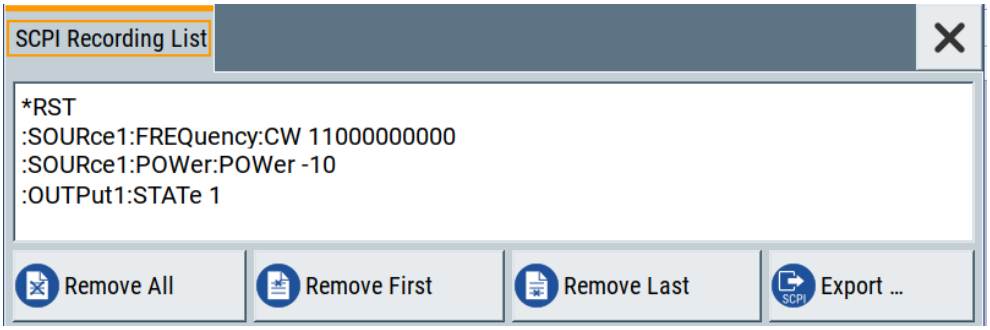
The instrument displays a recorded SCPI list and thus provides monitoring the recorded results before exporting.

► Depending on the starting point, you can access the "SCPI Recording List" dialog as follows:

- During recording
  Select "Show SCPI Recording List" in the context-sensitive menu.
- At any time outside recording
  Select "Show SCPI Recording List" in the context-sensitive menu.

This function assumes that at least one recording has been executed after power-on.

- At the end of the recording
  Select "Stop automatic SCPI recording". The dialog opens automatically.
- After you have exported the script to a file.
  Select "SCPI Recording Export > Show file content"
  See Section 13.11.3, "SCPI recording export settings", on page 565.



The "SCPI Recording List" shows the last recorded and exported commands.

SCPI Recording List
Lists the automatically or manually recorded SCPI commands.

Remove All
Deletes all entries in the SCPI command list.

Remove First
Deletes the first entry in the SCPI command list.

Remove Last
Deletes the last entry in the SCPI command list.

Export
Opens the "SCPI Recording Export" dialog for configuring the file parameters for the SPCI command script file.

See Section 13.11.3, "SCPI recording export settings", on page 565

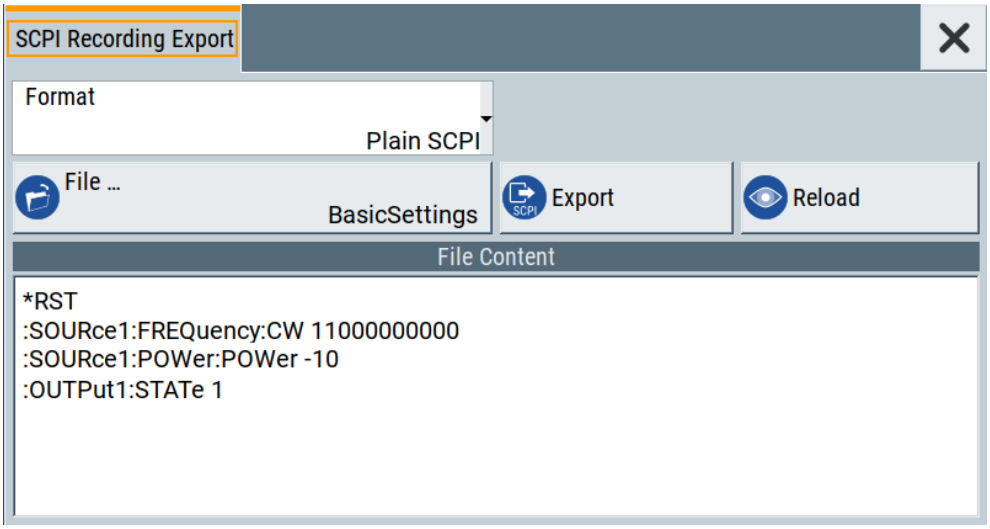
13.11.3 SCPI recording export settings

Scripts are configured and saved in the "SCPI Recording Export" dialog. This dialog opens automatically, when you stop recording.

Access:

1. Select "Show SCPI Recording List" in the context-sensitive menu.
   The "SCPI Recording List" dialog opens.

2. Select "Export".



The "SCPI Recording Export" dialog contains all functions required for export of command lists to a file. It enables you to select the source code format, assign an individual filename and display the file content.

Setttings:

Format....566
Code Template....566
File....566
Export....567
Reload....567
File content....567

Format
Selects the source code format for the command list.

"Plain SCPI" Uses SCPI syntax.

"Predefined Code Generator"
Accesses the predefined templates for common source code generators that convert the recorded settings in the programming languages MATLAB or NICVI or Python.

"User Code Generator"
Use this setting to convert a script by a user-specific code generator.

Code Template
Opens a standard file handling dialog for saving or loading predefined or user-defined code templates.

File
Opens a standard file handling dialog for selecting the directory and file name for the output file.

Export
Saves the remote command list file in the selected directory.

Reload
Reloads a remote command list file.

File content
Displays the content of the remote command list in the selected format and code template.

13.11.4 How to record / create SCPI lists

The following examples show how to proceed for creating remote command lists.

For comprehensive description, see 1GP98: SCPI Recorder Test Automation on a Fingertip.

To record settings automatically

1. On the screen, open the context-sensitive menu.
2. Select "Start SCPI recording".



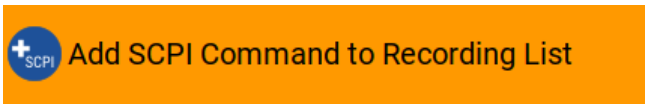
   The R&S SMCV100B now records all steps you take.
3. To stop SCPI recording, select "Stop SCPI recording" in the context-sensitive menu.



   The "SCPI Recording List" dialog opens.
4. Proceed with "To review a remote command list" on page 570.

To record settings manually

1. Select the parameter or function.
2. Set the parameter.
3. Open the context-sensitive menu.
4. Select "Add SCPI Command to Recording List".



The R&S SMCV100B adds the SCPI command of the setting including the value in a temporary SCPI command list.

Tip: "Context-Sensitive > Show SCPI Recording List" opens the dialog with the recorded settings.



5. Continue with the next setting accordingly whenever you want to record it.
6. Proceed with "To review a remote command list" on page 570.

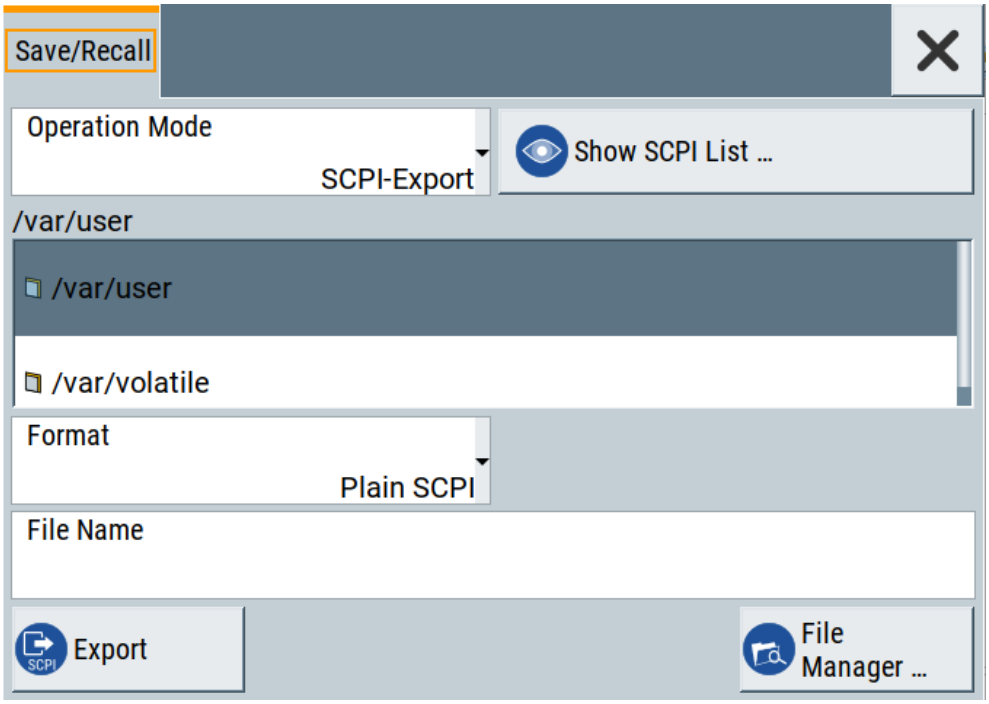
To generate a SCPI command list of all settings in one step

Using the save/recall function, you can create a SCPI command list for all settings in one step.

1. Press the [Save/Recall] key.

   The instrument opens the standard "Save/Recall" dialog.

2. Select "Operation mode" > "SCPI Export".



   The dialog adjusts the entry fields for configuring the command list file. "Show SCPI List" provides access to the list of all setttings the instrument has recorded.

3. Select the "/var/user" directory in which you want to save the SCPI command list.
4. In the "Format" entry field, select the source code format.
5. Enter a filename.
6. Select "Export".

The R&S SMCV100B saves the SCPI command list as `*.txt` file.

Note: Exporting the SCPI list of the instrument state in one step usually requires postprocessing on an external PC, as this function lists all instrument states and commands in alphabetical order.
In contrast, recording or manual creation of a SCPI command list considers the order the settings are configured.

To copy and paste SCPI commands

1. On the instrument, select the parameter or function.
2. Set the parameter.
3. Open the context-sensitive menu.
4. Select "Show SCPI Command".



The R&S SMCV100B displays the syntax and the setting value of the SCPI command.

With the "Copy" function, you can copy and paste the SCPI command and setting value, e.g., in a command script on a PC.

How to check a SCPI list

The easiest way to check a list, is to execute it. The generator returns a warning if a setting could not be performed.

However, we recommend that you check the list and possibly rework. It can be that ...

- A parameter has not assigned a SCPI command or an element of the user interface has not an assigned parameter. In these cases, `:SYST:INF:SCPI 'SCPI command not available'` is entered in the list instead.
  Such entries are also detected during execution. The instrument recognizes these incomplete commands and displays an error message.
- A preset has been executed, but several standards then perform some internal settings that are also assigned to the list with "SCPI Export".
- After a preset still some settings are defined, which are then written to the list generated with "SCPI Export."

To display a remote command list

On the instrument, you have different options to access a remote command list.

1. During automatic or manual recording:
   a) Open the context-sensitive menu.
   b) Select "Show SCPI Recording List".
2. At the end of automatic recording:
   a) Open the context-sensitive menu.

b) Select "Stop SCPI Recording".

3. After exporting a command list to a file.
   a) Select "SCPI Recording Export" > "Show file content".
   The "SCPI Recording List" opens.

To review a remote command list

To rework a remote command list, you must transfer it to a computer.

1. Export the list to a PC, using, for example, a USB flash drive.
2. Check the list, e.g. by comparing it with the modified settings in the manual mode.
   Tip: To find out your settings, you can use the "Mark all parameters changed from preset" function.
   See Section 11.3.2, "Identifying parameters with non-default values", on page 424.
3. Search for missing or incomplete command entries.
   a) Add missing commands.
   b) Complete missing parts of commands.
   c) Remove superfluous entries, e.g. `:SYST:INF:SCPI 'SCPI command not available'`.
   d) Remove unnecessary content written after a preset.
4. Rearrange the commands to a reasonable order. For example, if you set a `STATe` command to the last position in a list, you can avoid intermediate calculations of the signal.

13.11.5 How to convert and save SCPI lists

For conversion of a remote command list into an executable script, a code generator translates the commands into the source code of a proprietary programming language, based on a code template. Therefore, each progamming language requires a dedicated code template.

To configure a plain SCPI script file

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. Select "Export".
   The "SCPI Recording Export" dialog opens.
3. Select the "Format" > "Plain SCPI".
4. Select "File".
   A standard file handling dialog opens.
5. Configure filename and directory and confirm with "Ok".
6. In the "SCPI Recording Export" dialog, select "Export".

The R&S SMCV100B saves the recorded data in `*.txt` format. The "File Content" section shows the SCPI commands of the script file.

To convert the command list to a predefined code template

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. Select "Export".
   The "SCPI Recording Export" dialog opens.
3. In the "SCPI Recording Export" dialog, select "Format" > "Predefined Code Generator".
   The "CodeTemplate" button appears.
4. Select "Code Template".
   The "SCPI Recording Export - Select Predefined Code Template" dialog opens.
5. Select a predefined code template, e.g., "MATLAB".
6. Confirm with "Select".
   The R&S SMCV100B returns to the "SCPI Recording Export" dialog.
7. Select "File".
   A standard file handling dialog opens.
8. Configure filename and directory and confirm with "Ok".
9. In the "SCPI Recording Export" dialog, select "Export".
   The R&S SMCV100B saves the recorded data in the corresponding format. The "File Content" section shows the content of the script file in the corresponding programming language.

To convert the command list to a user-defined code template

Before creating a script in a user-specific format, make sure that you have saved the code template with the file extension `*.expcodetmpl` in the instrument.

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. In the "SCPI Recording Export" dialog, select "Format" > "Use Code Generator".
   The "CodeTemplate" button appears.
3. Select "Code Template".
   The "SCPI Recording Export - Select User Code Template" dialog opens.
4. Select your user-defined code template.
5. Confirm with "Select".
   The R&S SMCV100B returns to the "SCPI Recording Export" dialog.
6. Select "File".
   A standard file handling dialog opens.
7. Configure filename and directory and confirm with "Ok".

8. In the "SCPI Recording Export" dialog, select "Export".
   The R&S SMCV100B saves the recorded data in the corresponding format. The "File Content" section shows the content of the script file in the corresponding programming language.

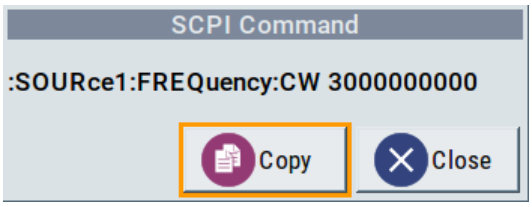
13.11.6 How to find out the SCPI commands for GUI functions

Finding out the SCPI command with the "Show SCPI Command" function

1. To find out the SCPI command of a parameter in manual operation, select the parameter.
2. Open the context-sensitive menu and select "Show SCPI command"



   You get the detailed command syntax, including the currently set value.



   With the "Copy" function, you can conveniently paste the command including the current setting, e.g., in a command script.

Finding out the SCPI command using the online help

If you are looking for the remote command to a function in manual operation, you find it in the description of the online help.

1. To find out the SCPI command of a parameter in manual operation, select the respective parameter.
2. To open the corresponding help topic, select one of the following:
   - In the display, select "context-sensitive menu > Help".



   - On the front panel, press the [Help] key.

   The help topic opens. Apart from the function description, it contains the SCPI command in detailed syntax.

How to find the corresponding GUI function to a command

Conversely, if you are looking for a function in the GUI, which belongs to a SCPI, you find it via a cross-reference in the online help and in the user manual.

13.12 To operate the instrument using VNC

This section shows you some examples of the various possibilities to set up remote operation.

- Using a desktop system
  - Section 13.12.2.1, "Using a web browser", on page 573
  - Section 13.12.2.2, "Using a VNC client software", on page 574
- Using a smart device
  - Section 13.12.3.1, "Using a VNC app", on page 577
  - Section 13.12.3.2, "Using a web browser with HTML5", on page 578
  - Section 13.12.3.3, "Special mode QR code", on page 578

13.12.1 Enabling VNC service

To enable VNC service on the R&S SMCV100B

1. **NOTICE!** Enabled VNC service can lead to unauthorized access.
   Change the computer name and password of the instrument.
   See Section 12.6.5, "Preventing unauthorized access", on page 503.
2. Select "System Config > Setup > Security > Security".
3. Select "LAN Services > Common Services".
4. Enable "VNC".
5. Enter the Security Password.
6. Confirm with "Accept".

13.12.2 How to set up remote operation from a desktop system

13.12.2.1 Using a web browser

The R&S SMCV100B supports remote operation over VNC with any web browser, e.g., Windows Internet Explorer, Mozilla Firefox, or an HTML5 web browser.

To operate the instrument from a web browser over VNC

1. Install the *JRE (Java Runtime Environment)* on the remote computer.
   Note: Skip this step if you are working with an HTML5 web browser.
2. Enter the IP address of the instrument in the address field of the web browser, e.g. *http://10.113.1.151*

   The VNC authentication screen appears.
3. Enter the user password.
   The default password is *instrument*.
4. Confirm with with "OK".

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

13.12.2.2 Using a VNC client software

A VNC client software is an application which can be used to access and control the instrument from a remote computer over the LAN connection.

The VNC client software for setting up the connection is included in the operating system Linux/Unix per default. For Windows operating systems, a VNC client software must be installed manually.

Various free-of charge programs such as Ultr@VNC or similar VNC client programs are available for download on the Internet.

To operate the instrument from a Linux/Unix client over VNC

1. Start a web browser on the remote computer. Enter the IP address of the instrument.
2. Enter the following address:
   `vnc://<IP-address of the instrument>`, for example *vnc://10.113.1.151*.

   A dialog opens requesting the password for the remote VNC connection.
3. Enter the user password.
   The default password is *instrument*.
4. Confirm with with "OK".

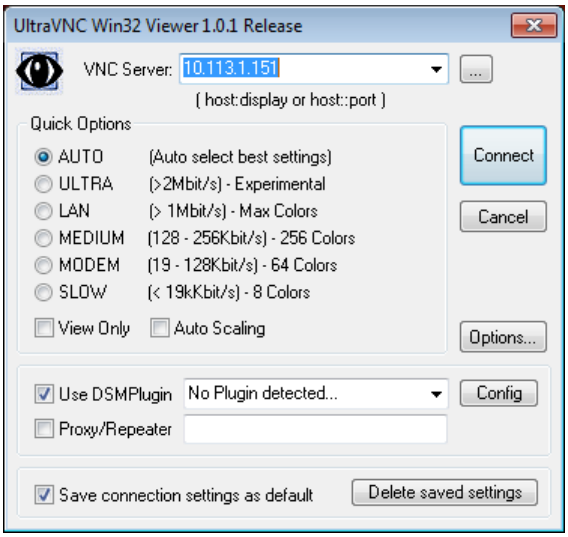
   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

To operate the instrument from a Windows client over VNC

1. Install the VNC viewer program component on the remote computer.
   a) Download a VNC client program from the Internet.
   For example the free of charge software Ultr@VNC (`vncviewer.exe` is available, see http://www.uvnc.com/download/index.html.
   b) Execute the VNC client installation.

c) Select the VNC viewer program component and follow the installation instructions.

2. Start VNC viewer program component on the PC.



3. Select "VNC Server"
4. Enter the IP address of the instrument.
5. Confirm with "Connect".

   An authentication dialog opens.



6. Enter the user password for authentication.
   The default password is *instrument*.
7. Confirm with "LogOn".

   When the connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

To stop remote operation

To terminate remote operation over VNC depends on the used client:

► Select the action that applies to the used client:

a) On an external Unix/Linux PC, close the Internet browser or the signal generator window.
b) On an external Windows PC, close the VNC viewer program.

c) On a smart device, close the application.

The connection is terminated but not disabled. It can be established again anytime.

13.12.3 How to set up remote operation from a smart device

The R&S SMCV100B supports remote operation over VNC from a smart device (remote client), like a tablet (tablet computer) or a smartphone. The smart device accesses the instrument over WLAN, either by a suitable App, or an HTML5 web browser with embedded *javascript*.

There are several possibilities to establish a WLAN connection between the smart device and the R&S SMCV100B. This section gives an example of how a network environment can be built up, and some essential configuration steps.

For more information, see:

- 1MA216: Remote Operation of Windows Based Instruments with Apple iPad
- 7BM82: Apple iPad Remote Control of Broadcasting T&M Instruments

Example:

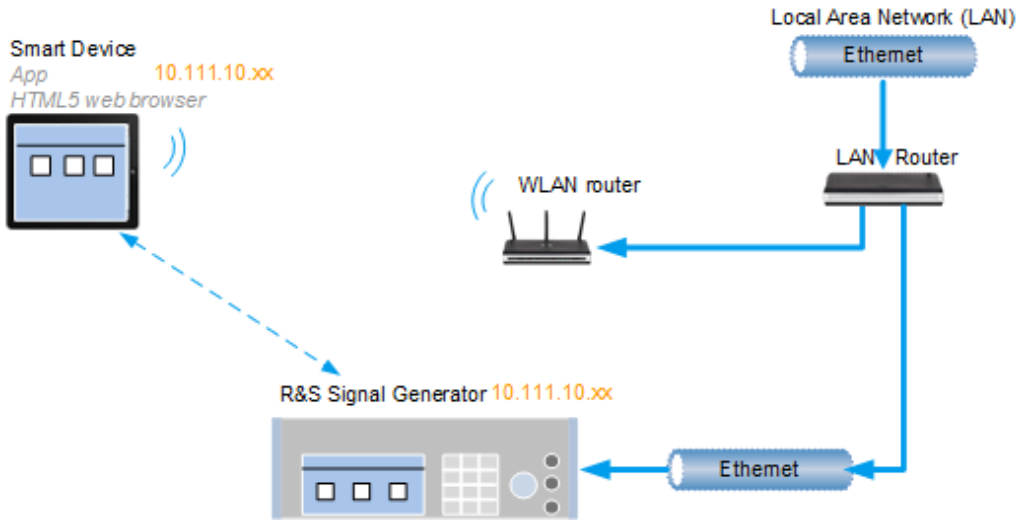


Figure 13-8: Example of a network configuration for remote operation with a smart device

As shown in the figure, the R&S SMCV100B and the WLAN router are connected to the LAN router. The smart device accesses the Rohde & Schwarz instrument via the WLAN router.

The WLAN router as an additional access point enables you to operate the instrument even from a great distance.

Prerequisites

For the remote operaton, you need the following equipment and configuration:

- Equipment:
  - LAN router

  - WLAN router (hot spot) for accessing the instrument
  - Smart device
- The instrument and the smart device PC are connected in the same network.
- The instrument and the smart device are switched on.
- The LAN interface and VNC LAN service is enabled.
  See Section 12.6.3, "Configuring LAN services", on page 496.
- A suitable application is running on the smart device.
  - Web browser
    The R&S SMCV100B supports remote operation over VNC with any HTML5 compliant web browser, e.g., Internet Explorer, Firefox, Google Chrome or Safari.
  - VNC app
    An application that implements the VNC functionality for remote operation. The VNC App must be suitable to the used smart device.
    Refer to the manufacturer's website to find a VNC App supported for your smart device, and how it is installed.
  - QR code
    If your smart device is equipped with a camera and a QR code reader, you can scan the instrument's IP address or access the instrument with the Safari web browser.
    Refer to the manufacturer's website to find a QR code reader supported for your smart device, and how it is installed.

We recommend that all components in the network use DHCP, which automatically assigns the relevant address information.

13.12.3.1 Using a VNC app

Using a *VNC App* enables the smart device to access the R&S SMCV100B for remote operation over WLAN.

Refer to the manufacturer's website to find a VNC App supported for your smart device, and how it is installed.

To operate the instrument using a VNC App on a smart device

1. Set up the network connection as shown in Figure 13-8
2. Configure the WLAN router according to the manufacturer's instructions.
3. Install the required *VNC App* on your smart device.
4. On the smart device, start the *VNC App*.
   Enter the IP address of the instrument in the address field of *VNC App*.

   The VNC authentication screen appears.
5. Enter the user password.
   The default password is *instrument*.
6. Enter the password to establish the remote access.

The default user name and password is *instrument*.

When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the smart device.

13.12.3.2 Using a web browser with HTML5

The R&S SMCV100B supports remote operation from a smart device over VNC with any HTML5 compliant web browser, like Internet Explorer, Firefox, Google Chrome, or Safari for instance.

To operate the instrument from a web browser over VNC

1. Install the *JRE (Java Runtime Environment)* on the remote computer.
   Note: Skip this step if you are working with an HTML5 web browser.
2. Enter the IP address of the instrument in the address field of the web browser, e.g. *http://10.113.1.151*

   The VNC authentication screen appears.
3. Enter the user password.
   The default password is *instrument*.
4. Confirm with with "OK".

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

13.12.3.3 Special mode QR code

If your smart device is equipped with a camera and a QR code reader, you can scan the instrument's IP address or access the instrument with the Safari web browser.

Refer to the manufacturer's website to find a QR code reader supported for your smart device, and how it is installed.

To access the instrument with QR code on a smart device

1. Set up the network connection as shown in Figure 13-8
2. Configure the WLAN router according to the manufacturer's instructions.
3. Install the required QR code reader software on your smart device.
4. On the smart device, start the QR code reader.
5. On the R&S SMCV100B, select "System Config > Remote Access".
6. Select the "QR-Code" tab.
7. Scan the QR code of the instrument with your smart device.
8. On the smart device, decode the scanned QR code and forward it to the web browser.

The VNC authentication screen appears.

9. Enter the user password.
   The default password is *instrument*.

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the smart device.

13.13 References

13.13.1 LXI functionality

LAN Extensions for Instrumentation (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology.

The LXI implementation in the R&S SMCV100B allows you to change certain LAN settings, to reset the LAN connection, and to identify the instrument.

For information about the LXI standard, refer to the LXI website at https://www.lxistandard.org.

See also "News from Rohde & Schwarz, article 2006/II - 190".

The LXI functionality in the R&S SMCV100B is characterized by a common LAN implementation, including an ICMP ping responder for diagnostics. Using a web browser, you can configure the instrument. A LAN Configuration Initialize (LCI) mechanism resets the LAN configuration. The instrument also supports automatic detection in a LAN via the VXI-11 discovery protocol and programming by IVI drivers.

In addition, the R&S SMCV100B provides the following LXI-related functionality:

- Integrated "LXI Status" dialog for LXI status indication and reset of the LAN configuration, see Section 13.6.1, "LXI status settings", on page 541.
- "LXI Browser Interface", as described in Section 13.6.2.1, "LAN configuration", on page 544.
- "SCPI Remote Trace" utility, see Section 13.6.2.2, "SCPI remote trace", on page 546.

Firmware update

To enable the full LXI functionality after a firmware update, shut down and restart the instrument.

13.13.2 Code generator templates

This section describes the main structure of the code generator templates, and shows the method with the NICVI template.

The code generation is controlled by templates with the following blocks:

Command	Function
#EXTENSION_START #EXTENSION_END	Defines the output file extension.
#INIT_CODE_START #INIT_CODE_END	Contains initial entries, such as included files and libraries, buffer size, commands for synchronization, or creating a VISA session. All entries between start and end are written once at the beginning of the output file.
#COMMAND_CODE_START #COMMAND_CODE_END	Frame for a SCPI command. A command is accessed with %COMMAND.
#NO_COMMAND_CODE_START #NO_COMMAND_CODE_END	Frame for a parameter with no SCPI command available. A parameter is accessed with %PARAMETER.
#EXIT_CODE_START #EXIT_CODE_END	Closes the visa session. All entries between start and end are written once at the end of the output file.

Templates are created in ASCII format with file extension *.expcodetempl.

Example:

Example to the code generator template NICVI.expcodetmpl:

```
#EXTENSION_START
.c
#EXTENSION_END

#INIT_CODE_START
#include <ansi_c.h>
#include <visa.h>
#include <cvirte.h>

#define MAX_BUFFER_SIZE 200
static ViStatus status;
static ViSession defaultRM, handle;

static void write_command(char *command)
{
  char writeBuffer[MAX_BUFFER_SIZE];
        char readBuffer[MAX_BUFFER_SIZE];
        int length;
        int readCount;

        strcpy(writeBuffer, command);
        //append "*OPC?" to sync
        strcat(writeBuffer, ";*OPC?");
        length = strlen (writeBuffer);
```

```
        writeBuffer[length]='\n';
        length = length+1;
        viWrite (handle, writeBuffer, length, VI_NULL);
        //read result
        viRead(handle, readBuffer, 100, &readCount);
}
int main (int argc, char *argv[])
{
  if (InitCVIRTE (0, argv, 0) == 0)
     return -1;    /* out of memory */
        //create a VISA session and return a handle to it
     viOpenDefaultRM (&defaultRM);
        //create a VISA session to the serial port and return a handle to it
        viOpen (defaultRM, (ViRsrc)"TCPIP::localhost::INSTR", VI_NULL, VI_NULL,
&handle);
#INIT_CODE_END

#COMMAND_CODE_START
  write_command("%COMMAND");
#COMMAND_CODE_END

#NO_COMMAND_CODE_START
  //no SCPI command available for parameter %PARAMETER !
#NO_COMMAND_CODE_END

#EXIT_CODE_START
  viClose (handle);
        viClose (defaultRM);
        return 0;
}
#EXIT_CODE_END
```

13.13.3 Remote control states

How to recognize if there is an active remote connection to the instrument

► Observe the indication on the taskbar.

A softkey in the taskbar indicates if and what kind of remote connections are currently set up.
See also Section 13.5.4, "Remote connections settings", on page 528.

The following table shows the different remote control states and the associated commands or actions to return to manual control.

14 Remote control commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

For an introduction to remote control and the status registers, see Section 13, "Network operation and remote control", on page 509.

- Conventions used in SCPI command descriptions 582
- Programming examples 583
- Common commands 584
- Preset commands 588
- MMEMory subsystem 590
- CALibration subsystem 602
- DIAGnostic subsystem 606
- HUMS remote control commands 609
- DISPlay subsystem 617
- FORMat subsystem 621
- HCOPy subsystem 623
- KBOard subsystem 628
- OUTPut subsystem 629
- SENSe, READ, INITiate and SLISt subsystems 632
- SCONfiguration subsystem 646
- SOURce subsystem 660
- SYSTem subsystem 825
- STATus subsystem 853
- TEST subsystem 857
- TRIGger subsystem 860
- UNIT subsystem 862

14.1 Conventions used in SCPI command descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**

Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S SMCV100B follow the SCPI syntax rules.

- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Factory preset values**
  Default parameter values that are reset only by factory preset.
- **Default unit**
  The default unit is used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

14.2 Programming examples

The corresponding sections of the same title provide simple programming examples for the R&S SMCV100B. The purpose of these examples is to present all commands for a given task. Real applications require application-specific sets of commands and configurations.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines start with two characters `//`, for example, comments.

At the beginning of the most remote control program, an instrument preset or reset is recommended to set the R&S SMCV100B to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

In all the examples we assume the following:

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

14.3 Common commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

*CLS....584
*ESE....584
*ESR?....584
*IDN?....585
*IST?....585
*OPC....585
*OPT?....585
*PRE....586
*PSC....586
*RCL....586
*RST....586
*SAV....587
*SRE....587
*STB?....587
*TRG....587
*TST?....588
*WAI....588

***CLS**

Clear status

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Usage: Setting only

***ESE** <Value>

Event status enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

Parameters:
<Value> Range: 0 to 255

***ESR?**

Event status read

Returns the contents of the event status register in decimal form and then sets the register to zero.

Return values:
<Contents> Range: 0 to 255

Usage: Query only

***IDN?**

Identification

Returns the instrument identification.

Return values:
<ID> "Rohde&Schwarz,<device type>,<part number>/<serial number>,<firmware version>"

Usage: Query only

Manual operation: See "IDN String" on page 528
See "Hardware Options/Software Options" on page 874

***IST?**

Individual status query

Returns the contents of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

Return values:
<ISTflag> 0 | 1

Usage: Query only

***OPC**

Operation complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query writes a "1" into the output buffer when all preceding commands have been executed, which is useful for command synchronization.

***OPT?**

Option identification query

Queries the options included in the instrument. For a list of all available options and their description, refer to the specifications document.

Return values:
<Options> The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

Usage: Query only

Manual operation: See "OPT String" on page 528
See "Hardware Options/Software Options" on page 874

***PRE** <Value>

Parallel poll register enable

Sets parallel poll enable register to the indicated value. The query returns the contents of the parallel poll enable register in decimal form.

Parameters:
<Value> Range: 0 to 255

***PSC** <Action>

Power on status clear

Determines whether the contents of the `ENABle` registers are preserved or reset when the instrument is switched on. Thus a service request can be triggered when the instrument is switched on, if the status registers ESE and SRE are suitably configured. The query reads out the contents of the "power-on-status-clear" flag.

Parameters:
<Action> 0 | 1

0
The contents of the status registers are preserved.

1
Resets the status registers.

***RCL** <Number>

Recall

Loads the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command `*SAV` with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>, <file_name.extension>` command.

Manual operation: See "Quick Recall x" on page 430

***RST**

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

Usage: Setting only

Manual operation: See "Preset" on page 424

***SAV** <Number>

Save

Stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command `*RCL` with the associated number.

To transfer the stored instrument settings in a file, use the command `:MMEMory:STORe:STATe`.

Manual operation: See "Quick Save x" on page 430

***SRE** <Contents>

Service request enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

Parameters:

<Contents> Contents of the service request enable register in decimal form. Bit 6 (MSS mask bit) is always 0.

Range: 0 to 255

***STB?**

Status byte query

Reads the contents of the status byte in decimal form.

Usage: Query only

***TRG**

Trigger

Triggers all actions waiting for a trigger event. In particular, *TRG generates a manual trigger signal. This common command complements the commands of the `TRIGger` subsystem.

`*TRG` corresponds to the `INITiate:IMMediate` command.

Usage: Event

***TST?**

Self-test query

Initiates self-tests of the instrument and returns an error code.

Return values:

<ErrorCode> **integer > 0 (in decimal format)**
An error occurred.
(For details, see the Service Manual supplied with the instrument).

0
No errors occurred.

Usage: Query only

***WAI**

Wait to continue

Prevents servicing of the subsequent commands until all preceding commands have been executed and all signals have settled (see also command synchronization and `*OPC`).

Usage: Event

14.4 Preset commands

The preset commands are not bundled in one subsystem. Therefore, they are listed separately in this section.

In addition, a specific preset command is provided for each digital standard. These specific commands are described in the associated subsystems.

Four presetting actions are available:

- Activating the default state of all internal instrument functions (`*RST` on page 586). Functions that concern the integration of the instrument into a measurement setup are not changed, e.g. reference oscillator source settings.
- Activating the preset state of the parameters related to the selected signal path (`:SOURce<hw>:PRESet` on page 589)
- Activating the preset state of all parameters that are not related to the signal path (`:DEVice:PRESet` on page 589)
- Activating the original state of delivery (factory reset, `:SYSTem:FPReset` on page 589). Only functions that are protected by a password remain unchanged as well as the passwords themselves.

When resetting, the following deviation between remote and manual control exists:
In contrast to the [Preset] key, the SCPI commands `*RST` and `:SYSTem:PRESet` do not close open dialogs in the GUI.

:DEVice:PRESet 589
:SOURce<hw>:PRESet 589
:SYSTem:PRESet 589
:SYSTem:FPReset 589

:DEVice:PRESet

Presets all parameters which are not related to the signal path, including the LF generator.

Example: `DEV:PRES`
Presets all instruments settings that are not related to the signal path.

Usage: Event

:SOURce<hw>:PRESet

Presets all parameters which are related to the selected signal path.

Example: `SOUR:PRES`
Presets all settings that are related to signal path

Usage: Event

:SYSTem:PRESet

Triggers an instrument reset. It has the same effect as:

- The [Preset] key.
  However, the command does not close open GUI dialogs like the key does.
- The `*RST` command

For an overview of the settings affected by the preset function, see Table 11-1

Example: `SYST:PRES`
All instrument settings (also the settings that are not currently active) are reset to their default values.

Usage: Setting only

:SYSTem:FPReset

Triggers an instrument reset to the original state of delivery.

Example: `SYST:FPR`
All instrument settings (also the settings that are not currently active) are reset to the factory values.

Usage: Event

Manual operation: See "Execute Factory Preset" on page 424

14.5 MMEMory subsystem

The `MMEMory` subsystem (Mass MEMory) contains the commands for managing files and directories as well as for loading and saving complete instrument settings in files.

Mass storage location

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

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

Default storage location

The R&S SMCV100B stores user data in the user directory.

In the file system, user directory is always indicated as **`/var/user/`**.

In manual control, you access this directory via the "File Manager", see Section 11.9, "Using the file manager", on page 434. In remote control, you can query it with the command `:SYSTem:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command `:MMEMory:CDIRectory`.

14.5.1 File naming conventions

To enable files to be used in different file systems, consider the following file naming conventions:

- The *filename* can be of any length and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters.
- All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the filename).
- Avoid using special characters.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

File extension

The file and the optional file *extension* are separated by a period sign. The R&S SMCV100B distinguishes the files according to their extensions; each type of file

is assigned a specific file content and hence a specific file extension. Refer to Section A, "Available user files and file extensions", on page 898 for an overview of the supported file extensions.

Wildcards

The two characters "*" and "?" function as "wildcards", i.e. they are used for selecting several files. The "?" character represents exactly one character, while the "*" character represents all characters up to the end of the filename. "*.*" therefore represents all files in a directory.

Filename and file path

When used in remote control commands, the parameter `<filename>` is specified as a string parameter with quotation marks. It can contain either the complete path including the root user directory `/var/user` and filename, or only the filename. The filename must include the file extension. The same applies for the directory `/var/volatile` and for the parameters `<directory_name>` and `<path>`.

Depending on how much information is provided, the values specified in the parameter or with the command `MMEM:CDIR` are used for the path and drive setting in the commands.

14.5.2 Handling files in the default or in a specified directory

For better overview and easy file handling, you may not save all user files in the user directory `/var/user` but rather organize them into subdirectories.

The command syntax defines two general ways to access files with user data in a *specific* directory:

- **Change the current default directory** for mass memory storage and then directly access the files in this default directory, like saved list files, files with user data or save/recall files.
  (See Example "Save the user settings in a file in a specific directory" on page 592).
  The subsequent commands for file handling (select, delete, read out files in the directory, etc.) require only specification of the filename. File extension can be omitted; after syntax evaluation of the used command, the R&S SMCV100B filters out the relevant files.
- Define the **complete file path**, including the user directory `/var/user`, created subdirectories and filename.
  As a rule, whenever an complete file path is determined, it overwrites a previously specified default directory.

The following example explains this rule as a principle. Exceptions of this general rule are stated in the description of the corresponding command. The Section 14.5.3, "Programming examples", on page 592 explains the general working principle with the commands for mass memory storage.

The same rule applies to the `/var/volatile` directory, see Example "Working with files in the volatile memory" on page 594.

Example: Save the user settings in a file in a specific directory

This example uses the commands for saving and loading files with custom digital modulation settings. We assume that the directory `/var/user/DigMod` is existing and contains the files `SaveRecallTest.dm` and `dmSavRcl.dm`.

```
// Set the default directory first
MMEMory:CDIRectory "/var/user/DigMod"
SOURce1:BB:DM:SETTing:CATalog?
// "SaveRecallTest","dmSavRcl"

// Specify only the file name; the extenssion *.dm is assigned automatically
SOURce1:BB:DM:SETTing:STORe "dmSettings"
SOURce1:BB:DM:SETTing:DELete "dmSavRcl"
SOURce1:BB:DM:SETTing:LOAD "SaveRecallTest"
SOURce1:BB:DM:SETTing:CATalog?
// "SaveRecallTest","dmSettings"
```

Example: Load file with user data from a specific directory

This example shows how to use the custom digital modulation commands to set the data source and select a data list. We assume that the directory `/var/user/lists` is existing and contains the files `dlist1.dm_iqd` and `myDList.dm_iqd`.

```
// Select a data list file as data source
SOURce1:BB:DM:SOURce DLISt

// Query the data list files (*.dm_iqd) in the default directory
MMEMory:CDIRectory "/var/user/lists"
SOURce1:BB:DM:DLISt:CATalog?
// "dlist1","myDList"

// Specify the complete path to select a data list file (*.dm_iqd)
// in the specific directory
MMEMory:CDIRectory
SOURce1:BB:DM:DLISt:SELect "/var/user/lists/myDList"
SOURce1:BB:DM:DLISt:DELete "/var/user/lists/dlist1"
```

14.5.3 Programming examples

Example: Saving and loading current settings

This example shows two ways of how to save the current instrument setting in the file `settings.savrcltxt` in the directory `/var/user/savrcl`.

Before the instrument settings can be saved in a file, they have to be saved in an intermediate memory using common command *SAV <number>. The specified number is then used in the :MMEMory:STORe:STATe command.

Also, after loading a file with instrument settings with command :MMEMory:LOAD:STATe, these settings have to be activated with the common command *RCL <number>.

```
// Save the current settings in an intermediate memory with number 4
*SAV 4

// save the settings in a file in a specific directory;
// the complete path has to be specyfied
MMEMory:STORe:STATe 4,"/var/user/savrcl/settings.savrcltxt"

// save the settings in a file in the default directory;
// set the default directory; specify only the file name
MMEMory:CDIRectory  "/var/user/savrcl"
*SAV 4
MMEMory:STORe:STATe 4,"settings.savrcltxt"

// Load the saved settings in the intermediate memory 4 and activate them
MMEMory:LOAD:STATe 4,"/var/user/settings.savrcltxt"
*RCL 4
```

Example: Working with files and directories

This example shows how to list files in a directory, list the subdirectories, query the number of files in a directory, create directory, rename and delete files.

```
// Query the current default directory for mass storage,
// change the directory to the default user directory "/var/user"
// and read out the files in it
MMEMory:CDIRectory?
// "/var/user/temp"
MMEMory:CDIRectory
MMEMory:CDIRectory?
// "/var/user/"
MMEMory:CATalog?
// 1282630,8102817792,".,DIR,4096","..,DIR,4096","Log,DIR,4096",
// "settings.savrcltxt,BIN,16949","temp,DIR,4096","test,DIR,4096",
// "list.lsw,BIN,1245201"
// the directory "/var/user" contains the predefined directory "Log",
// the subdirectories "test" and "temp"
// as well as the files "settings.savrcltxt" and "list.lsw"

// query only the subdirectories of the current or specified directory
MMEMory:DCATalog? "/var/user"
// ".","..","Log","temp","test"
```

```
// query only number of subdirectories in the current or specified directory
MMEMory:DCATalog:LENGth? "/var/user"
// 5

// query number of files in the current or specified directory
MMEMory:CATalog:LENGth? "/var/user"
// 7

// Create a new directory for mass memory storage in the specified directory
MMEMory:MDIRectory "/var/user/new"

// Copy the file "settings.savrcltxt" into the new directory
MMEMory:COPY "/var/user/settings.savrcltxt","/var/user/new/settings.savrcltxt"

// Rename the file "settings.savrcltxt" into the new directory
// and read out the files in this specific directory
MMEMory:CDIRectory  "/var/user/new"
MMEMory:MOVE "settings.savrcltxt","settings_new.savrcltxt"
MMEMory:CATalog? "/var/user/new"
// 25141,8102789120,".,DIR,4096","..,DIR,4096","settings_new.savrcltxt,BIN,16949"

// Delete an empty directory, e.g. the "test" directory
MMEMory:RDIRectory "/var/user/test"
// Delete the entire directory, including files and subdirectories
:MMEMory:RDIRectory:RECursive "var/user/test"
```

Example: Working with files in the volatile memory

This example shows how to work with files in the `/var/volatile` directory.

```
// Change the default directory for mass storage,
// read out the files, load and play a file with the ARB
MMEMory:CDIRectory "/var/volatile"
MMEMory:CDIRectory?
// "/var/volatile"
MMEMory:CATalog?
//13928,525352960,".,DIR,60","..,DIR,4096","list.lst,BIN,9772"

SOURce1:LIST:SELect "/var/volatile/list"
SOURce1:FREQuency:MODE LIST
OUTPut1:STATe 1
```

14.5.4 Remote control commands

:MMEMory:CATalog?....595
:MMEMory:CATalog:LENGth?....595
:MMEMory:CDIRectory....595
:MMEMory:COPY....596
:MMEMory:DATA....596

:MMEMory:DATA:UNPRotected....597
:MMEMory:DCATalog?....598
:MMEMory:DCATalog:LENGth?....599
:MMEMory:DELete....599
:MMEMory:LOAD:STATe....599
:MMEMory:MDIRectory....600
:MMEMory:MOVE....600
:MMEMory:MSIS....600
:MMEMory:RDIRectory....600
:MMEMory:RDIRectory:RECursive....601
:MMEMory:STORe:STATe....601
:MEMory:HFRee?....601

:MMEMory:CATalog?

Returns the content of a particular directory.

Return values:

<Catalog> string

String parameter to specify the directory.
If you leave out the path, the command returns the contents of the directory selected with `:MMEMory:CDIRectory`.
The path may be relative or absolute.

Usage: Query only

Manual operation: See "Directory, File List and Filename" on page 429

:MMEMory:CATalog:LENGth? [<Path>]

Returns the number of files in the current or in the specified directory.

Query parameters:

<Path> string

String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with `:MMEMory:CDIRectory` command.

Return values:

<FileCount> integer

Number of files.

Usage: Query only

:MMEMory:CDIRectory <Directory>

Changes the default directory for mass memory storage. The directory is used for all subsequent `MMEM` commands if no path is specified with them.

Parameters:

<Directory> <directory_name>

String containing the path to another directory. The path can be relative or absolute.
To change to a higher directory, use two dots '..' .

Manual operation: See "Directory, File List and Filename" on page 429
See "Directory and Filename" on page 436

: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

Manual operation: See "Cut, Copy&Paste and Delete" on page 436

:MMEMory:DATA <Filename>, <BinaryData>
:MMEMory:DATA? <Filename>

The setting command writes the block data `<BinaryBlock>` to the file identified by `<Filename>`.

Tip: Use this command to read/transfer stored instrument settings or waveforms directly from/to the instrument.

Parameters:

<BinaryData>

Setting parameters:

<Filename> string

String parameter to specify the name of the file.

Query parameters:

<Filename> #<number><length_entry><data>

`#`: Hash sign; always comes first in the binary block
`<number>`: the first digit indicates how many digits the subsequent length entry has

<length_entry>: indicates the number of subsequent bytes
<data>: binary block data for the specified length.
For files with a size with more than nine digits (gigabytes), the instrument allows the syntax #(<Length>), where <Length> is the file size in decimal format.

Example:
MMEMory:DATA '/var/user/test.txt',#15hallo
Writes the block data to the file test.txt.
The digit 1 indicates a length entry of one digit; the digit 5 indicate a length of the binary data (hallo) in bytes.
MMEMory:DATA? '/var/user/test.txt'
Sends the data of the file test.txt from the instrument to the controller in the form of a binary block.
Response: #15hallo

:MMEMory:DATA:UNPRotected <Msus>, <Data>

The **setting** command sends the I/Q data and the marker data to the file defined with the <Msus> parameter. The required tags are created automatically so that the file content follows the waveform file format.

The **query** reads out the I/Q data part or the marker information of the specified file.

Waveform files can also be created with the command [:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA. In this case, the *complete content* of the waveform file must be specified, i.e. not only the I/Q or marker data but all required tags.

(see Section 4.6.7, "Tags for waveforms, data and control lists", on page 175).

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 can also be specified. If omitted, files are stored in the default directory and the extension *.wv is assigned to the file name.

Setting parameters:

<Data> block data

I/Q data or marker binary data, where the number of marker elements has to be equal to the number of I/Q samples
Binary block data follows 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 the 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 to 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?

Returns the subdirectories of a particular directory.

Return values:

<DCatalog> <file_entry>

Names of the subdirectories separated by colons. The first two strings are related to the parent directory.

Usage: Query only

:MMEMory:DCATalog:LENGth? [<Path>]

Returns the number of subdirectories in the current or specified directory.

Query parameters:

<Path> string

String parameter to specify the directory. If the directory is omitted, the command queries the contents of the current directory, to be queried with `:MMEMory:CDIRectory` command.

Return values:

<DirectoryCount> integer

Number of 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: Setting only

Manual operation: See "Cut, Copy&Paste and Delete" on page 436

:MMEMory:LOAD:STATe <SavRclStateNumb>, <file_name>

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

Setting parameters:

<SavRclStateNumb> Determines to the specific <number> to be used with the `*RCL` command, e.g. `*RCL 4`.

<file_name> String parameter to specify the file name with extension `*.savrcltxt`.

Usage: Setting only

Manual operation: See "Recall" on page 430

: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: Setting only

Manual operation: See "Create New Directory" on page 436

: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: Setting only

Manual operation: See "Rename" on page 436

:MMEMory:MSIS <Path>

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.

:MMEMory:RDIRectory <Directory>

Removes an empty directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

To remove a directory with contents, use command `:MMEMory:RDIRectory:RECursive` on page 601.

Setting parameters:

<Directory> string
String parameter to specify the directory to be deleted.

Example: See Example "Working with files and directories" on page 593.

Usage: Setting only

:MMEMory:RDIRectory:RECursive <Directory>

Removes the specified directory, including files and subdirectories from the mass memory storage system. If no directory is specified, the command removes the subdirectories of the default directory.

The command the entire directory without further prompt or notification.

Setting parameters:

<Directory> string
String parameter to specify the directory to be deleted.

Example: See Example "Working with files and directories" on page 593.

Usage: Setting only

:MMEMory:STORe:STATe <savrcl_state_nr>, <file_name>

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an internal memory with the same number using the common command `*SAV`.

Setting parameters:

<savrcl_state_nr> Corresponds to the specific `<number>` defined with the `*SAV` command, e.g. `*SAV 4`.

<file_name> String parameter to specify the file name with extension `*.savrcltxt`.

Usage: Event

Manual operation: See "Save" on page 429

: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

14.6 CALibration subsystem

The `CALibration` subsystem contains the commands needed for performing internal adjustments. This procedure is triggered by the query commands.

Common suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
`CALibration<hw>`	[1]	Optional suffix

Understanding the query response

- `1`: error-free execution of the adjustments
- `0`: indicates that an error occurred; the process has been canceled

:CALibration:ALL[:MEASure]? 602
:CALibration<hw>:ALL:DATE? 603
:CALibration<hw>:ALL:INFormation? 603
:CALibration<hw>:ALL:TEMP? 603
:CALibration<hw>:ALL:TIME? 604
:CALibration<hw>:CONTinueonerror 604
:CALibration:DATA:EXPort 604
:CALibration:DATA:FACTory:DATE? 604
:CALibration:ROSCillator[:DATA] 605
:CALibration:DELay:MINutes 605
:CALibration:DELay:SHUTdown[:STATe] 605
:CALibration:DELay[:MEASure]? 605

:CALibration:ALL[:MEASure]? [<Force>]

Starts all internal adjustments that do not need external measuring equipment.

Query parameters:
<Force> string

Return values:
<Measure> 1 | ON | 0 | OFF

Example:
```
CAL:ALL:MEAS?
// Response: "1"
// Executes the adjustments of all instrument functions.
// When completed, it indicates that the adjustment has
// been performed successfully.
```

Usage: Query only

Manual operation: See "Adjust All" on page 888

:CALibration<hw>:ALL:DATE?

Queries the date of the most recently executed full adjustment.

Suffix:
<hw> [1]
Optional suffix

Return values:
<Date> string

Example:
```
CAL:ALL:DATE?
// "2016-01-01"
```

Usage: Query only

Manual operation: See "Last Full Adjustment" on page 888

:CALibration<hw>:ALL:INFormation?

Queries the current state of the internal adjustment.

Return values:
<CalInfoText> string

Example:
```
CAL:ALL:INF?
"Instrument is calibrated, no adjustment required."
"UNCAL, instrument is warming up."
"UNCAL, Please perform full adjustment after warming up."
"UNCAL, Please perform full adjustment."
```

Usage: Query only

Manual operation: See "Information" on page 889

:CALibration<hw>:ALL:TEMP?

Queries the temperature deviation compared to the calibration temperature.

Suffix:
<hw> [1]
Optional suffix

Return values:
<Temperature> string

Example:
```
CALibration:ALL:TEMP?
// "+12.00 K"
```

Usage: Query only

Manual operation: See "Temperature Offset" on page 889

:CALibration<hw>:ALL:TIME?

Queries the time elapsed since the last full adjustment.

Return values:
<Time> string

Example:
```
CAL:ALL:TIME?
// "22 days"
```

Usage: Query only

Manual operation: See "Time" on page 888

:CALibration<hw>:CONTinueonerror <State>

Continues the calibration even though an error was detected. By default adjustments are aborted on error.

Suffix:
<hw> [1]
Optional suffix

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example:
```
CAL:CONT ON
// Continues calibration after an error
```

Manual operation: See "Continue Adjustment on Error" on page 889

:CALibration:DATA:EXPort

Collects the internal adjustment data and provides the data for export in a zip file. You can export the data for service and evaluation purposes.

Example:
```
:CALibration:DATA:EXPort
```

Usage: Event

:CALibration:DATA:FACTory:DATE?

Queries the date of the last factory calibration.

Return values:
<Date> string

Example:
```
CAL:DATA:FACT:DATE?
// "2016-01-01"
```

Usage: Query only

Manual operation: See "Last Factory Calibration" on page 873

:CALibration:ROSCillator[:DATA] <Data>

Sets a user-defined calibration value for the internal reference frequency.

Parameters:

<Data> integer

0 = the factory value is used (i.e. user-defined calibration is disabled)
Value > 0: positive calibration values are used
Value < 0: negative calibration values are used

Range: depends on other values
*RST: 0

Example: See [:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] on page 817.

:CALibration:DELay:MINutes <Minutes>

Sets the warm-up time to wait before internal adjustment starts automatically.

Automatic execution starts only, if you have enabled the calibration with command :CALibration:DELay[:MEASure]? ON.

Parameters:

<Minutes> integer

Range: 30 to 120
*RST: n.a. (no preset. default: 60)

Example:

```
:CALibration:DELay:MINutes 30
// sets the time delay for warm-up of the instrument.
```

Manual operation: See "Warm Up Time" on page 890

:CALibration:DELay:SHUTdown[:STATe] <Shutdown>

Enables the instrument to shut down automatically after calibration.

Parameters:

<Shutdown> 1 | ON | 0 | OFF

*RST: 0

Example:

```
:CALibration:DELay:SHUTdown[:STATe] ON|1
// inititates that the instrument shuts down when the adjustments are com
```

Manual operation: See "Shutdown After Adjustment" on page 890

:CALibration:DELay[:MEASure]?

Starts the delayed adjustment process. When the warm-up time has elapsed (see :CALibration:DELay:MINutes, it executes the internal adjustments.

If you have enabled automatic shutdown, `:CALibration:DELay:SHUTdown[:STATe] ON`, the instrument shuts down when the adjustments are completed.

Return values:

<Error> 1 | ON | 0 | OFF
*RST: n.a. (no preset. default: 0)

Example:
```
:CALibration:DELay[:MEASure] ON|1
// enables the adjustment processs to start after the warm-up time automa
```

Usage: Query only

Manual operation: See "Adjust All Delayed" on page 890

14.7 DIAGnostic subsystem

The `DIAGnostic` subsystem contains the commands used for instrument diagnosis and servicing. SCPI does not define any `DIAGnostic` commands; the commands listed here are all device-specific. All `DIAGnostic` commands are query commands which are not affected by `*RST`.

The test functions are intended for services purposes.
They are thus password-protected functions. Unlock the corresponding protection level to access them, see `:SYSTem:PROTect<ch>[:STATe]`.
For more information, see R&S SMCV100B Service Manual.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`DIAGnostic<hw>`	[1]	Optional suffix

Example: Programming example

The example lists the commands required to query assemblies and test points for diagnosis purposes.

```
// Query the modules available in the instrument
// and variant and revision state of a certain assembly
DIAGnostic1:BGINfo:CATalog?
// IPS3,BIOS,RFCV,BBCV, ...
DIAGnostic1:BGINfo? "RFCV"
// RFCV 1432.8207.02 01.00 100000

// Query the test points available in the instrument
// and trigger the measurement in a selected test point
DIAGnostic1:POINt:CATalog?
// ASATT6HP_M5V7,ASATT6HP_OFFSET,...
DIAGnostic1:MEASure:POINt? "BBB_CODER_BBB_US"
// -1.000000V/°C

// Query the operating hours and number of power-on so far.
DIAGnostic:INFO:OTIMe?
// 112 h
DIAGnostic:INFO:POCount?
// 14
```

Commands

:DIAGnostic<hw>:BGINfo:CATalog?....607
:DIAGnostic<hw>:BGINfo?....607
:DIAGnostic:INFO:OTIMe?....608
:DIAGnostic:INFO:POCount?....608
:DIAGnostic<hw>:POINt:CATalog?....609
:DIAGnostic<hw>[:MEASure]:POINt?....609

:DIAGnostic<hw>:BGINfo:CATalog?

Queries the names of the assemblies available in the instrument.

Return values:

<Catalog> string

List of all assemblies; the values are separated by commas
The length of the list is variable and depends on the instrument equipment configuration.

Example: See Example "Programming example" on page 607.

Usage: Query only

:DIAGnostic<hw>:BGINfo? [<Board>]

Queries information on the modules available in the instrument, using the variant and revision state.

Query parameters:

<Board> string

Module name, as queried with the command `:DIAGnostic<hw>:BGINfo:CATalog?`.
To retrieve a complete list of all modules, omit the parameter.
The length of the list is variable and depends on the instrument equipment configuration.

Return values:

<BgInfo> <Module name> <Module stock number incl. variant> <Module revision> <Module serial number>

List of comma-separated entries, one entry per module.
Each entry for one module consists of four parts that are separated by space characters.

Example: See Example "Programming example" on page 607.

Usage: Query only

Manual operation: See "Assembly" on page 872

:DIAGnostic:INFO:OTIMe?

Queries the operating hours of the instrument so far.

Return values:

<OperationTime> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Programming example" on page 607.

Usage: Query only

Manual operation: See "Operation Time / h" on page 873

:DIAGnostic:INFO:POCount?

Queris how often the instrument has been turned on so far.

Return values:

<PowerOnCount> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Programming example" on page 607.

Usage: Query only

Manual operation: See "Power On Count" on page 873

:DIAGnostic<hw>:POINt:CATalog?

Queries the test points available in the instrument.

For more information, see R&S SMCV100B Service Manual.

Return values:

<Catalog> string
List of comma-separated values, each representing a test point

Example: See Example "Programming example" on page 607.

Usage: Query only

:DIAGnostic<hw>[:MEASure]:POINt? <Name>

Triggers the voltage measurement at the specified test point and returns the measured voltage.

For more information, see R&S SMCV100B Service Manual.

Query parameters:

<Name> <test point identifier>
Test point name, as queried with the command `:DIAGnostic<hw>:POINt:CATalog?`

Return values:

<Value> <value><unit>

Example: See Example "Programming example" on page 607.

Usage: Query only

14.8 HUMS remote control commands

The remote control commands for the health and utilizations monitoring system (HUMS) comprise commands of the `DIAGnostic` subsystem and the commands of the `SYSTem:COMMunicate:REST` and `SYSTem:COMMunicate:REST` subsystems.

For all HUMS-related remote control commands, see refer to the "R&S®HUMS Health and Utilization Monitoring Service" User Manual on the Internet.

Commands

DIAGnostic:HUMS:DELete:ALL 610
DIAGnostic:HUMS:DEVice:HISTory? 610
DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL 611
DIAGnostic:HUMS:FORMat 611
DIAGnostic:HUMS:SAVE 611
DIAGnostic:HUMS:STATe 612
DIAGnostic:HUMS:TAGS:ALL? 612
DIAGnostic:HUMS:TAGS:DELete 612

DIAGnostic:HUMS:TAGS:DELete:ALL....613
DIAGnostic:HUMS:TAGS[:VALue]....613
SYSTem:COMMunicate:REST:ENABle....613
SYSTem:COMMunicate:SNMP:COMMunity:RO....613
SYSTem:COMMunicate:SNMP:COMMunity:RW....614
SYSTem:COMMunicate:SNMP:CONTact....614
SYSTem:COMMunicate:SNMP:LOCation....614
SYSTem:COMMunicate:SNMP:USM:USER....615
SYSTem:COMMunicate:SNMP:USM:USER:ALL?....615
SYSTem:COMMunicate:SNMP:USM:USER:DELete....616
SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL....616
SYSTem:COMMunicate:SNMP:VERSion....616

DIAGnostic:HUMS:DELete:ALL

Deletes the complete HUMS data. This includes device history, device tags, SCPI connections, utilization history and utilizations.

Example: //Delete HUMS data
`DIAG:HUMS:DEL:ALL`

Usage: Event

DIAGnostic:HUMS:DEVice:HISTory?

Queries the device history information of the connected instrument. Depending on the set data format, the queried data is either displayed in `XML` or `JSON` format. For more information about setting the data format, see `DIAGnostic:HUMS:FORMat` on page 611.

Return values:

<HistoryInfo> <block_data>

Device history information of the connected instrument as block data in a comma-separated list:
`#blockdata[{event1},{event2},{event3}...]`
With the following parameters:
`<eventID>,<eventTimestamp>,<eventMessage>,<eventDetails>,<eventSeverity>`
Binary block data with the following syntax:
`#<Digits><Length><Binarydata>`
#
Indicates the start of the binary block
<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>` value
<Length>
Decimal value
Number of bytes the follow in the `<Binary data>` part
<Binary data>

Binary data in ASCII format

Example: //Return device history
```
DIAG:HUMS:DEV:HIST?
```
Returns for example:
```
#44715[{"eventId":32,"eventTimestamp":
"2021-02-02T17:25:39Z","eventMessage":
"Deviation from Self Alignment Temperature",
"eventDetails":
"Deviations resolved","eventSeverity":0}
```

Usage: Query only

Manual operation: See "Export History" on page 531

DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL

Deletes the complete device history information of the connected instrument.

Example: //Delete complete device history
```
DIAG:HUMS:DEV:HIST:DEL:ALL
```

Usage: Event

Manual operation: See "Delete History" on page 531

DIAGnostic:HUMS:FORMat <DataFormat>

Selects the format for the queried HUMS data. You can query the HUMS data either in `JSON` format or `XML` format.

The defined format affects all other commands that return block data.

Parameters:
<DataFormat> JSON | XML

JSON
Returns the HUMS data in `JSON` format.

XML
Returns the HUMS data in `XML` format.

*RST: JSON

Example: //Return data in `JSON` format
```
DIAG:HUMS:FORM JSON
```

DIAGnostic:HUMS:SAVE <path>

Saves the HUMS history as a `ZIP` file to your preferred path.

Setting parameters:
<path>

Example: //Save HUMS history data
```
DIAG:HUMS:SAVE 'C:\HUMS\hums_2021.zip'
```

Usage: Setting only

Manual operation: See "Export History" on page 531

DIAGnostic:HUMS:STATe <State>

Turns the HUMS service and data collection on and off.

Parameters:

<State> ON | OFF | 1 | 0
*RST: ON

Example: //Turn on HUMS service
```
DIAG:HUMS:STAT ON
```

Manual operation: See "State" on page 531

DIAGnostic:HUMS:TAGS:ALL?

Queries all key-value tags that you have assigend to the instrument. Depending on the set data format, the queried data is either displayed in `XML` or `JSON` format. For more information about setting the data format, see `DIAGnostic:HUMS:FORMat` on page 611.

Return values:

<ID> ID number of the defined tag.

<Key> String containing key name of the defined tag.

<Value> String containing value of the defined tag.

Example: //Return all tags
```
DIAG:HUMS:TAGS:ALL?
1,"location","building_11",2,"time zone","CET"
```

Usage: Query only

Manual operation: See "Add" on page 540

DIAGnostic:HUMS:TAGS:DELete <ID>

Deletes a certain tag you assigned to your instrument, including its key and value.

Setting parameters:

<ID> ID number of the tag you want to delete.
To identify the ID number, query all device tags from the system first. For more information, see `DIAGnostic:HUMS:TAGS:ALL?` on page 612.

Example: //Delete tag
```
DIAG:HUMS:TAGS:DEL 0
```

Usage: Setting only

Manual operation: See "Delete" on page 540

DIAGnostic:HUMS:TAGS:DELete:ALL

Deletes all key-value tags you have assigned to the instrument.

Example: //Delete all tags
`DIAG:HUMS:TAGS:DEL:ALL`

Usage: Event

Manual operation: See "Delete All" on page 540

DIAGnostic:HUMS:TAGS[:VALue] <ID>, <Key>, <Value>
DIAGnostic:HUMS:TAGS[:VALue]? <ID>

Adds or modifies a key-value pair (device tag).

The query returns the key-value pair for a given ID or an empty string if the ID is unknown.

Parameters:
<Key> String containing key name of the queried tag.

<Value> String containing value of the queried tag.

Parameters for setting and query:
<ID> 0 - 31
ID number of the tag you want to modify or query.
To identify the ID number, query all device tags from the system first. For more information, read here `DIAGnostic:HUMS:TAGS:ALL?` on page 612.

Example: //Add or modify a tag (tag 1)
`DIAG:HUMS:TAGS 1,'location','building_11'`

Manual operation: See "Key" on page 539
See "Value" on page 539
See "Add" on page 540

SYSTem:COMMunicate:REST:ENABle <RestState>

Turns communication via the REST API on and off.

Parameters:
<RestState> ON | OFF | 0 | 1

Example: //Return REST state
`SYST:COMM:REST:ENAB?`

Manual operation: See "REST" on page 533

SYSTem:COMMunicate:SNMP:COMMunity:RO <CommunityString>

Defines the SNMP community string for read-only access.

Prerequisites for this command:

- Select an SNMP version that supports communities (`SYSTem:COMMunicate:SNMP:VERSion` on page 616).

Setting parameters:

<CommunityString> String containing the community name.

Example:

```
//Set community name
SYST:COMM:SNMP:VERS V12
SYST:COMM:SNMP:COMM:RO 'ABC'
```

Usage: Setting only

Manual operation: See "Access" on page 533

SYSTem:COMMunicate:SNMP:COMMunity:RW <CommunityString>

Defines the SNMP community string for read-write access.

Prerequisites for this command:

- Select an SNMP version that supports communities (`SYSTem:COMMunicate:SNMP:VERSion` on page 616).

Setting parameters:

<CommunityString> String containing the community name.

Example:

```
//Set read-write access
SYST:COMM:SNMP:VERS V12
SYST:COMM:SNMP:COMM:RW 'ABC'
```

Usage: Setting only

Manual operation: See "Access" on page 533

SYSTem:COMMunicate:SNMP:CONTact <SnmpContact>

Defines the SNMP contact information for the administrator.

You can also set the contact information via SNMP if you do not set it via SCPI.

Parameters for setting and query:

<SnmpContact> String containing SNMP contact.

*RST: "" (empty string)

Example:

```
//Set SNMP contact
SYST:COMM:SNMP:CONT 'ABC'
```

Manual operation: See "Contact" on page 533

SYSTem:COMMunicate:SNMP:LOCation <SnmpLocation>

Defines the SNMP location information for the administrator.

You can also set the location information via SNMP if you do not set it via SCPI.

Parameters for setting and query:

<SnmpLocation> String containing SNMP location.

*RST: "" (empty string)

Example: //Return SNMP location
`SYST:COMM:SNMP:LOC?`

Manual operation: See "Location" on page 533

SYSTem:COMMunicate:SNMP:USM:USER <Name>, <Access>, <Level>[, <Auth_pwd>[, <Priv_pwd>]]

Defines an SNMP user profile.

Prerequisites for this command:

- Select SNMPv3 (`SYSTem:COMMunicate:SNMP:VERSion` on page 616).

Setting parameters:

<Name> String containing name of the user.

<Access> RO | RW
Defines the access right a user can have.

<Level> NOAuth | AUTH | PRIVacy
Defines the security level.

<Auth_pwd> String containing the authentication password.

<Priv_pwd> String containing the privacy password.

Example: //Create user profile
```
SYST:COMM:SNMP:VERS V123
SYST:COMM:SNMP:USM:USER 'Peter','RO','PRIV',
'1234','XYZ'
```

Usage: Setting only

Manual operation: See "Add SNMP User for HUMS" on page 536

SYSTem:COMMunicate:SNMP:USM:USER:ALL?

Queries the number of users and a list of all SNMP users for SNMPv3.

Prerequisites for this command:

- Select SNMPv3 (`SYSTem:COMMunicate:SNMP:VERSion` on page 616).

Return values:

<Count> Total number of registered SNMP users.

<Name> List of all user names as a comma-separated list.

Example: //Return all SNMP users
`SYST:COMM:SNMP:USM:USER:ALL?`

Usage: Query only

Manual operation: See "User table" on page 535

SYSTem:COMMunicate:SNMP:USM:USER:DELete <UserName>

Deletes a specific SNMP user profile.

Setting parameters:
<UserName> String containing name of SNMP user profile to be deleted.

Example: //Delete SNMP user profile
```
SYST:COMM:SNMP:USM:USER:DEL "Peter"
```

Usage: Setting only

Manual operation: See "Delete" on page 536

SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL

Deletes all SNMP user profiles.

Example: //Delete all SNMP user profiles
```
SYST:COMM:SNMP:USM:USER:DEL:ALL
```

Usage: Event

Manual operation: See "Delete All" on page 535

SYSTem:COMMunicate:SNMP:VERSion <SnmpVersion>

Selects the SNMP version.

Parameters for setting and query:
<SnmpVersion> OFF | V12 | V123 | V3 | DEFault

OFF
SNMP communication is off.

V12
SNMP communication with SNMPv2 or lower.

V123
SNMP communication with SNMPv2 and SNMPv3.

V3
SNMP communication with SNMPv3.

*RST: V123

Example: //Select the SNMP version
```
SYST:COMM:SNMP:VERS V12
```

Manual operation: See "SNMP" on page 533

14.9 DISPlay subsystem

The `DISPlay` system contains the commands to set the power-save mode of the instrument.

Programming Examples

Example: Activating screen saver mode and display update

Use the following commands to switch on the screen saver of your instrument or to automatic display. These settings are particularly useful when you control the instrument remotely.

```
// Set the wait time interval and activate the screen saver
DISPlay:PSAVe:HOLDoff 10
DISPlay:PSAVe:STATe ON

// Disable the display of the current frequency and level values in remote control
DISPlay:ANNotation:ALL ON
// DISPlay:ANNotation:FREQuency "<password>", ON
// DISPlay:ANNotation:AMPLitude "<password>", ON

// Enable automatic update of the display at defined time intervals
DISPlay:UPDate[:STATe] ON
```

Example: Querying the dialog IDs, opening and closing dialogs

Use the following commands to query the dialog IDs of all currently open dialogs. The dialog ID is a prerequisite for opening and closing dialogs via the remote control.

The dialog ID is also required to define user key actions.

See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

```
// Query the dialog IDs of all open dialogs
DISPlay:DIALog:ID?
// CEUtraDLGenSetDlg,_,$A DlgKeyRf_Rosc

// Open and close dialogs via remote control
DISPlay:DIALog:OPEN "CEUtraDLGenSetDlg,_,$A"
DISPlay:DIALog:OPEN "DlgKeyRf_Rosc"
DISPlay:DIALog:CLOSe "DlgKeyRf_Rosc"
DISPlay:DIALog:CLOSe:ALL
```

:DISPlay:PSAVe:HOLDoff 618
:DISPlay:PSAVe[:STATe] 618
:DISPlay:BRIGhtness 618
:DISPlay:BUTTon:BRIGhtness 619
:DISPlay:UPDate[:STATe] 619
:DISPlay:ANNotation:AMPLitude 619
:DISPlay:ANNotation:FREQuency 619

:DISPlay:ANNotation[:ALL]....620
:DISPlay:DIALog:ID?....620
:DISPlay:DIALog:OPEN....621
:DISPlay:DIALog:CLOSe....621
:DISPlay:DIALog:CLOSe:ALL....621

:DISPlay:PSAVe:HOLDoff <HoldoffTimeMin>

Sets the wait time for the screen saver mode of the display.

Parameters:

<HoldoffTimeMin> integer

Range: 1 to 60
*RST: n.a. (factory preset: 10)
Default unit: minute

Example: see Example "Activating screen saver mode and display update" on page 617

Manual operation: See "Wait Time" on page 453

:DISPlay:PSAVe[:STATe] <State>

Activates the screen saver mode of the display.

We recommend that you use this mode to protect the display, if you operate the instrument in remote control.

To define the wait time, use the command `:DISPlay:PSAVe:HOLDoff`.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example: See Example "Activating screen saver mode and display update" on page 617

Manual operation: See "Screen Saver" on page 453

:DISPlay:BRIGhtness <BRIGhtness>

Sets the brightness of the dispaly.

Parameters:

<BRIGhtness> float

Range: 1.0 to 20.0
Increment: 1.0
*RST: 14.0

Example:

```
DISPlay:BRIGhtness 14
```

Manual operation: See "Display" on page 453

:DISPlay:BUTTon:BRIGhtness <ButtonBrightnes>

Sets the brightness of the [RF On/Off] key.

Parameters:

<ButtonBrightnes> integer

Range: 1 to 20
*RST: n.a. (no preset. default: 14)

Example: `DISPlay:BUTTon:BRIGhtness 15`

Manual operation: See "RF Hardkey" on page 453

:DISPlay:UPDate[:STATe] <Update>

Activates the refresh mode of the display.

Parameters:

<Update> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 617

Manual operation: See "Display Update is" on page 454

:DISPlay:ANNotation:AMPLitude <SecPassword>, <State>

Indicates asterisks instead of the level values in the status bar.

Parameters:

<SecPassword> string

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 617

Manual operation: See "Annotation Amplitude" on page 495

:DISPlay:ANNotation:FREQuency <SecPassWord>, <State>

Indicates asterisks instead of the frequency values in the status bar.

Parameters:

<SecPassWord> string

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 617

Manual operation: See "Annotation Frequency" on page 494

:DISPlay:ANNotation[:ALL] <State>

Displays asterisks instead of the level and frequency values in the status bar of the instrument.

We recommend that you use this mode if you operate the instrument in remote control.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Activating screen saver mode and display update" on page 617

:DISPlay:DIALog:ID?

Returns the dialog identifiers of the open dialogs in a string separated by blanks.

Return values:

<DialogIdList> <DialogID#1>< ><DialogID#2>< > ... < ><DialogID#n>

Dialog identifiers are string without blanks. Blanks are represented as `$$`.
Dialog identifiers `<DialogID>` are composed of two main parts: `<DialogName>[<OptionalParts>]`

<DialogName>
Meaningful information, mandatory input parameter for the commands:
`:DISPlay:DIALog:OPEN` on page 621
`:DISPlay:DIALog:CLOSe` on page 621

<Optional parts>
String of `$<X>` values, where `<X>` is a character, interpreted as follows:
`$q<DialogQualifier>`: optional dialog qualifier, usually the letter `A` or `B`, as displayed in the dialog title.
`$i<Instances>`: comma-separated list of instance indexes, given in the order `h,c,s,d,g,u,0`. Default is zero; the terminating `",0"` can be omitted.
`$t<TabIds>`: comma-separated indexes or tab names; required, if a dialog is composed of several tabs.
`$x<Left>$y<Top>$h<Left>$w<Top>`: position and size; superfluous information.

Example: See Example "Querying the dialog IDs, opening and closing dialogs" on page 617

Usage: Query only

Manual operation: See "SCPI" on page 473

:DISPlay:DIALog:OPEN <DialogId>

Opens the specified dialog.

Setting parameters:

<DialogId> string
To find out the dialog identifier, use the query `:DISPlay:DIALog:ID?`.
The `<DialogName>` part of the query result is mandatory.

Example: See Example "Querying the dialog IDs, opening and closing dialogs" on page 617

Usage: Setting only

Manual operation: See "SCPI" on page 473

:DISPlay:DIALog:CLOSe <DialogId>

Closes the specified dialog.

Setting parameters:

<DialogId> string
To find out the dialog identifier, use the query `:DISPlay:DIALog:ID?`.
The `<DialogName>` part of the query result is sufficient.

Example: See Example "Querying the dialog IDs, opening and closing dialogs" on page 617

Usage: Setting only

:DISPlay:DIALog:CLOSe:ALL

Closes all open dialogs.

Example: See Example "Querying the dialog IDs, opening and closing dialogs" on page 617

Usage: Event

14.10 FORMat subsystem

The commands in the `FORMat` subsystem determine the format of data returned by the R&S SMCV100B to the controller. This affects all query commands that return a list of numerical data or block data, noted in the descriptions of the commands. The set data format applies to both paths.

:FORMat:BORDer 622
:FORMat:SREGister 622
:FORMat[:DATA] 622

:FORMat:BORDer <Border>

Determines the sequence of bytes within a binary block. This only affects blocks which use the IEEE754 format internally.

Parameters:

<Border> NORMal | SWAPped

NORMal
Expects/sends the *least* significant byte of each IEEE754 floating-point number first and the *most* significant byte last.

SWAPped
Expects/sends the *most* significant byte of each IEEE754 floating-point number first and the *least* significant byte last.

*RST: NORMal

Example: `:FORM:BORD SWAP`
transfers the data with the most significant bit first.

:FORMat:SREGister <Format>

Determines the numeric format for responses of the status register.

Parameters:

<Format> ASCii | BINary | HEXadecimal | OCTal

ASCii
Returns the register content as a decimal number.

BINary|HEXadecimal|OCTal
Returns the register content either as a binary, hexadecimal or octal number. According to the selected format, the number starts with #B (binary), #H (hexadecimal) or #O (octal).

*RST: ASCii

Example: `:FORM:SREG HEX`
returns the register content as a hexadecimal number.

:FORMat[:DATA] <Data>

Determines the data format the instrument uses to return data via the IEC/IEEE bus.

The instrument automatically detects the data format used by the controller, and assigns it accordingly. Data format determined by this SCPI command is in this case irrelevant.

Parameters:

<Data> ASCii | PACKed

ASCii
Transfers numerical data as plain text separated by commas.

PACKed
Transfers numerical data as binary block data.
The format within the binary data depends on the command.
The various binary data formats are explained in the description of the parameter types.
*RST: ASCii

Example: `:FORM ASC`
transfers the data as ASCII data.

14.11 HCOPy subsystem

The `HCOPy` subsystem contains the commands to generate and save a hard copy of the display.

To access a stored hard copy file, use the commands of the `MEMM` subsystem.

Example: Store a hard copy of the display
The following example lists commands to configure and execute a hard copy to an automatic named file.

```
:HCOPy:DEVice:LANGuage PNG
:HCOPy:FILE:NAME:AUTO:STATe 1
// defines the output format
// sets the instrument to automatically create output file names

// ****************************************************************
// Configure hard copy options, set automatic naming rules
// An automatically generated file name consists of:
// <Prefix><YYYY><MM><DD><Number>.<Format>
// ****************************************************************
:HCOPy:DEVice:LANGuage BMP
// defines output format *.bmp
:HCOPy:REGion DIALog
// selects the region to be copied
:HCOPy:FILE:AUTO:DIR "/usb/HCopy"
// sets destination directory of automatic named file
:HCOPy:FILE:NAME:AUTO:FILE:PREFix:STATe 1
:HCOPy:FILE:NAME:AUTO:FILE:PREFix:"hardcopy"
:HCOPy:FILE:NAME:AUTO:FILE:YEAR:STATe 1
:HCOPy:FILE:NAME:AUTO:FILE:MONTh:STATe 1
// uses automatic naming prefix
// sets automatic naming prefix to "hardcopy"
// uses automatic naming date parameters year and month

// ****************************************************************
```

```
// Execute and transfer the hard copy
// ****************************************************************
:HCOPy:EXECute
:HCOPy:DATA
// generates a hard copy
// transfers the hard copy to the remote client
:HCOPy:FILE:AUTO:FILE?
// queries the automatic file name
// "hardcopy1607001.bmp"
:HCOPy:FILE:AUTO:NUMBer?
// queries the number in the automatic file name
// "001"
:HCOPy:FILE:AUTO?
// queries the path and file name of the automatically generated file
// "/usb/HCopy/hardcopy1607001.bmp"
```

14.11.1 Hard copy settings

With the following commands, you can configure the settings of a hard copy.

:HCOPy:DATA?....624
:HCOPy:IMAGe:FORMat....624
:HCOPy:DEVice:LANGuage....624
:HCOPy:REGion....625
:HCOPy:FILE[:NAME]....625
:HCOPy[:EXECute]....625

:HCOPy:DATA?

Transfers the hard copy data directly as a NByte stream to the remote client.

Return values:
<Data> block data

Example: See Example "Store a hard copy of the display" on page 623

Usage: Query only

:HCOPy:IMAGe:FORMat <Format>
:HCOPy:DEVice:LANGuage <Language>

Selects the graphic format for the hard copy. You can use both commands alternatively.

Parameters:
<Language> BMP | JPG | XPM | PNG
*RST: PNG

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Format" on page 447

:HCOPy:REGion <Region>

Selects the area to be copied.

You can create a snapshot of the screen or an active dialog.

Parameters:
<Region> ALL | DIALog
*RST: ALL

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Region" on page 448

:HCOPy:FILE[:NAME] <Name>

Determines the file name and path to save the hard copy, provided automatic naming is disabled.

Note: If you have enabled automatic naming, the instrument automatically generates the file name and directory, see Section 14.11.2, "Automatic naming", on page 625.

Parameters:
<Name> string

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "File..." on page 447

:HCOPy[:EXECute]

Generates a hard copy of the current display. The output destination is a file.

Example: See Example "Store a hard copy of the display" on page 623

Usage: Event

Manual operation: See "Save" on page 447

14.11.2 Automatic naming

Use the following commands to automatically assign a file name.

:HCOPy:FILE[:NAME]:AUTO? 626
:HCOPy:FILE[:NAME]:AUTO:DIRectory 626
:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar 626
:HCOPy:FILE[:NAME]:AUTO:FILE? 626
:HCOPy:FILE[:NAME]:AUTO:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer? 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix 628
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe 628

:HCOPy:FILE[:NAME]:AUTO?

Queries path and file name of the hardcopy file, if you have enabled *Automatic Naming*.

Return values:
<Auto> string

Example: See Example "Store a hard copy of the display" on page 623

Usage: Query only

:HCOPy:FILE[:NAME]:AUTO:DIRectory <Directory>

Determines the path to save the hard copy, if you have enabled *Automatic Naming*.

If the directory does not yet exist, the instrument automatically creates a new directory, using the instrument name and `/var/user/` by default.

Parameters:
<Directory> string
*RST: /var/user/

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Path..." on page 448

:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar

Deletes all files with extensions `*.bmp`, `*.jpg`, `*.png` and `*.xpm` in the directory set for automatic naming.

Example: See Example "Store a hard copy of the display" on page 623

Usage: Event

Manual operation: See "Clear Path" on page 448

:HCOPy:FILE[:NAME]:AUTO:FILE?

Queries the name of the automatically named hard copy file.

An automatically generated file name consists of:

<Prefix><YYYY><MM><DD><Number>.<Format>.

You can activate each component separately, to individually design the file name.

Return values:
<File> string

Example: See Example "Store a hard copy of the display" on page 623.

Usage: Query only

:HCOPy:FILE[:NAME]:AUTO:STATe <State>

Activates automatic naming of the hard copy files.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Automatic Naming" on page 447

:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe <State>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe <State>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe <State>

Uses the date parameters (year, month or day) for the automatic naming. You can activate each of the date parameters separately.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Prefix, Year, Month, Day" on page 449

:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer?

Queries the number that is used as part of the file name for the next hard copy in automatic mode.

At the beginning, the count starts at 0. The R&S SMCV100B searches the specified output directory for the highest number in the stored files. It increases this number by one to achieve a unique name for the new file.

The resulting auto number is appended to the resulting file name with at least three digits.

Return values:

<Number> integer
Range: 0 to 999999
*RST: 0

Example: See Example "Store a hard copy of the display" on page 623

Usage: Query only

Manual operation: See "Current Auto Number" on page 449

:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix <Prefix>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe <State>

Uses the prefix for the automatic generation of the file name, provided `PREF:STAT` is activated.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 623

Manual operation: See "Prefix, Year, Month, Day" on page 449

14.12 KBOard subsystem

The `KBOard` subsystem contains the commands to set a connected keyboard.

:FPANel:KEYBoard:LAYout 628
:KBOard:LAYout 628

:FPANel:KEYBoard:LAYout <Layout>

Selects the layout of the front panel keypad.

Parameters:

<Layout> DIGits | LETTers

DIGits
Enables numerical keys only.

LETTers
Enables numerical and alphanumerical keys.

*RST: n.a. (factory preset: DIGits)

Example:

```
:FPANel:KEYBoard:LAYout LETTers
// enables the alphanumerical additional
// and the numerical assignment of the keys.
```

:KBOard:LAYout <Layout>

Selects the language for an external keyboard and assigns the keys acccordingly.

Parameters:

<Layout> CHINese | DANish | DUTCh | DUTBe | ENGLish | ENGUK | FINNish | FRENch | FREBe | FRECa | GERMan | ITALian | JAPanese | KOREan | NORWegian | PORTuguese | RUSSian | SPANish | SWEDish | ENGUS

*RST: n.a. (factory preset: ENGLish)

Example:

```
:KBOard:LAYout US
// activates American keyboard
```

Manual operation: See "Layout" on page 453

14.13 OUTPut subsystem

In the `OUTPut` subsystem, you can configure the output signals.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`OUTPut<hw>`	[1]	Optional suffix

:OUTPut:ALL[:STATe] 629
:OUTPut<hw>[:STATe] 629
:OUTPut<hw>[:STATe]:PON 630
:OUTPut<hw>:AMODe 630
:OUTPut<hw>:IMPedance? 630
:OUTPut<hw>:AFIXed:RANGe:LOWer? 631
:OUTPut<hw>:AFIXed:RANGe:UPPer? 631
:OUTPut<hw>:PROTection:CLEar 631
:OUTPut<hw>:PROTection:TRIPped? 631

:OUTPut:ALL[:STATe] <State>

Enables the RF output signal of the instrument.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: `OUTPut:ALL:STATe 0`
Disables the RF output signal.

:OUTPut<hw>[:STATe] <State>

Activates the RF output signal.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:OUTPut1 ON`
Activates the RF output.

Manual operation: See "RF State/RF ON" on page 309

:OUTPut<hw>[:STATe]:PON <Pon>

Defines the state of the RF output signal when the instrument is switched on.

Parameters:

<Pon> OFF | UNCHanged

*RST: n.a. (factory preset: UNCHanged)

Example: `:OUTPut1:PON OFF`
The RF output is deactivated when the instrument is switched on.

Manual operation: See "Power-On State" on page 455

:OUTPut<hw>:AMODe <AMode>

Sets the step attenuator mode at the RF output.

Parameters:

<AMode> AUTO | FIXed | NORMal | HPOWer

AUTO
The step attenuator adjusts the level settings automatically, within the full variation range.

FIXed
The step attenuator and amplifier stages are fixed at the current position, providing level settings with constant output VSWR. The resulting variation range is calculated according to the position.

*RST: AUTO

Example:
```
:SOURce1:POWer:ALC:STATe 1
:OUTPut1:AMODe FIXed
```

Manual operation: See "Mode" on page 359

:OUTPut<hw>:IMPedance?

Queries the impedance of the RF outputs.

Return values:

<Impedance> G1K | G50 | G10K

*RST: G50

Example: `:OUTPut1:IMP?`
queries the impedance of RF output.
`Response: 50`
the impedance is 50 ohms

Usage: Query only

Manual operation: See "RF output impedance" on page 309

:OUTPut<hw>:AFIXed:RANGe:LOWer?
:OUTPut<hw>:AFIXed:RANGe:UPPer?

Queries the settable minimum/maximum value in mode `:OUTPut:AMODe FIXed`, i.e. when the attenuator is not being adjusted.

Return values:

<Upper> float
Increment: 0.01
Default unit: dBm

Example:
```
:OUTPut1:AMODe FIXed
:OUTPut1:AFIXed:RANGe:UPPer?
// -27
:OUTPut1:AFIXed:RANGe:LOW?
// -50
```

Usage: Query only

Manual operation: See "Level Range" on page 359

:OUTPut<hw>:PROTection:CLEar

Resets the protective circuit after it has been tripped.

To define the output state, use the command `:OUTPut<hw>[:STATe]`.

Example:
```
:OUTPut1:PROT:CLE
```
Resets the protective circuit of the RF output.

Usage: Event

Manual operation: See "Overload" on page 359

:OUTPut<hw>:PROTection:TRIPped?

Queries the state of the protective circuit.

Return values:

<Tripped> 1 | ON | 0 | OFF
*RST: 0

Example:
```
:OUTPut1:PROT:TRIP
```
queries the state of the protective circuit of the RF output.
```
Response: 0
```
the protective circuit has not tripped.

Usage: Query only

Manual operation: See "Overload" on page 359

14.14 SENSe, READ, INITiate and SLISt subsystems

These subsystems contain the commands for configuring the power measurements with R&S NRP power sensor connected to the R&S SMCV100B.

The local state is set with the `INIT` command. Switching off the local state enhances the measurement performance. Measurements results can be retrieved in local state on or off.

Sensor parameters are set with the `SENSe` commands.

To start the measurement and retrieve the result, use the `:READ<ch>[:POWer]?` command.

Suffix	Value range	Description
`SENSe<ch>`	[1] to 4	Indicates the sensor Use the `:SLISt` commands to change the sensor mapping
`READ<ch>`	[1] to 4	Sensor assignment
`INIate<hw>`	[1] to 4	Sensor assignment
`ELEMent<ch>`	[1] to 25	Sensor-mapping list

Programming examples

Example: Detecting and assigning a power sensor

```
SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy"
// 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]? 635
:SLISt:SCAN[:STATe] 635
:SLISt:SCAN:LSENsor 635
:SLISt:SCAN:USENsor 636
:SLISt:CLEar:LAN 636
:SLISt:CLEar:USB 636
:SLISt:CLEar[:ALL] 637
:SLISt:ELEMent<ch>:MAPPing 637
:SLISt:SENSor:MAP 637
:INITiate<hw>[:POWer]:CONTinuous 637
:READ<ch>[:POWer]? 638
:SENSe<ch>:UNIT[:POWer] 639
:SENSe<ch>[:POWer]:APERture:DEFault:STATe 639
:SENSe<ch>[:POWer]:APERture:TIMe 639
:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST? 640
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority 640
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe 641
:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO? 641

:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] 641
:SENSe<ch>[:POWer]:FILTer:NSRatio 642
:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe 642
:SENSe<ch>[:POWer]:FILTer:SONCe 642
:SENSe<ch>[:POWer]:FILTer:TYPE 643
:SENSe<ch>[:POWer]:FREQuency 643
:SENSe<ch>[:POWer]:LOGGing:STATe 644
:SENSe<ch>[:POWer]:OFFSet 644
:SENSe<ch>[:POWer]:OFFSet:STATe 644
:SENSe<ch>[:POWer]:SNUMber? 645
:SENSe<ch>[:POWer]:SOURce 645
:SENSe<ch>[:POWer]:STATus[:DEVice]? 645
:SENSe<ch>[:POWer]:TYPE? 646
:SENSe<ch>[:POWer]:ZERO 646

: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 633.

Usage: Query only

Manual operation: See "Sensor Mapping List" on page 386

: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 633.

Manual operation: See "Scan" on page 387

: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 633.

Usage: Setting only

Manual operation: See "Add LAN Sensor" on page 387

: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 633.

Usage: Setting only

Manual operation: See "Add USBTMC Sensor" on page 387

: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 633.

Usage: Event

Manual operation: See "Clear" on page 387

: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 633.

Usage: Event

Manual operation: See "Clear" on page 387

:SLISt:CLEar[:ALL]

Removes all R&S NRP power sensors from the list.

Example: See Example "Detecting and assigning a power sensor" on page 633.

Usage: Event

Manual operation: See "Clear" on page 387

: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 633.

Manual operation: See "Sensor Mapping List" on page 386

: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 633.

Usage: Setting only

Manual operation: See "Sensor Mapping List" on page 386

: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 382

:READ<ch>[:POWer]?

Triggers power measurement and displays the results.

Note: This command does not affect the local state, i.e. you can get results with local state on or off. For long measurement times, we recommend that you use an SRQ for command synchronization (MAV bit).

Suffix:

<ch> 1 to 3

Return values:

<Power> float or float,float

The sensor returns the result in the unit set with command `:SENSe<ch>:UNIT[:POWer]`
Certain power sensors, such as the R&S NRP-Z81, return two values, first the value of the average level and - separated by a comma - the peak value.

Example:
```
:SENS1:UNIT DBM
```
Selects unit dBm for presentation of measurement result.
```
:READ1?
```
Queries the measurement result of the sensor.
```
-45.6246576745440230
```
-45.6 dBm were measured at the given frequency.

Example: R&S NRP-Z81
```
:READ1?
-55.62403263352178,-22.419472478812476
```
-55.6 dBm is the measured average level, -22. 4 dBm is the measured peak level at the given frequency.

Usage: Query only

Manual operation: See "Measured Level" on page 379
See "Level (Peak) / Level (Average)" on page 382

:SENSe<ch>:UNIT[:POWer] <Power>

Selects the unit (Watt, dBm or dBµV) of measurement result display, queried with `:READ<ch>[:POWer]?`.

Parameters:

<Power> DBM | DBUV | WATT

*RST: DBM

Example: `:SENS2:UNIT DBM`
Selects dBm as unit for the measured value returned by command `READ`.
`:READ2?`
`Response: 7.34`
7.34 dBm are measured by sensor 2.

Manual operation: See "Measured Level" on page 379
See "Level (Peak) / Level (Average)" on page 382

: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 639.

Parameters:

<UseDefAp> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Performing a power measurement with a fixed filter" on page 634.

Manual operation: See "Default Aperture Time" on page 384

:SENSe<ch>[:POWer]:APERture:TIMe <ApTime>

Defines the aperture time (size of the acquisition interval) for the corresponding sensor.

Parameters:

<ApTime> float

Range: depends on connected power sensor
Increment: 1E-9
*RST: depends on connected power sensor

Example: See Example "Performing a power measurement with a fixed filter" on page 634.

Manual operation: See "Aperture Time" on page 384

: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 385

: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 385

: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 385

: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 382

:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe <State>

Activates the permanent display of the measured power level results. The instrument also indicates the sensor type, the connection, the measurement source and the offset if set.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENS1:POW:DISP:PERM:STAT ON`
Turns on the permanent view.

Manual operation: See "Display Permanent" on page 382

:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?

Queries the current filter length in filter mode `AUTO` (`:SENSe<ch>[:POWer]:FILTer:TYPE`)

Return values:

<Auto> float
Range: 1 to depends on R&S NRP power sensor type

Example: `:SENS1:FILT:TYPE AUTO`
Selects auto filter.
`:SENS1:FILT:LENG:AUTO?`
Queries the automatically set filter length.
`Response: 1024`

Usage: Query only

Manual operation: See "Filter Length" on page 384

:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] <User>

Selects the filter length for `SENS:POW:FILT:TYPE USER`. As the filter length works as a multiplier for the time window, a constant filter length results in a constant measurement time (see also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 374).

The R&S NRP power sensors provide different resolutions for setting the filter length, depending on the used sensor type.

For more information, refer to the specifications document.

Parameters:

<User> float
Range: 1 to depends on R&S NRP power sensor type
*RST: 1

Example: `:SENS1:FILT:TYPE USER`
Selects user filter mode.
`:SENS1:FILT:LENG 16`
Sets a filter length of 16. E.g. using a sensor with 20 ms time window, the resulting measurement time is 640 ms (2x16x20 ms)

Manual operation: See "Filter Length" on page 384

: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 634.

Manual operation: See "Noise/Signal Ratio" on page 384

:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe <MTime>

Sets an upper limit for the settling time of the auto-averaging filter and thus limits the length of the filter.

Parameters:
<MTime> float

Range: 1 to 999.99
Increment: 0.01
*RST: 4

Example: See Example "Performing a power measurement with a fixed filter" on page 634.

Manual operation: See "Timeout" on page 384

: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 384

:SENSe<ch>[:POWer]:FILTer:TYPE <Type>

Selects the filter mode. The filter length is the multiplier for the time window and thus directly affects the measurement time.

Parameters:

<Type> AUTO | USER | NSRatio

AUTO
Automatically selects the filter length, depending on the measured value. The higher the power, the shorter the filter length, and vice versa.
Note: To avoid long settling times when the power is low, you can limit the averaging factor limited with the "timeout" parameter (`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe`).

USER
Allows you to set the filter length manually. As the filter-length takes effect as a multiplier of the measurement time, you can achieve constant measurement times.

NSRatio
Selects the filter length (averaging factor) according to the criterion that the intrinsic noise of the sensor (2 standard deviations) does not exceed the specified noise content. You can define the noise content with command `:SENSe<ch>[:POWer]:FILTer:NSRatio`.

*RST: AUTO

Example: See Example "Performing a power measurement with a fixed filter" on page 634.

Manual operation: See "Filter" on page 383

: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 383

: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 385

: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 383

: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 383

: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 382

: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 634.

Manual operation: See "Use Frequency Of" on page 383

: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 382

: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 382

: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 382

14.15 SCONfiguration subsystem

The `SCONfiguration` subsystem contains the commands to define the system configuration, stream mapping and baseband configuration.

Required options

See "Required options" on page 257.

Common suffixes

The commands in this chapter use the following common suffixes:

Suffix	Suffix range	Description	Required options
CHANnel<ch0>	[1]	Channel number, up to 2 channels for both Dig. IQ HS x interfaces.	R&S SMCVB-K19
HSDigital<ch>	1 to 2	Dig. IQ HS x input or output connectors	R&S SMCVB-K19
STReam<st>	[1]	One I/Q stream, optional suffix	-

Example: Distributing the streams to the output connectors

The following example lists the commands necessary to fulfill this task.

```
// ******************************************************************************
// Map the I/Q streams to the output connectors.
// ******************************************************************************
SCONfiguration:OUTPut:MAPPing:RF1:STReam1:STATe ON
SCONfiguration:OUTPut:MAPPing:HSDigital1:CHANnel0:STReam1:STATe ON
```

Example: Connecting and configuring external instruments

The following example lists commands to connect and configure external instruments.

```
// ******************************************************************************
// Scan interfaces and your network for connected instruments.
// ******************************************************************************
SCONfiguration:EXTernal:DISPlay ALL
SCONfiguration:EXTernal:REMote:CLEan
SCONfiguration:EXTernal:REMote:SCAN
SCONfiguration:EXTernal:REMote:SCAN:STATe?
// Response: "0"
// The scanning procedure is finished.

// ******************************************************************************
// Query characteristics at the input and output interfaces.
// ******************************************************************************
SCONfiguration:EXTernal::HSDigital1:DIRection?
// Response: "IN"
SCONfiguration:EXTernal::HSDigital2:DIRection?
// Response: "OUT"
SCONfiguration:EXTernal::HSDigital1:IQConnection:STATe?
// Response: "0"
SCONfiguration:EXTernal::HSDigital2:IQConnection:STATe?
// Response: "1"

// ******************************************************************************
// Manage external instruments.
// ******************************************************************************
SCONfiguration:EXTernal:REMote:LIST?
// Response: "SMBV100B,SGS_2,SGT100A,SMBV_1"
```

```
// Add instruments to selection.
SCONfiguration:EXTernal:REMote:ADD "SGS_1","USB","100007"
SCONfiguration:EXTernal:REMote:ADD "SGT100A","LAN","10.112.11.125","1"
SCONfiguration:EXTernal:REMote:LIST?
SCONfiguration:EXTernal:REMote:REName "SGS_2","SGS (102030)"
SCONfiguration:EXTernal:REMote:LIST?
// Response: "SMBV100B,SGS (102030),SGT100A,SMBV_1"

// ******************************************************************************
// Detect external instruments and connect them to the R&S SMCV100B.
// ******************************************************************************
SCONfiguration:EXTernal:DIGital:REMote:DETect?
// Response: "SMBV100B"
SCONfiguration:EXTernal:HSDigital2:REMote:ISELect?
// Response: "SGT100A","A"
SCONfiguration:EXTernal:HSDigital2:REMote:CONNect
// Alternatively, combine instrument select and connect.
SCONfiguration:EXTernal:IQOutput:REMote:ICONnect "SGS100A","A"
// Define an external instrument manually.
SCONfiguration:EXTernal:HSDigital2:REMote:ISELect "SGS_1","A"
SCONfiguration:EXTernal:HSDigital2:REMote:CONNect
SCONfiguration:EXTernal:HSDigital2:RCONnection:STATe?
// Response: 1
SCONfiguration:EXTernal:HSDigital2:INAMe?
// Response: "SGS_1 [A]"

// ******************************************************************************
// Specify characteristics of the IQ output signal.
// ******************************************************************************
SCONfiguration:EXTernal:HSDigital2:RF:COUPling OFF
SCONfiguration:EXTernal:HSDigital2:RF:FREQuency 2143000000
SCONfiguration:EXTernal:HSDigital2:RF:POWer \-20
SCONfiguration:EXTernal:HSDigital2:RF:STATe ON

// ******************************************************************************
// Specify the intialization sequence with a user-defined initialization file.
// ******************************************************************************
MMEMory:CDIRectory "/var/user/RcExtInstr"
SCONfiguration:EXTernal:REMote:INITialization:CATalog?
// Response: "init_seq_sgs"
SCONfiguration:EXTernal:HSDigital2:REMote:INITialization:FILE "init_seq_sgs.iec"
SCONfiguration:EXTernal:ACONnect 1

*RST

SCONfiguration:EXTernal:REMote:PURGe
// Disabling remote control of the external instruments
SCONfiguration:EXTernal:REMote:DISConnect[:ALL]
```

Example: Configuring primary-secondary mode

```
// For the primary instrument:
SOURce1:ROSCillator:SOURce INT
SCONfiguration:MULTiinstrument:MODe PRIMary
SCONfiguration:MULTiinstrument:STATe 1
SCONfiguration:APPLy

// For the secondary instrument:
SOURce1:ROSCillator:SOURce EXT
SOURce1:ROSCillator:EXTernal:FREQuency 10MHZ
SCONfiguration:MULTiinstrument:MODe SECondary
SCONfiguration:MULTiinstrument:STATe 1
```

- Multi-instrument configuration commands 649
- I/Q stream mapper commands 650
- External RF and I/Q instruments commands 651

14.15.1 Multi-instrument configuration commands

The following commands configure multi-instrument settings.

Commands:

:SCONfiguration:MULTiinstrument:MODE 649
:SCONfiguration:MULTiinstrument:STATe 649
:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization? 650

:SCONfiguration:MULTiinstrument:MODE <MSMode>

Sets if the instrument works as a primary or as a secondary instrument.

Parameters:

<MSMode> PRIMary | SECondary
*RST: PRIMary

Example: See Example "Configuring primary-secondary mode" on page 649.

Manual operation: See "Multi Instrument Trigger" on page 417

:SCONfiguration:MULTiinstrument:STATe <TriggerState>

Activates the selected mode.

Parameters:

<TriggerState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring primary-secondary mode" on page 649.

Manual operation: See "State" on page 416

:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization?

Queries if synchronization is achieved.

Return values:
<SyncSTate> SYNC | NOSYnc
*RST: NOSYnc

Example: See Example "Configuring primary-secondary mode" on page 649.

Usage: Query only

14.15.2 I/Q stream mapper commands

The following commands configure the I/Q stream mapper.

:SCONfiguration:OUTPut:MAPPing:RF:STReam<st>:STATe 650
:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe 650
:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset 650
:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset 651

:SCONfiguration:OUTPut:MAPPing:RF:STReam<st>:STATe <State>
:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe <State>

Maps the I/Q output streams to the output connectors.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "Map stream x to connector" on page 258

:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset <SmFreqOffset>

Sets the frequency offset per stream.

This offset implies a shift in the frequency domain for all signals that the stream routes to a specific output connector. For example, RF or I/Q output connectors. Value ranges depend on installed options.

For more information, refer to the specifications document.

Parameters:
<SmFreqOffset> float
Range: depends on options
Increment: 0.01
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 647.

Manual operation: See "Frequency Offset" on page 257

:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset <SmPhasOffset>

Sets the phase offset per stream.

Parameters:

<SmPhasOffset> float

Range: -999.99 to 999.99
Increment: 0.01
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 647.

Manual operation: See "Phase Offset" on page 258

14.15.3 External RF and I/Q instruments commands

:SCONfiguration:EXTernal:DISPlay 652
:SCONfiguration:EXTernal:ACONnect 652
:SCONfiguration:EXTernal:REMote:CONNect[:ALL] 652
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL] 652
:SCONfiguration:EXTernal:PBEHaviour 652
:SCONfiguration:EXTernal:HSDigital<ch>:DIRection? 653
:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe? 653
:SCONfiguration:EXTernal:HSDigital<ch>:RCONnection:STATe? 653
:SCONfiguration:EXTernal:HSDigital<ch>:INAMe? 653
:SCONfiguration:EXTernal:HSDigital<ch>:RF:COUPling 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency:OFFSet 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer:OFFSet 655
:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe 655
:SCONfiguration:EXTernal:REMote:SCAN 655
:SCONfiguration:EXTernal:REMote:SCAN:STATe? 655
:SCONfiguration:EXTernal:REMote:LIST? 656
:SCONfiguration:EXTernal:REMote:ADD 656
:SCONfiguration:EXTernal:REMote:REName 657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect? 657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect 657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:CONNect 658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ICONnect 658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO? 658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DISConnect 659
:SCONfiguration:EXTernal:REMote:INITialization:CATalog? 659
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INITialization:FILE 659
:SCONfiguration:EXTernal:REMote:PURGe 659
:SCONfiguration:EXTernal:REMote:CLEan 660
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:SEND 660

:SCONfiguration:EXTernal:DISPlay <DisplayMode>

Filters the displayed connectors upon the selected criteria.

Parameters:
<DisplayMode> ALL | MAPPed | INPut | OUTPut
*RST: MAPPed

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "Display" on page 259

:SCONfiguration:EXTernal:ACONnect <State>

Enables automatic detection and connection setup of connected external instruments.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 647.

Manual operation: See "Auto Connect" on page 259

:SCONfiguration:EXTernal:REMote:CONNect[:ALL]
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]

Triggers the instrument to establish the connections to all configured external instruments or to disconnect all existing connections.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Event

Manual operation: See "Connect/Disconnect All Remote" on page 260

:SCONfiguration:EXTernal:PBEHaviour <State>

If enabled, the connection to the external instruments is retained after preset (`*RST`) of the instrument.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Manual operation: See "Preset behavior: Keep connections to external instruments" on page 260

:SCONfiguration:EXTernal:HSDigital<ch>:DIRection?

Queries the connector direction.

Return values:

<Direction> NONE | IN | OUT

*RST: IN

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Direction" on page 260

:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe?

Queries the status of the I/Q connection of the digital interfaces.

Return values:

<IQConnState> 1 | ON | 0 | OFF

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "I/Q Connection" on page 261

:SCONfiguration:EXTernal:HSDigital<ch>:RCONnection:STATe?

Return values:

<State> 1 | ON | 0 | OFF

Usage: Query only

:SCONfiguration:EXTernal:HSDigital<ch>:INAMe?

Queries the name of the connected external instrument.

Return values:

<InstrName> string

Returns the name of the connected external instrument.

<InstrmentName> (SerialNumber) <Path>
the instrument name, as retrieved via the DIG I/Q interface

<InstrmentName>[, <RfPath>] or <InstrmentName> (SerialNumber)
the instrument name, as defined in with the "Remote Config" settings or as defined by the command `:SCONfiguration:EXTernal:REMote:ADD`

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Instrument Name" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:COUPling <RfCouplingState>

Enables/disables coupling all major RF setting (like the frequency, level and RF state) of the external instrument to the R&S SMCV100B.

Parameters:

<RfCouplingState> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "RF Couple" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency <Frequency>

In uncoupled mode, sets the RF frequency of the external instrument.

Parameters:

<Frequency> float

Range: 100E3 to 3E9
Increment: 0.01
*RST: 1E9

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency:OFFSet <FreqOffset>

In coupled mode, offsets the RF frequency of the external instrument with the selected delta value.

Parameters:

<FreqOffset> float

Range: -3E9 to 3E9
Increment: 0.01
*RST: 0

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer <Power>

In uncoupled mode, sets the RF level of the external instrument.

Parameters:

<Power> float

Range: -130 to 20
Increment: 0.01
*RST: -30

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer:OFFSet <PowerOffset>

In coupled mode, offsets the RF level of the external instrument with the selected delta value.

Parameters:

<PowerOffset> float

Range: -100 to 100
Increment: 0.01
*RST: 0

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 262

:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe <RemConnState>

Queries/sets the RF output state of the connected external instrument.

Parameters:

<RemConnState> 1 | ON | 0 | OFF

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "RF State" on page 262

:SCONfiguration:EXTernal:REMote:SCAN

Scans the network for connected instruments.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Event

Manual operation: See "Scan" on page 264

:SCONfiguration:EXTernal:REMote:SCAN:STATe?

Queries if scanning is performed or not.

To start the scanning process, use the command :SCONfiguration:EXTernal:REMote:SCAN on page 655.

Return values:

<ScanState> 1 | ON | 0 | OFF

1
Scanning process running

0
Not scanning

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Scan" on page 264

:SCONfiguration:EXTernal:REMote:LIST?

Lists all available instruments.

Instruments found, e.g. by the :SCONfiguration:EXTernal:REMote:SCAN command.

Return values:

<InstrNames> String

String with symbolic names and/or alias names

Example: See Example "Connecting and configuring external instruments" on page 647

Usage: Query only

Manual operation: See "External Instrument" on page 265

:SCONfiguration:EXTernal:REMote:ADD <InstrName>, <HwChan>, <TcpIporUsbAddr>[, <RfPathNumber>]

Adds manually an external instrument to the list of available instruments.

Parameters:

<HwChan> String

Hardware channel (USB or LAN) used by the remote channel to the external instrument

Range: "LAN" to "USB"
*RST: "LAN"

<TcpIporUsbAddr> String

IP address or hostname of the connected external instrument

<RfPathNumber> String

Determines the number of RF paths the external instrument is equipped with

Range: "1" to "2"
*RST: "1"

Setting parameters:
<InstrName> String

Alias name of the instrument

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Setting only

Manual operation: See "External Instrument" on page 265
See "Set Symbolic Name" on page 265
See "Remote Channel" on page 265
See "Hostname or IP Address" on page 266
See "Device ID" on page 266
See "RF Path" on page 266

:SCONfiguration:EXTernal:REMote:REName

Changes the symbolic name of the instrument.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Setting only

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect?

Searches for external instruments connected to the particular digital interfaces.

Return values:
<DetectedInstr> string

If the detection fails, the query returns `"None"`.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Detect" on page 264

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect <InstrName>[, <RfPath>]

Select an external instrument for the selected connector.

Parameters:

<InstrName> String

Instrument alias name, as retrieved with the command `:SCONfiguration:EXTernal:REMote:LIST?` or defined with the command `:SCONfiguration:EXTernal:REMote:ADD`.

<RfPath> String

Determines the used RF output of the external instrument.

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "External Instrument" on page 265
See "Apply" on page 267
See "Apply and Connect" on page 267

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:CONNect

Usage: Event

Manual operation: See "Apply and Connect" on page 267

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ICONnect <InstrName>, <RfPath>

Selects an external instrument for the selected connector and triggers connection.

Parameters:

<InstrName> string

Instrument alias name, as retrieved with the command `:SCONfiguration:EXTernal:REMote:LIST?` or defined with the command `:SCONfiguration:EXTernal:REMote:ADD`.

<RfPath> string

Determines the used RF output of the external instrument.
For a one-path instrument, the output path is fixed.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Setting only

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?

Queries information on the external instrument.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Remote Connection Status" on page 261
See "Instrument Name" on page 262
See "Set Symbolic Name" on page 265
See "Remote Channel" on page 265
See "Hostname or IP Address" on page 266
See "RF Path" on page 266

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DISConnect

Disconnects the selected remote connection. To disconnect all remote connections at once, use the command `:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]`.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Event

Manual operation: See "Remote Connection Status" on page 261

:SCONfiguration:EXTernal:REMote:INITialization:CATalog?

Queries the names of the existing initialization files in the default directory.

Per default, the instrument saves user-defined files in the `/var/user/` directory. Use the command `:MMEM:CDIRectory` to change the default directory to the currently used one.

Only files with extension `*.iec` are listed.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Query only

Manual operation: See "Initialization Sequence" on page 266

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INITialization:FILE <Filename>

Queries the currently selected initialization file.

Parameters:

<Filename> string

filename with file extension (`*.iec`)

Example: See Example "Connecting and configuring external instruments" on page 647.

Manual operation: See "Initialization Sequence" on page 266

:SCONfiguration:EXTernal:REMote:PURGe

Removes unused instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 264

:SCONfiguration:EXTernal:REMote:CLEan

Removes all instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 264

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:SEND <SendScpiCommand>

Allows you to send SCPI commands to the RF instruments connected to the R&S SMCV100B.

Setting parameters:
<SendScpiCommand>"<SCPI syntax>"

String containing a SCPI command (query or setting)

Example: See Example "Connecting and configuring external instruments" on page 647.

Usage: Setting only

Manual operation: See "Command/Send Command" on page 268

14.16 SOURce subsystem

The `SOURce` subsystem contains the commands for configuring signals.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`SOURce<hw>`	[1]	SOURce[1] = RF output (optional keyword)

- Connector settings 661
- SOURce:AWGN subsystem 665
- SOURce:BBIN subsystem 673
- SOURce:BB subsystem 680
- SOURce:CORRection subsystem 768

- SOURce:FREQuency subsystem....776
- SOURce:INPut subsystem....782
- SOURce:IQ subsystem....782
- SOURce:IQ:OUTPut subsystem....783
- SOURce:LIST subsystem....788
- SOURce:PHASe subsystem....801
- SOURce:POWer subsystem....802
- SOURce:ROSCillator subsystem....814
- SOURce:SWEep subsystem....817

14.16.1 Connector settings

This section summarizes the commands of the `OUTPut` and `INPut` subsystems, necessary to configure the connectors settings. Listed are the commands for configuring the output signals and the inputs for trigger, data, and control signals.

The `...:USER<ch>:...` commands determine the global trigger threshold and input impedance values, that affect all trigger and control signal inputs. The connector settings concern to all digital modulations, the generation of waveforms or multi carrier signals, and all digital standards.

See Section 14.16.7, "SOURce:INPut subsystem", on page 782 for a description of the commands for configuring the inputs for external modulation signals.

See also Section 12.2, "Configuring global connectors", on page 456.

Example: Configuring global connectors

```
// ******************************************************************************
// Check the signal routing for a global connector, for example connector User 1.
// ******************************************************************************
SOURce1:INPut:USER1:DIRection?
// Response: "UNUS"
// User 1 connector is not in use.
SOURce1:INPut:USER1:SIGnal?
// Response: "NONE"
OUTPut1:USER1:SIGnal?
// Response: "NONE"
// User 1 connector expects no input signal and no output signal.

// ******************************************************************************
// Set signal direction and signal type.
// ******************************************************************************
SOURce1:INPut:USER1:DIRection INP
SOURce1:INPut:USER1:SIGNal TRIG1
SOURce1:INPut:USER2:DIRection OUTP
SOURce1:INPut:USER2:SIGNal MARKA2
SOURce1:INPut:USER3:DIRection INP
SOURce1:INPut:USER3:SIGNal NSEGM1
```

```
SOURce1:INPut:USER5:DIRection INP
SOURce1:INPut:USER5:SIGNal TRIG2

// ****************************************************************************
// Set input signal charateristics.
// ****************************************************************************
SOURce1:INPut:USER:TRIGger:LEVel 1.5
SOURce1:INPut:USER:PULM:LEVel 2

SOURce1:INPut:USER:IMPedance G1K
// Sets the impedance of 1 kOhm/GND for the trigger or clock input signals.
SOURce1:INPut:CLOCk:SLOPe POS
// Sets a positive polarity of the active slope for clock input signals.
SOURce1:INPut:TRIGger:SLOPe POS
// Sets a positive polarity of the active slope for trigger input signals.

// ****************************************************************************
// Set signal direction and signal type.
// ****************************************************************************
SOURce1:INPut:USER1:DIRection INP
SOURce1:INPut:USER1:SIGNal TRIG1
// The input signal at User 1 connector is a global trigger.
SOURce1:INPut:USER2:DIRection OUTP
OUTput1:USER2:SIGNal?
// Response: "MARKA1"
// The output signal at User 2 connector is the baseband marker 1.

// ****************************************************************************
// Set input signal charateristics.
// ****************************************************************************
SOURce1:INPut:USER:TRIGger:LEVel 1.5
// Sets a common threshold of 1.5 V for User 1 to User 2 connectors. This
// threshold applies to all input signals, in this example, TRIG1.
SOURce1:INPut:USER:TRIGger:IMPedance G1K
// Sets the impedance of 1 kOhm/GND for the trigger or clock input signals.
SOURce1:INPut:CLOCk:SLOPe POS
// Sets a positive polarity of the active slope for clock input signals.
SOURce1:INPut:TRIGger:SLOPe POS
// Sets a positive polarity of the active slope for trigger input signals.
```

Commands:

[:SOURce]:INPut:USER<ch>:DIRection....663
:OUTPut:USER<ch>:DIRection....663
[:SOURce]:INPut:USER<ch>:SIGNal....663
:OUTPut:USER<ch>:SIGNal....664
[:SOURce]:INPut:USER:CLOCk:LEVel....664
[:SOURce]:INPut:USER:TRIGger:LEVel....664
[:SOURce]:INPut:USER:CLOCk:IMPedance....664
[:SOURce]:INPut:USER:TRIGger:IMPedance....664
[:SOURce]:INPut:USER:CLOCk:SLOPe....665
[:SOURce]:INPut:USER:TRIGger:SLOPe....665

[:SOURce]:INPut:USER<ch>:DIRection <Direction>
:OUTPut:USER<ch>:DIRection <Direction>

Sets the direction of the signal at the connector that can be an input or an output.

Suffix:
USER<ch> 1 to 2
"User" connector number

Parameters:
<Direction> INPut | OUTPut | UNUSed

INPut|OUTPut
Input signal or output signal

UNUSed
No signals present at the connector.

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Direction" on page 463

[:SOURce]:INPut:USER<ch>:SIGNal <Signal>

Determines the control signal that is input at the selected connector.

To define the connector direction, use the command `[:SOURce]:INPut:USER<ch>:DIRection`.

Suffix:
USER<ch> 1 to 2

Parameters:
<Signal> TRIG1 | NSEGM1 | NONE | INST | TS | ETI | SDIF | PPS | SYNCIN

TRIG1
Global trigger input signal available at "User 1/2" connector

NSEGM1
Input global next segment for triggering of multi-segment waveform files. The signal is available at "User 1/2" connector.

NONE
No input signal

INST
Internal instrument trigger signal available at "User 1/2" connector.

TS
Transport stream (TS) input signal available at "User 1" connector only

ETI
Ensemble transport interface input signal compatible with DAB/T-DMB ETSI standard. The signal is available at "User 1" connector only.

SDIF
S/PDIF input signal available at "User 1" connector only

PPS
1PPS (one pulse per second) input signal available at "User 2" connector only

SYNCIN
In the secondary instruments, at most one input for the synchronization (and trigger) signal. Signal available at "User 2" connector only.

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Signal" on page 463

:OUTPut:USER<ch>:SIGNal <Signal>

Sets the control signal that is output at the selected connector.

To define the connector direction, use the command `:OUTPut:USER<ch>:DIRection`.

Parameters:
<Signal> MARKA1 | NONE
*RST: MARKA1

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Signal" on page 463

[:SOURce]:INPut:USER:CLOCk:LEVel <Level>
[:SOURce]:INPut:USER:TRIGger:LEVel <Level>

Sets the threshold for any input signal at the "User 1" and "User 2" connectors.

Parameters:
<Level> float
Range: 0.1 to 2
Increment: 0.1
*RST: 1

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Threshold User1-2 Input" on page 464

[:SOURce]:INPut:USER:CLOCk:IMPedance <Impedance>
[:SOURce]:INPut:USER:TRIGger:IMPedance <Impedance>

Selects the input impedance for the external trigger inputs.

Parameters:
<Impedance> G50 | G1K

G50
50 Ω per ground
G1K
1 kΩ per ground
*RST: G1K

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Impedance Clock/Trigger Input" on page 464

[:SOURce]:INPut:USER:CLOCk:SLOPe <Slope>

Sets the polarity of the active slope of an externally applied clock signal.

Parameters:
<Slope> NEGative | POSitive
*RST: POSitive

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Clock Input Slope" on page 464

[:SOURce]:INPut:USER:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an external trigger signal.

Parameters:
<Slope> NEGative | POSitive
*RST: POSitive

Example: See Example "Configuring global connectors" on page 661.

Manual operation: See "Trigger Input Slope" on page 465

14.16.2 SOURce:AWGN subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

Required options

See Section 6.1.1, "Required options", on page 283.

Programming examples

Example: To generate a pure noise signal

The following example generates a pure noise signal with a specified bandwidth and noise level.

```
:SOURce1:AWGN:MODE ONLY
:SOURce1:AWGN:BWIDth 3840000
:SOURce1:AWGN:BWIDth:RATio 2
```

```
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:BWIDth:NOISe?
// Response: 7680000
:SOURce1:AWGN:FREQuency:CENTer:OFFSet 1000000
// Shifts the noise signal by 1 MHz relative to the carrier frequency.
:SOURce1:AWGN:DISP:MODE RFA
:SOURce1:AWGN:POWer:NOISe -80
:SOURce1:POWer:LEVel:IMMediate:AMPlitude?
// Response: -80
:SOURce1:AWGN:POWer:NOISe:TOTal?
// Response: -80
```

Example: To generate a CW interferer signal

The following example generates a CW interferer signal with a specified target frequency and level.

```
:SOURce1:AWGN:MODE CW
:SOURce1:AWGN:FREQuency:TARGet 20000000
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:FREQuency:RESult?

:SOURce1:AWGN:POWer:RMODe CARRier
:SOURce1:AWGN:CNRatio 10
:SOURce1:AWGN:POWer:CARRier -80
// The level display indicates the PEP of the carrier.
:SOURce1:POWer:LEVel:IMMediate:AMPlitude?
// Response: -80
// Querry the power of the interfering signal
:SOURce1:AWGN:POWer:NOISe?
// Response: -90
:SOURce1:AWGN:POWer:SUM?
// Response: -79.5860731484178
:SOURce1:AWGN:POWer:SUM:PEP?
// Response: -80
```

Example: To generate an additive noise signal

The following example shows how to adjust the AWGN settings to generate a signal with the following characteristics:

- The carrier signal is an uplink EUTRA/LTE signal with:
  - "Channel Bandwidth" = "1.4 GHz" corresponds to "Occupied Bandwidth" = "1.080 MHz"
  - "RF Frequency" = "1.95 GHz"
  - "RF Level" = "-76 dBm"
- Required is an SNR of 12.7 dB.

```
:SOURce1:FREQuency:CW 1950000000
:SOURce1:POWer:LEVel:IMMediate:AMPlitude -76
```

```
:SOURce1:AWGN:MODE ADD
// set the system bandwidht to the occupied bandwidth
:SOURce1:AWGN:BWIDth 1080000
:SOURce1:AWGN:BWIDth:RATio 1.5
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:BWIDth:NOISe?
// Response: 1620000

:SOURce1:AWGN:DISP:MODE RFA
:SOURce1:AWGN:POWer:MODE CN
:SOURce1:AWGN:POWer:RMODe CARRier
:SOURce1:AWGN:BRATe?
//  Response: 100000
:SOURce1:AWGN:CNRatio 12.7
:SOURce1:AWGN:ENRatio?
// Response: 23.0342375548695
:SOURce1:AWGN:POWer:CARRier?
// Response: -76
// the Level display indicates the PEP of the carrier

// Querry the resulting noise power, in the system and total bandwidht
:SOURce1:AWGN:POWer:NOISe?
// Response: -88.7
:SOURce1:AWGN:POWer:NOISe:TOTal?
// Response: -88.7
// Querry the carrier+noise power and PEP
:SOURce1:AWGN:POWer:SUM?
// Response: -75.7728170942726
:SOURce1:AWGN:POWer:SUM:PEP?
// Response: -76
```

14.16.2.1 General commands

[:SOURce<hw>]:AWGN:STATe....668
[:SOURce<hw>]:AWGN:MODE....668
[:SOURce<hw>]:AWGN:BWIDth....668
[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe]....669
[:SOURce<hw>]:AWGN:BWIDth:RATio....669
[:SOURce<hw>]:AWGN:BWIDth:NOISe?....669
[:SOURce<hw>]:AWGN:DISP:MODE....670
[:SOURce<hw>]:AWGN:POWer:MODE....670
[:SOURce<hw>]:AWGN:POWer:RMODe....670
[:SOURce<hw>]:AWGN:BRATe....670
[:SOURce<hw>]:AWGN:CNRatio....671
[:SOURce<hw>]:AWGN:ENRatio....671
[:SOURce<hw>]:AWGN:POWer:CARRier....671
[:SOURce<hw>]:AWGN:POWer:NOISe....671
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?....672

[:SOURce<hw>]:AWGN:POWer:SUM?....672
[:SOURce<hw>]:AWGN:POWer:SUM:PEP?....672
[:SOURce<hw>]:AWGN:FREQuency:TARGet....673
[:SOURce<hw>]:AWGN:FREQuency:RESult?....673

[:SOURce<hw>]:AWGN:STATe <State>

Activates or deactivates the AWGN generator.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To generate a pure noise signal" on page 665.

Manual operation: See "State" on page 288

[:SOURce<hw>]:AWGN:MODE <Mode>

Determines how the interfering signal is generated.

Parameters:

<Mode> ONLY | ADD | CW

ADD
The AWGN noise signal is added to the baseband signal.

ONLY
The pure AWGN noise signal is modulated to the carrier. The connection to the baseband is interrupted

CW
The sine interfering signal is added to the baseband signal.

*RST: ADD

Example: See Example "To generate an additive noise signal" on page 666

Manual operation: See "Mode" on page 289

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

Sets the system bandwidth.

Parameters:

<BWidth> float

Range: 1000 to 80E6
Increment: 100
*RST: 3.84E6

Example: See Example "To generate an additive noise signal" on page 666.

Manual operation: See "System Bandwidth" on page 289

[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe] <AwgnBwCoupState>

Enables bandwidth coupling.

If enabled, the digital broadcast baseband signal bandwidth couples to the AWGN system bandwidth.

Parameters:

<AwgnBwCoupState> 1 | ON | 0 | OFF

*RST: 0

Example:

```
:SOURce1:AWGN:BWIDth?
// Response in Hz: "3840000"
// Enable a digital broadcast standard, e.g.
DVB-T.
:SOURce1:BB:DVBT:STATe 1
:SOURce1:AWGN:BWIDth:COUPling:STATe 1
:SOURce1:AWGN:BWIDth?
// Response in Hz: "76071143"
```

Manual operation: See "Bandwidth Coupling" on page 289

[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>

Sets the ratio of minimum real noise bandwidth to system bandwidth, see also "Signal and noise parameters" on page 284.

Parameters:

<Ratio> float

Range: 1 to Max
Increment: 0.1
*RST: 1

Example: see Example "To generate an additive noise signal" on page 666.

Manual operation: See "Minimum Noise/System Bandwidth Ratio" on page 289

[:SOURce<hw>]:AWGN:BWIDth:NOISe?

Queries the real noise bandwidth.

Return values:

<Noise> float

Range: 0 to 200E6
Increment: 100
*RST: 0

Example: See Example "To generate an additive noise signal" on page 666.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 295

[:SOURce<hw>]:AWGN:DISP:MODE <Mode>

Sets the output to that the AWGN settings are related.

Parameters:

<Mode> RFA | IQOUT1

*RST: RF

Example: See Example "To generate an additive noise signal" on page 666.

Manual operation: See "Show Powers For Output" on page 291

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

Selects the mode for setting the noise level.

Parameters:

<Mode> CN | SN | EN

*RST: SN

Example: see Example "To generate an additive noise signal" on page 666

Manual operation: See "Set Noise Power Via" on page 291

[:SOURce<hw>]:AWGN:POWer:RMODe <RMode>

Determines whether the carrier or the noise level is kept constant when the C/N value or Eb/N0 value is changed.

Parameters:

<RMode> CARRier | NOISe

*RST: CARRier

Example: See Example "To generate an additive noise signal" on page 666

Manual operation: See "Reference Mode" on page 291

[:SOURce<hw>]:AWGN:BRATe <BRate>

Sets the bit rate used for calculation of bit energy to noise power ratio.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

Parameters:

<BRate> float

Range: 400 to depends on the installed options
Increment: 0.001
*RST: 100000

Example: see Example "To generate an additive noise signal" on page 666

Manual operation: See "Bit Rate" on page 291

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

Sets the carrier/interferer ratio.

Parameters:

<CnRatio> float

Range: -50 to 45
Increment: 0.01
*RST: 0

Example: See Example "To generate an additive noise signal" on page 666

Manual operation: See "Carrier/Noise Ratio, Signal/Noise Ratio" on page 292

[:SOURce<hw>]:AWGN:ENRatio <EnRatio>

Sets the ratio of bit energy to noise power density.

Parameters:

<EnRatio> float

Range: -50 to depends on the installed options
Increment: 0.01
*RST: 15.84
Default unit: dB

Example: See Example "To generate an additive noise signal" on page 666

Manual operation: See "E_b/N_0" on page 292

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

Sets the carrier power.

Parameters:

<Carrier> float

Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 666

Manual operation: See "Carrier Power, Signal Power" on page 292

[:SOURce<hw>]:AWGN:POWer:NOISe <Noise>

Sets the power of the noise signal in the system respectively total bandwidth.

Parameters:

<Noise> float

Increment: 0.01

Example: see Example "To generate an additive noise signal" on page 666

Manual operation: See "Noise Power (System Bandwidth), Interferer Power" on page 293

[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?

Queries the noise level in the total bandwidth.

Return values:

<Total> float

Range: -145 to 20
Increment: 0.01
*RST: -30

Example: see Example "To generate an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 294

[:SOURce<hw>]:AWGN:POWer:SUM?

Queries the overall power of the noise/interferer signal plus useful signal

Return values:

<Sum> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power" on page 294

[:SOURce<hw>]:AWGN:POWer:SUM:PEP?

Queries the peak envelope power of the overall signal comprised of noise signal plus useful signal.

Return values:

<Pep> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP" on page 294

[:SOURce<hw>]:AWGN:FREQuency:TARGet <Target>

Sets the desired frequency of the sine wave.

Parameters:

<Target> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: see Example "To generate a CW interferer signal" on page 666

Manual operation: See "Target CW Frequency Offset" on page 290

[:SOURce<hw>]:AWGN:FREQuency:RESult?

Queries the actual frequency of the sine wave.

Return values:

<Result> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: see Example "To generate a CW interferer signal" on page 666

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 295

14.16.3 SOURce:BBIN subsystem

The `SOURce:BBIN` subsystem contains the commands for setting the external digital baseband signal.

Suffix	Value range	Description
`CHANnel<ch0>`	0 to 7	Channel number Up to 8 channels per Dig. IQ HS x interface and max. 8 channels for both interfaces.

Required options

See "Required options" on page 270.

See also Section 5.1, "Overview of the input and output signals and interfaces", on page 252.

Example: Applying an external digital baseband signal (Dig. IQ HS x)

An external digital signal must be applied at the Dig. IQ HS x connectors.

```
SOURce1:BBIN:STATe 1

SOURce1:BBIN:DIGital:INTerface HSD
SOURce1:BBIN:SRATe:SOURce? HSD
SOURce1:BBIN:CHANnel0:NAME?
SOURce1:BBIN:CHANnel0:SRATe?
// 100000000
SOURce1:BBIN:CHANnel0:POWer:CFACtor 0.5
SOURce1:BBIN:CHANnel0:POWer:PEAK 3
SOURce1:BBIN:CHANnel0:POWer:RMS?
// 2.5
SOURce1:BBIN:CHANnel0:BB:STATe 1
SOURce1:BBIN:SRATe:SUM?
// 100000000
SOURce1:BBIN:SRATe:MAX?
// 1250000000

// Set the sample rate per channel.
SOURce1:BBIN:SRATe:SOURce USER
SOURce1:BBIN:CHANnel0:SRATe 500000000
SOURce1:BBIN:SRATe:SUM?
// 500000000

SOURce1:BBIN:MPERiod 2
SOURce1:BBIN:ALEVel:EXECute
```

[:SOURce<hw>]:BBIN:STATe ... 675
[:SOURce<hw>]:BBIN:DIGital:INTerface ... 675
[:SOURce<hw>]:BBIN:CDEVice? ... 675
[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe ... 675
[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME ... 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor ... 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK ... 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS ... 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe ... 677
[:SOURce<hw>]:BBIN:MODE ... 677
[:SOURce<hw>]:BBIN:SRATe:SOURce ... 677
[:SOURce<hw>]:BBIN:SRATe:SUM? ... 678
[:SOURce<hw>]:BBIN:SRATe:MAX? ... 678
[:SOURce<hw>]:BBIN:SRATe[:ACTual]? ... 678
[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe ... 678
[:SOURce<hw>]:BBIN:MPERiod ... 679
[:SOURce<hw>]:BBIN:ALEVel:EXECute ... 679
[:SOURce<hw>]:BBIN:POWer:CFACtor ... 679
[:SOURce<hw>]:BBIN:POWer:PEAK ... 680
[:SOURce<hw>]:BBIN:POWer:RMS? ... 680

[:SOURce<hw>]:BBIN:STATe <State>

Enables feeding of an external digital signal into the signal path.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "State" on page 272

[:SOURce<hw>]:BBIN:DIGital:INTerface <BBinDigInterfac>

Selects the input connector at that the signal is fed.

Parameters:
<BBinDigInterfac> DIGital | HSDin | HSDin
HSDin
Dig. IQ HS 1
*RST: HSDin

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Interface" on page 272

[:SOURce<hw>]:BBIN:CDEVice?

Indicates the ID of an externally connected Rohde & Schwarz Instrument or Rohde & Schwarz device.

Return values:
<CDevice> string
"None" - no device is connected.

Example: `SOURce:BBIN:CDEVice?`
Queries the connected device ID.

Usage: Query only

Manual operation: See "Connected Device" on page 273

[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe <BbinIqHsChanSta>

Activates the channel.

Parameters:
<BbinIqHsChanSta> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "BB" on page 274

[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME <BbinIqHsChanNam>

Queries the channel name.

Parameters:
<BbinIqHsChanNam> string

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Name" on page 274

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor <BbinIqHsChCrFac>

Sets the crest factor of the individual channels.

Parameters:
<BbinIqHsChCrFac> float

Range: 0 to 30
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Crest Factor" on page 274

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK <BbinHsChPoPeak>

Sets the peak level per channel.

Parameters:
<BbinHsChPoPeak> float

Range: -60 to 3.02
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Peak Level" on page 274

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS <BbinIqHsChPoRms>

Queries the estimated RMS level.

Parameters:
<BbinIqHsChPoRms> float

Range: -100 to 10
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Level" on page 274

[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe <BbinIqHsChSaRat>

Queries the sample rate per channel.

Parameters:
<BbinIqHsChSaRat> float

Range: 400 to 250E6 ("System Config > Mode = Advanced")/1250E6 ("System Config > Mode = Standard")
Increment: 0.001
*RST: 100E6

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Sample Rate" on page 274

[:SOURce<hw>]:BBIN:MODE <Mode>

Defines that a digital external signal is applied.

Parameters:
<Mode> DIGital

*RST: DIGital

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

[:SOURce<hw>]:BBIN:SRATe:SOURce <Source>

Queries the digital interface used to estimate the sample rate.

Parameters:
<Source> HSDin

HSDin
Queried for `[:SOURce<hw>]:BBIN:DIGital:INTerface HSDin`.

*RST: HSDin

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Sample Rate Source" on page 272

[:SOURce<hw>]:BBIN:SRATe:SUM?

Queries the sum of the sample rates of all active channels.

Return values:
<DigIqHsOutSRSum> integer

Range: 0 to depends on settings
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Usage: Query only

Options: R&S SMCVB-K521/-K522/-K523

Manual operation: See "Aggregated Link Sample Rate" on page 275

[:SOURce<hw>]:BBIN:SRATe:MAX?

Queries the maximum sample rate.

Return values:
<DigIqHsOutSRMax> integer

Range: 400 to 600E6
*RST: 600E6

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Usage: Query only

Manual operation: See "Aggregated Link Sample Rate" on page 275

[:SOURce<hw>]:BBIN:SRATe[:ACTual]?

Queries the sample rate of the external digital baseband signal.

Return values:
<Actual> float

Range: 400 to 100E6
Increment: 0.001
*RST: 100E6

Usage: Query only

[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe <State>

Activates automatic adjustment of the baseband input signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "DIG IQ Auto Setting" on page 275

[:SOURce<hw>]:BBIN:MPERiod <MPeriod>

Sets the recording duration for measuring the baseband input signal by executed `[:SOURce<hw>]:BBIN:ALEVel:EXECute`.

Parameters:

<MPeriod> integer

Range: 1 to 32
*RST: 2
Default unit: s

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Manual operation: See "Measurement Period" on page 275

[:SOURce<hw>]:BBIN:ALEVel:EXECute

Starts measuring the input signal. The measurement estimates the crest factor, peak and RMS level.

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Usage: Event

Manual operation: See "Auto Level Set" on page 275

[:SOURce<hw>]:BBIN:POWer:CFACtor <CFactor>

Sets the crest factor of the external baseband signal.

Parameters:

<CFactor> float

Range: 0 to 30
Increment: 0.01
*RST: 0
Default unit: dB

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

[:SOURce<hw>]:BBIN:POWer:PEAK <Peak>

Peak level of the external baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Parameters:

<Peak> float

Range: -60 to 3.02
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

[:SOURce<hw>]:BBIN:POWer:RMS?

Queries the RMS level of the external digital baseband signal.

Return values:

<Rms> float

Range: -100 to 10
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 674.

Usage: Query only

14.16.4 SOURce:BB subsystem

This subsystem contains all commands for digital signal generation. It is divided into several subsystems which are described separately.

- SOURce:BB subsystem general commands 680
- SOURce:BB:DM subsystem 683
- SOURce:BB:ARBitrary subsystem 709
- SOURce:BB:General subsystem 755
- SOURce:BB:IMPairment subsystem 762
- SOURce:BB:GRAPhics subsystem 764
- SOURce:BB:PROGress subsystem 767

14.16.4.1 SOURce:BB subsystem general commands

The following section describes the commands for setting the frequency shift and the phase offset for the signal at the output of the "Baseband" and "BB Input" blocks.

Commands:

[:SOURce<hw>]:BBIN:FOFFset....681
[:SOURce<hw>]:BB:FOFFset....681
[:SOURce<hw>]:BBIN:POFFset....681
[:SOURce<hw>]:BB:POFFset....681
[:SOURce<hw>]:BB:ROUTe....682
[:SOURce<hw>]:BBIN:ROUTe....682
[:SOURce<hw>]:BB:POWer:PEAK?....682
[:SOURce<hw>]:BB:CFACtor?....682
[:SOURce<hw>]:BB:POWer:RMS?....683

[:SOURce<hw>]:BBIN:FOFFset <FOffset>
[:SOURce<hw>]:BB:FOFFset <FOffset>

Sets a frequency offset for the internal or external baseband signal. The offset affects the generated baseband signal.

Parameters:

<FOffset> float

Range: depends on the installed options
Increment: 0.01
*RST: 0
Default unit: Hz

Example: `SOURce1:BB:FOFFset 2MHZ`

Manual operation: See "Frequency Offset" on page 250

[:SOURce<hw>]:BBIN:POFFset <POffset>

Sets the relative phase offset for the external baseband signal.

Parameters:

<POffset> float

Range: -999.99 to 999.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce1:BBIN:POFFset 0.5`

Manual operation: See "Phase Offset" on page 250

[:SOURce<hw>]:BB:POFFset <POffset>

Sets the relative phase offset for the selected baseband signal.

Parameters:

<POffset> float

Range: 0 to 359.9
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce1:BB:POFFset 0.5DEG`

Manual operation: See "Phase Offset" on page 250

[:SOURce<hw>]:BB:ROUTe <Route>
[:SOURce<hw>]:BBIN:ROUTe <Route>

Selects the signal route for the internal/external baseband signal.

Parameters:

<Route> A

Example: `SOURce1:BBIN:ROUTe A`

[:SOURce<hw>]:BB:POWer:PEAK?

Queries the peak level of the baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Return values:

<Peak> float

Range: -145 to 30
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: `BB:POW:PEAK`
Queries the peak level of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:CFACtor?

Queries the crest factor of the baseband signal.

Return values:

<CFactor> float

Range: 0 to 100
Increment: 0.01
*RST: 0
Default unit: dB

Example: `SOURce1:BB:CFACtor?`
Queries the crest factor of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:POWer:RMS?

Queries the RMS level of the baseband signal relative to full scale of 0.5V (in terms of dB full scale).

Return values:

<Rms> float

Range: -145 to 30
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: `BB:POW:RMS?`
Queries the rms level of the baseband signal.

Usage: Query only

14.16.4.2 SOURce:BB:DM subsystem

This section list the commands of the `SOURce:BB:DM` subsystem. The commands are divided into sections, where the last one describes how to use lists for digital modulation in remote control, and all other sections describe the configuration of the digital modulation.

Required options

See Section 4.5.1, "Required options", on page 106

The commands are grouped in the following sections:

- Programming examples 683
- General commands 686
- Save/recall commands 688
- Filter commands 689
- Modulation and coding commands 691
- Power ramping 694
- Trigger commands 696
- Marker commands 700
- Clock commands 702
- Handling list files 703

Programming examples

Example: Performing general tasks

This example shows how to enable custom digital modulation with predefined settings as basis for further customization (e.g. adjusting the data source); intermediate results and configuration are stored with the save/recall function.

```
// ***************************************************************
// Reset instrument first
```

```
// ********************************************************************
*RST; *CLS

SOURce1:BB:DM:PRESet
SOURce1:BB:DM:STANDard W3GPp
SOURce1:BB:DM:SRATe?
// 3840000
SOURce1:BB:DM:CODing?
// WCDMA
SOURce1:BB:DM:FORMat?
// QPSK45
SOURce1:BB:DM:STATe ON
SOURce1:BB:DM:SETTing:STORe "/var/user/ digMod/CustDM3GPP"

// ********************************************************************
// Recall settings
// ********************************************************************
MMEM:CDIR "/var/user/digMod"
SOURce1:BB:DM:SETTing:CATalog?
// CusDigMod,cdm3gpp, CustDM3GPP
SOURce1:BB:DM:SETTing:DELete "cdm3gpp"
SOURce1:BB:DM:SETTing:LOAD "CusDigMod"

// ********************************************************************
// Change the data source
// ********************************************************************
SOURce1:BB:DM:SOURce?
// PRBS
SOURce1:BB:DM:PRBS:LENGth?
// 9
SOURce1:BB:DM:SOURce DLISt
// Set the default directory and query the existing data lists
MMEM:CDIR "/var/user/DLists"
SOURce1:BB:DM:DLISt:CATalog?
// "DList1","DList2"
// delete a list and create a new data list
SOURce1:BB:DM:DLISt:DELete "DList1"
SOURce1:BB:DM:DLISt:SELect "DList2"
// copy the content of an existing data list to the new data list
SOURce1:BB:DM:DLISt:COPY "DList3"
// query the content of the new data list and modify it (append data to it)
FORM ASCI
SOURce1:BB:DM:DLISt:DATA? 2048,1024
// 1,1,0,0,0, ...
SOURce1:BB:DM:DLISt:DATA:APPend 1,1,1,0,0,0,1,1,0,1...
SOURce1:BB:DM:DLISt:SELect "DList3"
// query the free memory and number of bits to be utilized
SOURce1:BB:DM:DLISt:FREE?
SOURce1:BB:DM:DLISt:POINts?
```

Example: Adjusting clock, marker and trigger settings

The following example lists the provided commands

```
// ***************************************************************
// Clock settings
// ***************************************************************
SOURce1:BB:DM:CLOCk:SOURce INTernal

// ***************************************************************
// Configure and enable standard marker signals
// ***************************************************************
SOURce1:BB:DM:TRIGger:OUTPut2:MODE PULSe
SOURce1:BB:DM:TRIGger:OUTPut2:PULSe:DIVider 5
SOURce1:BB:DM:TRIGger:OUTPut2:PULSe:FREQuency?
SOURce1:BB:DM:TRIGger:OUTPut3:MODE PATTern
SOURce1:BB:DM:TRIGger:OUTPut3:PATTern #HE0F52,20
SOURce1:BB:DM:TRIGger:OUTPut1:MODE RATio
SOURce1:BB:DM:TRIGger:OUTPut1:ONTime 40
SOURce1:BB:DM:TRIGger:OUTPut1:OFFTime 20

SOURce1:BB:DM:TRIGger:OUTPut2:DELay 16

// ***************************************************************
// Configure and enable signal generation
// ***************************************************************
SOURce1:BB:DM:TRIGger:SEQuence SINGle
SOURce1:BB:DM:TRIGger:SLENgth 200
// the first 200 samples will be output after the next trigger event
SOURce1:BB:DM:TRIGger:SEQuence ARETrigger
SOURce1:BB:DM:TRIGger:SOURce EGT1
// external trigger signal must be provided at the connector
// configured for the external global trigger 1 signal
SOURce1:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut ON
SOURce1:BB:DM:TRIGger:EXTernal:DELay 200
SOURce1:BB:DM:TRIGger:EXTernal:INHibit 100

// with internal trigger source
SOURce1:BB:DM:TRIGger:SEQuence AAUTo
SOURce1:BB:DM:TRIGger:SOURce INTernal
SOURce1:BB:DM:STAT ON
SOURce1:BB:DM:TRIGger:EXEC
```

Example: Enable power ramping

The following example lists the provided commands

```
SOURce1:BB:DM:PRAMp:SOURce INTernal
SOURce1:BB:DM:PRAM:SHAP COS
SOURce1:BB:DM:PRAMp:TIME 5
SOURce1:BB:DM:PRAMp:RDELay 0
SOURce1:BB:DM:PRAMp:FDELay -1
```

```
SOURce1:BB:DM:PRAMp:ATTenuation 10
SOURce1:BB:DM:PRAMp:BBONly:STATe ON
SOURce1:BB:DM:PRAMp:STATe ON
```

General commands

[:SOURce<hw>]:BB:DM:STATe....686
[:SOURce<hw>]:BB:DM:PRESet....686
[:SOURce<hw>]:BB:DM:SRATe....686
[:SOURce<hw>]:BB:DM:STANdard....687
[:SOURce<hw>]:BB:DM:SOURce....687
[:SOURce<hw>]:BB:DM:PATTern....687
[:SOURce<hw>]:BB:DM:PRBS[:LENGth]....688

[:SOURce<hw>]:BB:DM:STATe <State>

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

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Performing general tasks" on page 683

Manual operation: See "State" on page 107

[:SOURce<hw>]:BB:DM:PRESet

Sets the default settings for digital modulation (`*RST` values specified for the commands).

Not affected is the state set with the command `SOURce<hw>:BB:DM:STATe`

Example: See Example "Performing general tasks" on page 683

Usage: Event

Manual operation: See "Set To Default" on page 108

[:SOURce<hw>]:BB:DM:SRATe <SRate>

Sets the symbol rate in Hz/kHz/MHz or sym/s, ksym/s and Msym/s.

Parameters:

<SRate> float

Range: 400 to depends on the installed options
Increment: 0.001
*RST: 270833.333
Default unit: Hz or sym/s

Example: See Example "Performing general tasks" on page 683.

Manual operation: See "Symbol Rate" on page 109

[:SOURce<hw>]:BB:DM:STANdard <Standard>

Selects predefined set of settings according to the selected standard, see Table 4-5.

Parameters:

<Standard> USER | BLUetooth | DECT | ETC | GSM | GSMEdge | NADC | PDC | PHS | TETRa | W3GPp | TDSCdma | CFORward | CREVerse | WORLdspace | TFTS | APCOPH1C4fm | APCOPH1CQpsk | APCOPH2HCpm | APCOPH2HDQpsk | APCOPH2HD8PSKW | APCOPH2HD8PSKN | APCOPH1Lsm | APCOPH1Wcqpsk | CWBPsk | SOQPSKTG

A query returns the value `USER` if settings deviate from standard-compliant settings.

*RST: GSM

Example: See Example "Performing general tasks" on page 683.

Manual operation: See "Set according to Standard" on page 108

[:SOURce<hw>]:BB:DM:SOURce <Source>

Selects the data source.

Parameters:

<Source> ZERO | ONE | PRBS | PATTern | DLISt

*RST: PRBS

Example: See Example "Performing general tasks" on page 683

Manual operation: See "Data Source" on page 110

[:SOURce<hw>]:BB:DM:PATTern <Pattern>, <BitCount>

Selects the data pattern for the internal data source.

Parameters:

<Pattern> numeric

*RST: #H0

<BitCount> integer

Range: 1 to 64
*RST: 1

Example:

```
SOURce:BB:DM:SOURce PATT
SOURce:BB:DM:PATTern #B01110111010101010,17
```

Generates the user-defined sequence of 0/1 data.

Manual operation: See "Data Source" on page 110

[:SOURce<hw>]:BB:DM:PRBS[:LENGth] <Length>

Defines the length of the pseudo-random sequence in accordance with the following equation:

Length = (2^`Length`) - 1

Parameters:

<Length> 9 | 11 | 15 | 16 | 20 | 21 | 23 | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23

*RST: 9

Example: See Example "Performing general tasks" on page 683

Manual operation: See "Data Source" on page 110

Save/recall commands

[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog? 688
[:SOURce<hw>]:BB:DM:SETTing:CATalog? 688
[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe 688
[:SOURce<hw>]:BB:DM:SETTing:STORe 688
[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD 689
[:SOURce<hw>]:BB:DM:SETTing:LOAD 689
[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete 689
[:SOURce<hw>]:BB:DM:SETTing:DELete 689

[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog?
[:SOURce<hw>]:BB:DM:SETTing:CATalog?

Queries the files with digital modulation respectively user standard settings in the default directory. Listed are files with the file extension `*.dm` and `*.dm_stu`.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Example: See Example "Performing general tasks" on page 683

Usage: Query only

Manual operation: See "Save/Recall" on page 108

[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe <Filename>
[:SOURce<hw>]:BB:DM:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.dm` respectively `*.dm_stu`) is assigned automatically.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Setting parameters:
<Filename> string

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

Manual operation: See "Save/Recall" on page 108

[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD <Filename>
[:SOURce<hw>]:BB:DM:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.dm` respectively `*.dm_stu`.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Setting parameters:
<Filename> string

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

Manual operation: See "Save/Recall" on page 108

[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.dm` respectively `*.dm_stu`.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Setting parameters:
<Filename> string

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

Manual operation: See "Save/Recall" on page 108

Filter commands

[:SOURce<hw>]:BB:DM:FILTer:TYPE <Type>

Selects the filter type.

If you select a standard (`:BB:DM:STAN`), the firmware automatically sets the standard-compliant filter type and filter parameter.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | USER | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LTEFilter | LPASSEVM | APCO25Hcpm | APCO25Lsm | HRP | SOQPSK

*RST: GAUSs

Example: See `[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 690.

Manual operation: See "Filter" on page 114

[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 <Apco25>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs <Gauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass <FiltParm>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth <Bandwidth>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff] <Cosine>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs <Gauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs <LPass>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM <LPassEvm>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss <PGauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine <RCosine>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase <SPhase>

Sets the filter parameter.

Filter Type	Parameter	Parameter Name	Min	Max	Increment	Default
APCO25	Roll-off factor	<Apco25>	0.05	0.99	0.01	0.2
APCO25Lsm	Cut off frequency for the lowpass/gauss filter (:LOWPass/:GAUSs)	<Cosine>	400	25E6	1E-3	270833.333
COSine	Bandwidth	<FiltParm>	400	depends on the installed options*)	1E-3	270833.333
COSine	Roll-off factor	<Cosine>	0.05	1	0.01	0.35
GAUSs	Roll-off factor	<Gauss>	0.15	100000	0.01	0.3
LPASs	Cut-off frequency	<LPass>	0.05	2	0.01	0.5
LPASSEVM	Cut-off frequency	<LPassEvm>	0.05	2	0.01	0.5
PGAuss	Roll-off factor	<PGauss>	0.15	2.5	0.01	0.3
RCOSine	Roll-off factor	<RCosine>	0.05	1	0.001	0.35
SPHase	B x T	<SPhase>	0.15	2.5	0.01	2

*)120E6 (R&S SMCVB-K521) / 160E6 (R&S SMCVB-K522) / 240E6 (R&S SMCVB-K522)

Parameters:

<SPhase> float

Range: 0.15 to 2.5
Increment: 0.01
*RST: 2

Example:

```
SOURce:BB:DM:FILTer:TYPE SPHase
SOURce:BB:DM:FILTer:PARameter:SPHase 0.5
```

Manual operation: See "Roll Off Factor/B*T" on page 114

[:SOURce<hw>]:DM:FILTer:PARameter <Parameter>

Sets the filter parameter of the currently selected filter type.

To set the filter type, use command `[:SOURce<hw>]:BB:DM:FILTer:TYPE` on page 689.

Parameters:

<Parameter> float

Range: 0.05 to 2.5
Increment: 0.01
*RST: 0.35

Example: See `[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 690

Modulation and coding commands

[:SOURce<hw>]:BB:DM:CODing <Coding>

Selects the modulation coding.

Parameters:

<Coding> OFF | DIFF | DPHS | DGRay | GRAY | GSM | NADC | PDC | PHS | TETRa | APCO25 | PWT | TFTS | INMarsat | VDL | EDGE | APCO25FSK | ICO | CDMA2000 | WCDMA | APCO258PSK

OFF
The coding is automatically disabled if the selected modulation type is not possible with the coding that has been set

DPHS
Phase Difference

DGRay
Difference + Gray

*RST: GSM

Example: See Example "Performing general tasks" on page 683

Manual operation: See "Coding" on page 109

[:SOURce<hw>]:BB:DM:FORMat <Format>

Sets the modulation type.

When a standard is selected ([:SOURce<hw>]:BB:DM:STANdard), the modulation type is set to the default value.

Parameters:

<Format> ASK | BPSK | P2DBpsk | QPSK | QPSK45 | OQPSk | P4QPsk | P4DQpsk | PSK8 | P8D8psk | P8EDge | QAM16 | QAM32 | QAM64 | QAM256 | QAM1024 | MSK | FSK2 | FSK4 | USER | FSKVar | QAM128 | QEDGe | QAM16EDge | QAM32EDge | AQPSk | QAM4096 | APSK16 | APSK32 | FSK32 | FSK64 | FSK8 | FSK16 | QAM512 | QAM2048

*RST: MSK

Example: See Example "Performing general tasks" on page 683

Manual operation: See "Modulation Type" on page 112

[:SOURce<hw>]:BB:DM:AQPSk:ANGLe <Angle>

For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.

Parameters:

<Angle> float

Range: 0 to 180
Increment: 0.01
*RST: 0
Default unit: Deg

Example:

```
BB:DM:FORM AQPS
BB:DM:AQPS:ANGL 45
```

Manual operation: See "Angle Alpha" on page 112

[:SOURce<hw>]:BB:DM:ASK:DEPTh <Depth>

Sets the ASK modulation depth for modulation type ASK.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 100
Default unit: PCT

Example:

```
BB:DM:FORM ASK
BB:DM:ASK:DEPT 50 PCT
```

Manual operation: See "ASK Depth" on page 112

[:SOURce<hw>]:BB:DM:FSK:DEViation <Deviation>

Sets the frequency deviation when FSK modulation is selected.

Parameters:

<Deviation> float

The value range depends on the symbol rate.

Range: 1 to 40E6
Increment: 0.5
*RST: 135416.5

Example:

```
SOURce:BB:DM:FORMat FSK4
SOURce:BB:DM:FSK:DEViation 1MHZ
```

Manual operation: See "FSK Deviation" on page 112

[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation <Deviation>

Sets the deviation of the selected symbol for variable FSK modulation mode.

The value range depends on the configured symbol rate.

For more information, refer to the specifications document.

Parameters:

<Deviation> float

Range: depends on settings
Increment: 0.5
Default unit: Hz

Example:

```
SOURce:BB:DM:FORMat FSKVar
SOURce:BB:DM:FSK:VARiable:TYPE FSK4
SOURce:BB:DM:FSK:VARiable:SYMBol0:DEViation 135000
```

Manual operation: See "Deviation xxxx" on page 113

[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE <Type>

The command selects the modulation type for Variable FSK.

Parameters:

<Type> FSK4 | FSK8 | FSK16

*RST: FSK4

Example: See `[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation` on page 693

Manual operation: See "FSK Type" on page 113

[:SOURce<hw>]:BB:DM:APSK16:GAMMa <Gamma>

Sets the gamma function γ for the 16APSK modulation.

Parameters:

<Gamma> G2D3 | G3D4 | G4D5 | G5D6 | G8D9 | G9D10
`GxDy`: G = Gamma function, `xy` = code rate
*RST: G2D3

Example:
```
SOURce1:BB:DM:FORMat APSK16
SOURce1:BB:DM:APSK16:GAMMa G9D10
```

Manual operation: See "Gamma/Gamma 1" on page 113

[:SOURce<hw>]:BB:DM:APSK32:GAMMa <Gamma>

Sets the gamma function γ for the 32APSK modulation.

Parameters:

<Gamma> G3D4 | G4D5 | G5D6 | G8D9 | G9D10
`GxDy`: G = Gamma function, `xy` = code rate
*RST: G3D4

Example:
```
SOURce1:BB:DM:FORMat APSK32
SOURce1:BB:DM:APSK32:GAMMa G9D10
```

Manual operation: See "Gamma/Gamma 1" on page 113

[:SOURce<hw>]:BB:DM:SWITching:STATe <State>

Enables switching between a modulated and an unmodulated signal.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "State Modulation CW Switching" on page 113

Power ramping

[:SOURce<hw>]:BB:DM:PRAMp:SOURce....694
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe....695
[:SOURce<hw>]:BB:DM:PRAMp:TIME....695
[:SOURce<hw>]:BB:DM:PRAMp:FDELay....695
[:SOURce<hw>]:BB:DM:PRAMp:RDELay....695
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation....696
[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe]....696
[:SOURce<hw>]:BB:DM:PRAMp[:STATe]....696

[:SOURce<hw>]:BB:DM:PRAMp:SOURce <Source>

Sets the source for the power ramp control signals.

Parameters:
<Source> INTernal
*RST: INTernal

Example: See Example "Enable power ramping" on page 685

Manual operation: See "Source" on page 116

[:SOURce<hw>]:BB:DM:PRAMp:SHAPe <Shape>

Sets the edge shape of the ramp envelope.

Parameters:
<Shape> LINear | COSine
*RST: COSine

Example: See Example "Enable power ramping" on page 685

Manual operation: See "Ramp Function" on page 117

[:SOURce<hw>]:BB:DM:PRAMp:TIME <Time>

Sets the power ramping rise time and fall time for a burst.

Parameters:
<Time> float
Range: 0.25 to 16
Increment: 0.01
*RST: 1
Default unit: symbol

Example: See Example "Enable power ramping" on page 685

Manual operation: See "Ramp Time" on page 117

[:SOURce<hw>]:BB:DM:PRAMp:FDELay <FDelay>
[:SOURce<hw>]:BB:DM:PRAMp:RDELay <RDelay>

Sets the delay in the rising edge.

Parameters:
<RDelay> float
Range: 0 to 4
Increment: 0.01
*RST: 0
Default unit: symbol

Example: See Example "Enable power ramping" on page 685

Manual operation: See "Rise Delay" on page 117

[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation <Attenuation>

Sets the level attenuation for signal ranges that are flagged with level attribute *attenuated* by the control signal.

Parameters:

<Attenuation> float

Range: 0 to 50
Increment: 0.1
*RST: 15
Default unit: dB

Example: See Example "Enable power ramping" on page 685

Manual operation: See "Attenuation" on page 117

[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe] <State>

Enables power ramping in the baseband only or mixed power ramping in the baseband and the RF section.

The ON setting is mandatory if, with power ramping active, only the baseband signal is output (I/Q outputs).

Only then can a signal with a defined, predictable level be output.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Enable power ramping" on page 685.

Manual operation: See "In Baseband Only" on page 117

[:SOURce<hw>]:BB:DM:PRAMp[:STATe] <State>

Enables or disables power ramping.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Enable power ramping" on page 685

Manual operation: See "State" on page 116

Trigger commands

[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence 697
[:SOURce<hw>]:BB:DM:TRIGger:SOURce 697
[:SOURce<hw>]:BB:DM:TRIGger:SLENgth 697
[:SOURce<hw>]:BB:DM:TRIGger:RMODe? 698
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut 698
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute 698

[:SOURce<hw>]:BB:DM:TRIGger:EXECute 699
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT 699
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay 699
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay 699
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay? 700
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit 700

[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode.

See also "About trigger modes" on page 85.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

*RST: AUTO

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Mode" on page 100

[:SOURce<hw>]:BB:DM:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are the following trigger sources:

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the global connectors:
  `EGT1`: External global trigger
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMCV100B accepts this value and maps it automatically as follows:
  `EXTernal = EGT1`

Parameters:

<Source> INTernal|EXTernal

*RST: INTernal

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Source" on page 101

[:SOURce<hw>]:BB:DM:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence to be output in the `SINGle` trigger mode.

Parameters:

<SLength> integer

Range: 1 to 4294967295
*RST: 1000
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Signal Duration" on page 102

[:SOURce<hw>]:BB:DM:TRIGger:RMODe?

Queries the status of signal generation.

Return values:

<RMode> STOP | RUN

Example:

```
SOURce1:BB:DM:TRIGger:SOURce ELTRigger
SOURce1:BB:DM:TRIGger:SEQuence ARETrigger
SOURce1:BB:DM:TRIGger:RMODe?
Response: RUN
```

Usage: Query only

Manual operation: See "Running/Stopped" on page 100

[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Sync. Output to Ext. Trigger/Sync. Output to Trigger" on page 101

[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute

Stops signal generation; a subsequent internal or external trigger event restart signal generation.

Example: See also Example "Adjusting clock, marker and trigger settings" on page 685

Usage: Event

Manual operation: See "Arm" on page 101

[:SOURce<hw>]:BB:DM:TRIGger:EXECute

Executes a trigger.

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Usage: Event

Manual operation: See "Execute Trigger" on page 101

[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT <TrigDelUnit>

Sets the unit of the trigger delay.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "(External) Delay Unit" on page 102

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay <Delay>

Sets the trigger delay in symbols.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<Delay> float

Range: 0 to depends on the symbol rate
Increment: 0.01
*RST: 0
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 685.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 102

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>

Sets the trigger delay for external triggering. The value affects all external trigger signals.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<ExtTimeDelay> float

Range: 0 to 7929.170398682
Increment: 0.25E-9
*RST: 0
Default unit: s

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 102

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResTimeDelaySec> float

Range: 0 to 688
Increment: 0.25E-9
*RST: 0

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 102

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit <Inhibit>

Sets the number of symbols that inhibit a restart of the signal generation.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (symbol rate)
*RST: 0
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 685.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 101

Marker commands

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE 701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime 701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime 701

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern....701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider....702
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?....702
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay....702

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

For detailed description of the regular marker modes, refer to "Marker modes" on page 83.

Parameters:

<Mode> CLISt | PULSe | PATTern | RATio

CLISt
A marker signal that is defined in the selected control list is generated.

*RST: RATio

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Mode" on page 104

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of symbols in a period (ON time + OFF time) for marker `RATio`.

Parameters:

<OffTime> integer

Range: 1 to 16777215
*RST: 1
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Mode" on page 104

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric

*RST: #H2

<BitCount> integer

0 = marker off, 1 = marker on

Range: 1 to 64
*RST: 2

Example: See Example "Adjusting clock, marker and trigger settings" on page 685.

Manual operation: See "Mode" on page 104

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for pulse marker mode (`PULSe`).

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Manual operation: See "Mode" on page 104

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal `PULSe`.

Return values:

<Frequency> float

Example: See Example "Adjusting clock, marker and trigger settings" on page 685

Usage: Query only

Manual operation: See "Mode" on page 104

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signal, expressed in terms of symbols.

Parameters:

<Delay> float

Range: 0 to 16777215
Increment: 0.001
*RST: 0

Example: See Example "Adjusting clock, marker and trigger settings" on page 685.

Manual operation: See "Delay" on page 104

Clock commands

[:SOURce<hw>]:BB:DM:CLOCk:SOURce 703

[:SOURce<hw>]:BB:DM:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "Adjusting clock, marker and trigger settings" on page 685.

Manual operation: See "Clock Source" on page 105

Handling list files

[:SOURce<hw>]:BB:DM:CLISt:CATalog?
[:SOURce<hw>]:BB:DM:FLISt:CATalog?
[:SOURce<hw>]:BB:DM:MLISt:CATalog?
[:SOURce<hw>]:BB:DM:DLISt:CATalog?

Reads out the list files present in the default directory (see `:MMEMory:CDIRectory`).

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Example: See Example "Performing general tasks" on page 683.

Usage: Query only

Manual operation: See "Data Source" on page 110
See "Select Data List" on page 110

[:SOURce<hw>]:BB:DM:CLISt:SELect <Filename>
[:SOURce<hw>]:BB:DM:FLISt:SELect <Filename>

[:SOURce<hw>]:BB:DM:MLISt:SELect <Filename>
[:SOURce<hw>]:BB:DM:DLISt:SELect <Select>

Selects the specified list file from the default directory (see `:MMEMory:CDIRectory`) or in the directory specified with the complete file path.

If a list with the specified name does not yet exist, it is created. The file extension can be omitted.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User standard	`...:ULISt...`	`*.dm_stu`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Parameters:
<Select> <list name>

Example: See Example "Performing general tasks" on page 683

Manual operation: See "Data Source" on page 110
See "Select Data List" on page 110
See "Functions for handling of data lists" on page 433

[:SOURce<hw>]:BB:DM:CLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:FLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:MLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:DLISt:DELete <Filename>

Deletes the specified list from the default directory (see `:MMEMory:CDIRectory`) or from the directory specified with the complete file path.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User standard	`...:ULISt...`	`*.dm_stu`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Setting parameters:
<Filename> string

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

Manual operation: See "Select Data List" on page 110

[:SOURce<hw>]:BB:DM:CLISt:FREE?
[:SOURce<hw>]:BB:DM:FLISt:FREE?
[:SOURce<hw>]:BB:DM:MLISt:FREE?
[:SOURce<hw>]:BB:DM:DLISt:FREE?

Queries the list free memory.

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Return values:
<Free> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Performing general tasks" on page 683

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:POINts?

Queries the number of lines (2 bytes) in the currently selected list.

Return values:
<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example:
```
SOURce:BB:DM:CLISt:SELect "c_list"
SOURce:BB:DM:CLISt:POINts?
// 20
// the control list consists of 20 lines
```

Usage: Query only

[:SOURce<hw>]:BB:DM:DLISt:POINts <Points>

Defines the number of bits in the selected data list to be utilized. When a list is being filled with block data, this data is only ever sent in multiples of 8 bits. However the exact number of bits to be exploited can be set to a different figure. The superfluous bits in the list are then ignored.

Parameters:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: `SOURce:BB:DM:DLISt:POINts 234`
Defines the number of bits in the data list to be utilized as 234 bits. If the list was filled with block data, at least the last 6 bits are ignored.

[:SOURce<hw>]:BB:DM:FLISt:POINts?
[:SOURce<hw>]:BB:DM:MLISt:POINts?

Queries the user modulation mapping/user filter list length.

Return values:

<Points> integer

Range: max
*RST: 0

Example:
```
BB:DM:FORM USER
BB:DM:MLIS:POIN?
```

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:COPY <Filename>
[:SOURce<hw>]:BB:DM:DLISt:COPY <Filename>

Copies the selected data list (`*.dm_iqd`)/ control list (`*.dm_iqc`) as a new list with name specified by `<Filename>`. If a list with the specified name exists, it is overwritten. If it does not yet exist, it is created.

The source file has to be available in the default directory (see `:MMEMory:CDIRectory`) .

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and a specific directory.

Setting parameters:

<Filename> string

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

Manual operation: See "Select Data List" on page 110

[:SOURce<hw>]:BB:DM:CLISt:DATA <Data>

Sends the data to the currently selected control list. If the list already contains data, it is *overwritten*. This command only writes data into the data section of the file.

The values for the control signals are sent, arranged in an 8-bit value as defined in Table 14-1.

Table 14-1: Contents of a control lists

Signal	Order	Decimal value of bits
Marker 1 Marker 2 Marker 3	LSB	1 2 4
Burst	LSB	16
LevAtt1	LSB	32
CWMod	LSB	64
Hop	MSB	128

The data can also be sent as a binary block, each binary block being a 2-byte value in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSB first).

Tip: Control lists are created in binary format. You may however need the control list in an ASCII format, e.g for creating a waveform file with R&S WinIQSIM2. Refer to the examples in Section 4.6.4.6, "Creating control lists with tag file format", on page 166 for description on how to create a control list file in ASCII format manually.

`*RST` has no effect on data lists.

Setting parameters:
<Data> string

Example:
```
:MMEMory:CDIrectory "/var/user/clists"
:SOURce1:BB:DM:CLISt:SELect "clist_marker3"
:SOURce1:BB:DM:CLISt:DATA 0,0,0,0,4,4,4,0,0,0,0...
// Enters the control values in the selected list.
// In the example, only ramps for Marker 3 are set.
```

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 122

[:SOURce<hw>]:BB:DM:DLISt:DATA <Data>
[:SOURce<hw>]:BB:DM:DLISt:DATA? [<Start>[, <Count>]]

The **Setting** command sends the bit data to the selected data list. Any existing content in the list is *overwritten*. This command only writes data into the data section of the file.

Data can be sent as block data in binary or packet format (`:FORMat ASCii | PACKed`), each byte being interpreted as 8 data bits.

The **query** reads out the data part of the list file. If the query is expanded by using the two parameters `<Start>` and `<Count>`, the list is read out in smaller sections. Without the parameters the total length is always read out starting from address 1.

`*RST` has no effect on data lists.

Parameters:

<Data> integer
bit data

Query parameters:

<Start> integer
Range: 1 to 2147483647

<Count> integer
Range: 1 to 2147483647

Example: See Example "Performing general tasks" on page 683

[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend <Bits>

Appends the bit data onto the end of the existing data in the selected data list. Existing content in the data list is not overwritten. Hence, you can create long data lists piecemeal.

The command cannot be used with an empty data list, like for example data lists that has just been created. Use the command `[:SOURce<hw>]:BB:DM:DLISt:DATA` first and enter modulation data in the list.

`*RST` has no effect on data lists.

Setting parameters:

<Bits> 0 | 1 {,0 | 1 } | block data

Example: See Example "Performing general tasks" on page 683

Usage: Setting only

[:SOURce<hw>]:BB:DM:CLISt:TAG?
[:SOURce<hw>]:BB:DM:DLISt:TAG?

Queries the content of the specified tag in the selected file.

Return values:

<Tag> <control list>,<tag name>
Refer to Section 4.6.7, "Tags for waveforms, data and control lists", on page 175 for description of the available tag formats.

Example: `SOURce1:BB:DM:DLISt:TAG? "D_list","date"`
Queries the `Date` tag in list `D_list`.

Usage: Query only

14.16.4.3 SOURce:BB:ARBitrary subsystem

This section list the commands of the `SOURce:BB:ARBitrary` subsystem.

Required options

See Section 4.6.1, "Required options", on page 138.

The commands are grouped in the following sections:

- Programming examples....709
- General commands....717
- Test signal commands....717
- Waveform commands....721
- Multi-segment commands....726
- Multi-segment sequencing commands....730
- Multicarrier commands....734
- Trigger commands....746
- Marker commands....752
- Clock commands....754

Programming examples

Example: To create test signals

This example provides the commands to configure the different test signals.

```
// ****************************************************************************
// Reset the instrument first.
// ****************************************************************************
*RST; *CLS
:SOURce1:BB:ARBitrary:PRESet

// ****************************************************************************
// Create test signals.
// ****************************************************************************
:SOURce1:BB:ARBitrary:SIGNal:TYPE CIQ
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:I -0.5
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:Q -0.33
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:CREate

:SOURce1:BB:ARBitrary:TSIGnal:SINE:FREQuency 1MHz
:SOURce1:BB:ARBitrary:TSIGnal:SINE:SAMPles 100
:SOURce1:BB:ARBitrary:TSIGnal:SINE:PHASe -90
:SOURce1:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed "/var/user/sine_test"

:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 100kHz
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:SAMPles 1000
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude 0.5
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:OFFSet -0.3
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed "/var/user/rect_test"
```

```
:SOURce1:BB:ARBitrary:STATe ON
```

Example: To manage waveform files

The following example lists the commands provided for handling of waveform files.

```
// ****************************************************************************
// Reset instrument first
// ****************************************************************************
*RST; *CLS
:SOURce1:BB:ARBitrary:PRESet

// ****************************************************************************
// Set the default directory and list the available waveform files
// ****************************************************************************
MMEM:CDIR "/var/user/ARBtestSigs"
:SOURce1:BB:ARBitrary:WAVeform:CATalog?
// sineTest,rectTest,ciqTestSignal,waveformTest,test2
:SOURce1:BB:ARBitrary:WAVeform:CATalog:LENGth?
// Response is the number of files: "5"
// Optionally query free disk space.
:SOURce1:BB:ARBitrary:WAVeform:FREE?

// ****************************************************************************
// Select a waveform and querry information
// ****************************************************************************
:SOURce1:BB:ARBitrary:WAVeform:DELete "/var/user/ARBtestSigs/test2"
:SOURce1:BB:ARBitrary:WAVeform:SELect "/var/user/ARBtestSigs/wvTest"
:SOURce1:BB:ARBitrary:WAVeform:POINts?
// 100
:SOURce1:BB:ARBitrary:WAVeform:TAG? "TYPE"
// "SMU-WV"
:SOURce1:BB:ARBitrary:WAVeform:TAG? "COMMENT"
// "Waveform for test purposes"
// alternatively: query the comment tag of the current waveform file
:SOURce1:BB:ARBitrary:WAVeform:DATA?
// Response is the comment: "Waveform for test purposes"
// Query the date tag of a specific waveform file.
:SOURce1:BB:ARBitrary:WAVeform:DATA? "/var/user/ARBtestSigs/waveformTest","date"
// Response: #2192014-04-15;16:19:30
```

Example: To configure marker signals

This example provides the commands to configure the marker signals.

```
// ***************************************************************************
// Configure and enable standard marker signals
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE RESTart
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE RATio
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:ONTime 40
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:OFFTime 20
// ***************************************************************************
// Configure a pulsed marker signal.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE PULSe
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PULSe:DIVider 5
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PULSe:FREQuency?
// Response in Hz: "20000000"
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:DELay 16
// ***************************************************************************
// Configure a pattern marker signal.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE PATTern
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PATTern #HE0F52,20
```

Example: To configure clock settings

This example provides the commands to configure the clock settings.

```
// ***************************************************************************
// Clock settings
// ***************************************************************************
SOURce1:BB:ARBitrary:CLOCk:SOURce INTernal
SOURce1:BB:ARBitrary:CLOCk?
// Response in Hz: "1000000"
// The clock frequency is 1 MHz.
// Or alternativelly use the following tag:
SOURce1:BB:ARBitrary:WAVeform:TAG? "CLOCK"
```

Example: To enable HDD waveform streaming

The following example provides commands to enable and query waveform streaming from an HDD connected to the R&S SMCV100B.

```
SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:STATe ON
SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?
// Response in percent: "94"
```

Example: Creating a multi-segment waveform

The following example lists the commands necessary to create a multi-segment waveform.

```
// ***************************************************************************
// Reset instrument first
// ***************************************************************************
*RST; *CLS
// :SOURce1:BB:ARBitrary:PRESet

// ***************************************************************************
// Set the default directory and list the available waveform files
// ***************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WAVeform:CATalog:LENGth?
// 4
:SOURce1:BB:ARBitrary:WAVeform:CATalog?
// Seg_0, Seg_1, Seg_2, Seg_3
// ***************************************************************************
// List the available configuration files and select/create file
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// multi_segment,ms_waveform
// the directory contains the configuration files multi_segment.inf_mswv
and ms_waveform.inf_mswv
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:DELete "ms_waveform.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect
"/var/user/ARB/multi_segment/config.inf_mswv"
// Creates an empty configuration file "config.inf_mswv".

// ***************************************************************************
// Append waveforms to the multi segment sequence
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_0"
// Waveform Seg_0.wv will be the first segment of a
// multi segment waveform created with configuration file config.inf_mswv
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_1"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_2"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_3"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend 1000,100000000
// adds a blank segment with 1000 samples and 100 MHz clock rate
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex0:DOWN
// Changes the segment order by shifting the first segment behind the second.
// segment. You can also move later segments up or delete segements.
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex1:UP
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex2:DELete
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:LEVel:MODE ERMS
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE HIGHest
// :SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE USER
// :SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk 30000000
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE TAKE
```

```
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect
"/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:COMMent "Multi Segment File"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe "ms_0to3"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?
// /var/user/ARB/multi_segment/Seg_0.wv,/var/user/ARB/multi_segment/Seg_1.wv,
// /var/user/ARB/multi_segment/Seg_2.wv,/var/user/ARB/multi_segment/Seg_3.wv

// ********************************************************************************
// Create and load the multi segment waveforms
// ********************************************************************************
// The first segment is output deppending on the trigger settings.
:SOURce1:BB:ARBitrary:WSEGment:CREate "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STAT ON
:SOURce1:BB:ARBitrary:TRIGger:EXEC
```

Example: Configuring the output order of the segments

The following example lists the commands necessary to trigger the output of the segments in the desired playback order. The example lists only the relevant commands.

We assume that the multi-segment sequence `ms_0to3` composed of four segments, Seg_0, Seg_1, Seg_2 and Seg_3 is created and loaded in the ARB (see Example "Creating a multi-segment waveform" on page 712). The required output order of the segments is Seg_0, Seg_3 [2], Seg_2.

```
// ********************************************************************************
// Select a multi segment waveform
// ********************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

// ********************************************************************************
// Adjust trigger settings and enable the ARB
// ********************************************************************************
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STATe ON

// ********************************************************************************
// Select the next segment trigger mode and source
// ********************************************************************************
:SOURce1:BB:ARBitrary:TRIGger:SMODe NEXT
// :SOURce1:BB:ARBitrary:TRIGger:SMODe NSEam
:SOURce1:BB:ARBitrary:WSEGment:NEXT:SOURce INTernal
```

```
:SOURce1:BB:ARBitrary:WSEGment?
// 0
:SOURce1:BB:ARBitrary:WSEGment:NAME?
// "/var/user/ARB/multi_segment/Seg_0.wv"
// Seg_0 is output continuously

// ***************************************************************************
// Trigger a switch over to the next segment
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:NEXT 3
// stops Seg_0 and starts immediatly Seg_3; Seg_3 is output continuously
:SOURce1:BB:ARBitrary:TRIGger:EXECute
//restarts Seg_3
:SOURce1:BB:ARBitrary:WSEGment:NEXT 2
:SOURce1:BB:ARBitrary:WSEGment:NEXT 0

// ***************************************************************************
// Scrolling trough the segments, i.e. shwitch over in incremental order
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:NEXT:EXECute
:SOURce1:BB:ARBitrary:WSEGment?
// 1
:SOURce1:BB:ARBitrary:WSEGment:NEXT:EXECute
:SOURce1:BB:ARBitrary:WSEGment?
// 2
```

For configuring waveform segments in manual operation of the instrument, see "To switch output segments manually" on page 215.

Example: Using the ARB sequencer

The following example lists the commands necessary to configure a play list. The example lists only the relevant commands.

We assume that the multi-segment sequence `ms_0to3` composed of four segments, Seg_0, Seg_1, Seg_2 and Seg_3 is created and loaded in the ARB (see Example "Creating a multi-segment waveform" on page 712). The required output order of the segments is Seg_0, Seg_3 [2], Seg_2.

The ARB sequencer mode requires waveform files with equal clock rate.

```
// ***************************************************************************
// Select a multi-segment waveform with equal segment clock rates.
// ***************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
```

```
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// Response: "/var/user/ARB/multi_segment/ms_0to3.wv"

// ****************************************************************************
// Select a sequencing list (*.wvs).
// ****************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:SELect "play_list"
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,0,1,NEXT
// Adds the segment number 0 as a new (first) segment in the sequencing list.
// This segment is activ and will be repeated once followed by the next segment.
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,3,2,NEXT
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,2,1,SEG0

:SOURce1:BB:ARBitrary:TRIGger:SMODe SEQuencer
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STAT ON
:SOURce1:BB:ARBitrary:TRIGger:EXEC
```

For configuring waveform segments in manual operation of the instrument, see "To switch output segments manually" on page 215.

Example: Adding extra marker signals

The following example lists the commands necessary to add two marker signals, a sequence restart marker and a segment restart marker, to the multi-segment sequence. The example lists only the relevant commands.

```
// ****************************************************************************
// Select the multi segment file and the corresponding configuration list.
// ****************************************************************************
:MMEM:CDIR "/var/lists/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// Response: "config"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// ****************************************************************************
// Enable restart markers on marker trace 1 and 2.
// ****************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE IGNore
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment MRK1
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment MRK2

:SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE UNCHanged
:SOURce1:BB:ARBitrary:TRIGger:OUTPut2:MODE UNCHanged
```

Example: To generate a multicarrier signal

The following example lists the commands to configure and generate an ARB multicarrier signal.

```
// ***************************************************************************
// Generating a single-carrier or standard waveform signal.
// ***************************************************************************
// Load a standardized 3GPP downlink test model, e.g. "Test Model 1 16 Channels"
:SOURce1:BB:W3GPp:SETTing:TMODel:BSTation "Test_Model_1_16channels"'
// Confirm that the standardized 3GPP downlink test model is currently selected
:SOURce1:BB:W3GPp:SETTing:TMODel:BSTation?
// "Test_Model_1_16channels"
// Enable the generation of 3GPP FDD signal
:SOURce1:BB:W3GPp:STATe ON
// Generate a 3GPP FDD ARB waveform file with name "3gpp_arb".
// Save the waveform in the default directory "/var/user".
:SOURce1:BB:W3GPp:WAVeform:CREate "3gpp_arb"

// ***************************************************************************
// Enable a multicarrier scenario with 4 carriers and carrier spacing of 5 MHz.
// ***************************************************************************
:SOURce1:BB:ARBitrary:MCARrier:CARRier:COUNt 4
:SOURce1:BB:ARBitrary:MCARrier:CARRier:SPACing 5 MHz
:SOURce1:BB:ARBitrary:MCARrier:CARRier1:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier2:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier3:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier4:STATe ON

// ***************************************************************************
// Select and load the waveform file "3gpp_arb" to all 4 carriers
// ***************************************************************************
// The file "3gpp_arb" is in default directory "/var/user".
:SOURce1:BB:ARBitrary:MCARrier:CARRier1:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier2:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier3:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier4:FILE "3gpp_arb"

// ***************************************************************************
// Trigger the signal caulation and load the waveform in the ARB generator
// ***************************************************************************
// Define the file name of the multi carrier output file, e.g. "3gpp_mc"
:SOURce1:BB:ARBitrary:MCARrier:OFILe "3gpp_mc"
// Create and load the multi carrier waveform file in the ARB generator
:SOURce1:BB:ARBitrary:MCARrier:CLOad
// Alternatively: create the multi carrier waveform and
// load it subsequently in the ARB generator
// :SOURce1:BB:ARBitrary:MCARrier:CREate
// :SOURce1:BB:ARBitrary:WAVeform:SELect"3gpp_mc"

// Activate the ARB generator
:SOURce1:BB:ARBitrary:STATe ON
```

```
// ****************************************************************************
// Use the save and recall function.
// ****************************************************************************
// Query available settings files in a specified directory
MMEM:CDIR "/var/user/waveform"
:SOURce1:BB:ARBitrary:MCARrier:SETTing:CATalog?
// mcar1, mcar2
// the directory contains the settings files mcar1.arb_multcarr and mcar2.arb_multcarr
:SOURce1:BB:ARBitrary:MCARrier:SETTing:STORe "3gpp_mc"
```

General commands

[:SOURce<hw>]:BB:ARBitrary:PRESet

Sets all ARB generator parameters to their default values.

Example: See Example "To create test signals" on page 709.

Usage: Event

Manual operation: See "Set To Default" on page 146

[:SOURce<hw>]:BB:ARBitrary:STATe <State>

Enables the ARB generator.

A waveform must be selected before the ARB generator is activated.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To create test signals" on page 709.

Manual operation: See "State" on page 146

Test signal commands

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE 718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I 718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q 718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude 718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet 719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles 719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency 719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe 720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles 720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed 720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed 720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed 720

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate 721
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate 721
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate 721

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE <ArbSignalType>

Selects the type of test signal.

Parameters:

<ArbSignalType> SINE | RECT | CIQ

*RST: SINE

Example: See Example "To create test signals" on page 709.

Manual operation: See "Test Signal Form" on page 148

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I <I>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q <TSig>

Sets the value for the I and Q component of the test signal

Parameters:

<TSig> float

Range: -1 to 1
Increment: 0.001
*RST: 0
Default unit: FS

Example: See Example "To create test signals" on page 709.

Manual operation: See "I ValueIQ Value" on page 152

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude <Amplitude>

Sets the digital amplitude of the rectangular wave.

Parameters:

<Amplitude> float

Range: 0 to 1
Increment: 0.001
*RST: 0.800
Default unit: FS

Example: See Example "To create test signals" on page 709.

Manual operation: See "Amplitude" on page 151

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency <Frequency>

Sets the frequency of the test signal.

Parameters:

<Frequency> float

Range: 100 to depends on the installed options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "To create test signals" on page 709.

Manual operation: See "Frequency" on page 151

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet <Offset>

Sets the DC component.

Parameters:

<Offset> float

Range: -1 to 1
Increment: 0.001
*RST: 0
Default unit: FS

Example: See Example "To create test signals" on page 709.

Manual operation: See "Offset DC" on page 151

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles <Samples>

Sets the number of sample values required for the rectangular signal per period.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100

Example: See Example "To create test signals" on page 709.

Manual operation: See "Samples per Period" on page 151

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency <Frequency>

Sets the frequency of the simple sinusoidal test signal.

Parameters:

<Frequency> float

Range: 100 to depends on the installed options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "To create test signals" on page 709.

Manual operation: See "Frequency" on page 149

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe <Phase>

Sets the phase offset of the sine wave on the Q channel relative to the sine wave on the I channel.

Parameters:

<Phase> float

Range: -180 to 180
Increment: 0.01
*RST: 90
Default unit: DEG

Example: See Example "To create test signals" on page 709.

Manual operation: See "Phase Offset Q" on page 149

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles <Samples>

Sets the sample rate for the sine signal in samples per period.

Make sure that the resulting clock rate does not exceed the maximum ARB clock rate. The maximum value is automatically restricted by reference to the set frequency and has to fulfill the rule *Frequency * Samples <= ARB clock rate*.

For more information, refer to the specifications document.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100

Example: See Example "To create test signals" on page 709.

Manual operation: See "Samples per Period" on page 149

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed <Filename>

Generates a signal and saves it to a waveform file.

Setting parameters:

<Filename> string

Example: See Example "To create test signals" on page 709.

Usage: Setting only

Manual operation: See "Generate Signal File" on page 150

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate

Generates a signal and uses it as output straight away.

Example: See Example "To create test signals" on page 709.

Usage: Event

Manual operation: See "Generate Signal RAM" on page 150
See "Generate Signal RAM" on page 151

Waveform commands

The following rule applies for all commands described in this section.

By default, the waveform files are saved in the default directory of the instrument that is the `/var/user/` directory or the directory specified with the command `:MMEMory:CDIRectory`. To access the waveform files in this default directory, only the filename is required, without the path and the file extension (`*.wv`).

However, to access waveform files located in a directory different to the default one, the complete file path and filename are required.

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog? 721
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth? 722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect 722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DELete 722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE? 722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts? 723
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA 723
[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG? 724
[:SOURce<hw>]:BB:ARBitrary:CLOCk 724
[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel? 724
[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe 725
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk 725

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?

Reads out the files extension `*.wv` in the default directory.

Return values:
<Catalog> string
Returns a list of the file names separated by commas

Example: See Example "To manage waveform files" on page 710.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth?

Reads out the files with extension `*.wv` in the default directory and returns the number of waveform files in this directory. The default directory is set using command `MMEM:CDIRectory`.

Return values:

<Length> integer

Number of waveform files in default directory

Range: 0 to INT_MAX
*RST: 0

Example: See Example "To manage waveform files" on page 710.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect <Filename>

Selects an existing waveform file, i.e. file with extension `*.wv`.

Parameters:

<Filename> string

Example: See Example "To manage waveform files" on page 710.

Manual operation: See "Load Waveform" on page 147

[:SOURce<hw>]:BB:ARBitrary:WAVeform:DELete <Filename>

Deletes the specified waveform file. If the file is not on the default path, the path must be specified at the same time. The file extension may be omitted. Only files with the file extension `*.wv` are deleted.

Setting parameters:

<Filename> string

Example: See Example "To manage waveform files" on page 710.

Usage: Setting only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE?

Queries the free disk space on the default path of the instrument's hard disk.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 1

Example: See Example "To manage waveform files" on page 710.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts?

Queries the number of samples (the number of I/Q values pairs) in the selected waveform file.

Return values:

<Points> <waveform filename>

Range: 0 to 1000
*RST: 1

Example: See Example "To manage waveform files" on page 710.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA <Filename>, <Data>
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA? <Tag>

The **setting** command writes the binary block data `<data>` to the file identified by `<filename>`. The *complete content* of the waveform file (i.e. including all tags) must be specified; the complete content is transmitted as binary data block.

Tip: To ensure trouble-free data transmission, set the GPIB delimiter to EOI.

The **query** command retrieves the content of the specified tag of the currently selected waveform file or the waveform file specified with the `<filename>`.

See also Section 4.6.7, "Tags for waveforms, data and control lists", on page 175.

Parameters:

<Filename> string

Specifies the name of the waveform file in that the binary data is copied

Setting parameters:

<Data> block data

Binary block data with the following syntax:
`#<Digits><Length><Binary data>`

#
Indicates the start of the binary block

<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>` value

<Length>
Decimal value
Number of bytes the follow in the `<Binary data>` part

<Binary data>
Binary data in ASCII format

Query parameters:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset'

Example: **Query**
See Example "To manage waveform files" on page 710.

Example: **Setting**

```
SOURce:BB:ARB:WAVeform:DATA "/var/user/test1.wv",#220<binary data>
// Writes the binary block data <binary data> to file test1.wv
// <binary data> contains 20 bytes
// <binary data> is a placeholder;
// the actual ASCII values are not printable
```

[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG?

Queries the content of the specified tag of the selected waveform file (see also Section 4.6.7, "Tags for waveforms, data and control lists", on page 175).

Return values:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset' | 'samples'

Example: See Example "To manage waveform files" on page 710.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:CLOCk <Clock>

Sets the clock frequency.

If you load a waveform, the clock rate is determined as defined with the waveform tag `{CLOCK: frequency}`. This command subsequently changes the clock rate; see specifications document for value range.

For more information, refer to the specifications document.

Parameters:

<Clock> float

Range: depends on the installed options
Increment: 0.001
*RST: 1E6
Default unit: Hz
E.g. 400 Hz to 300 MHz

Example: See Example "To manage waveform files" on page 710.

Manual operation: See "Clock Frequency" on page 147

[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?

Queries the filling level of the streaming buffer.

During normal operation, the streaming buffer level has a value of 90 % to 100 %. Buffer level around 0 % indicates a buffer underrun and interrupts the signal processing.

Enabling or disabling the streaming state can decrease the streaming buffer level.

Return values:
<BLevel> integer
Range: 0 to 100
*RST: 0

Example: See Example "To enable HDD waveform streaming" on page 711.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe <State>

Enables the streaming of modulation data directly from a connected hard disc drive (HDD).

Use this function to processing large waveform files, that you cannot load from the internal system drive.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "To enable HDD waveform streaming" on page 711.

Manual operation: See "HDD Streaming" on page 147

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk <Filename>, <Clock>

Appends information on the ARB clock rate to the specified waveform file. This file must contain I/Q or marker data.

Use the following command to create the data:

`:MMEMory:DATA:UNPRotected` on page 597

Parameters:
<Filename> string
Complete file path and filename with file extension (`*.wv`).
If the file is in the default directory, the file path can be omitted.

Setting parameters:
<Clock> float
Range: 400 to 100E6
Increment: 1E-3
*RST: 1E6

Example: See `:MMEMory:DATA:UNPRotected` on page 597.

Multi-segment commands

Required options

See Section 4.8.1, "Required options", on page 193.

[:SOURce<hw>]:BB:ARBitrary:WSEGment? 726
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME? 726
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT 727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute 727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce 727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe 727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog? 728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect 728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend 728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate 729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad 729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE 729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment 730
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment 730
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe 730

[:SOURce<hw>]:BB:ARBitrary:WSEGment?

Queries the index of the currently processed segment.

Return values:

<WSegment> integer

Range: 0 to 1023
*RST: 0

Example: see Example "Configuring the output order of the segments" on page 713

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?

Queries the name of the waveform of the currently output segment of the multi-segment waveform.

Return values:

<Name> string

Example: See Example "Configuring the output order of the segments" on page 713

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT <Next>

Selects the segment to be output.

Parameters:

<Next> integer

Range: 0 to 1023
*RST: 0

Example: see Example "Configuring the output order of the segments" on page 713

Manual operation: See "Segment" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute

Triggers manually switchover to the subsequent segment in the multi-segment file.

This command is disabled, if a sequencing play list is enabled.

Example: See Example "Configuring the output order of the segments" on page 713

Usage: Event

Manual operation: See "Execute Next Segment" on page 214

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce <Source>

Selects the next segment source.

Parameters:

<Source> INTernal | NSEGM1 | INTernal | NSEGM1

*RST: INTernal

Example: See Example "Configuring the output order of the segments" on page 713.

Manual operation: See "Next Segment Source" on page 213

[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe <LevelMode>

Sets how the segments are leveled.

Parameters:

<LevelMode> HIGHest | UNCHanged

*RST: HIGHest

Example:
```
:SOURce1:BB:ARBitrary:WSEGment:LMODe HIGHest
```

Manual operation: See "Level Mode" on page 213

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?

Queries the segments of the currently selected configuration file.

Return values:
<Catalog> string

Example: See Example "Creating a multi-segment waveform" on page 712.

Usage: Query only

Manual operation: See "Segment Table" on page 203

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:
<Filename> string

Example: see Example "Using the ARB sequencer" on page 714

Manual operation: See "New Sequencing List/Load Sequencing List" on page 208
See "Append" on page 210
See "Sequencing List" on page 214

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend <State>, , <Count>, <Next>

Appends a new segment to the selected sequencing play list.

Setting parameters:
<State> ON | OFF
Activates/deactivates the appended segment
*RST: ON

 integer
Indicates the number of the segment as in the multi-segment waveform file
Range: 0 to SegmentCount - 1

<Count> integer
Defines how many times this segment is repeated
Range: 1 to 1048575

<Next> NEXT | BLANk | ENDLess | SEG0 | SEG1 | ... | SEG31 | 0...maxSegment
Determines the action after completing the current segment, like for instance which segment is processed after the processing of the current one is finished.

Example: See Example "Using the ARB sequencer" on page 714

Usage: Setting only

Manual operation: See "Append" on page 210

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate <FilenameInput>

Creates a multi-segment waveform (`*.wv`) using the current settings of the specified *configuration file* (`*.inf_mswv`).

Setting parameters:

<FilenameInput> Complete file path, file name of the configuration file and file extension (*.inf_mswv)

Example: See Example "Creating a multi-segment waveform" on page 712

Usage: Setting only

Manual operation: See "Create Output File/Create and Load Output File" on page 201

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad <FilenameInput>

Creates a multi-segment waveform using the current entries of the specified *configuration file* (`*.inf_mswv`).

The ARB generator is activated, the new multi-segment waveform (`*.wv`) is loaded and the first segment is output in accordance to the trigger settings.

Setting parameters:

<FilenameInput> string

Complete file path, file name of the configuration file and file extension (`*.inf_mswv`)

Example: See Example "Creating a multi-segment waveform" on page 712

Usage: Setting only

Manual operation: See "Create Output File/Create and Load Output File" on page 201

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE <Mode>

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

Parameters:

<Mode> IGNore | TAKE

*RST: TAKE

Example: see Example "Adding extra marker signals" on page 715

Manual operation: See "Segment Marker" on page 206

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment <Mode>
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment <Mode>

Enables/disables the generation of an additional marker restart signal at the beginning of the first segment (`FSEGment`) or at the beginning of each segment (`ESEGment`).

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

Parameters:
<Mode> OFF | MRK1 | MRK2 | MRK3 | MRK4
*RST: OFF

Example: see Example "Adding extra marker signals" on page 715

Manual operation: See "Sequence Restart" on page 206

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe <SMode>

Selects the extended trigger mode for multi segment waveforms.

Parameters:
<SMode> SAME | NEXT | SEQuencer | NSEam
NSEam = Next Segment Seamless
*RST: NEXT

Example: See Example "Configuring the output order of the segments" on page 713.

Manual operation: See "Next Segment Mode" on page 212

Multi-segment sequencing commands

Required options

See Section 4.8.1, "Required options", on page 193.

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP....734
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect....734

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend <SampCount>, <Frequency>

Adds a blank segment to the multi-segment file.

Setting parameters:

<SampCount> float

Specifies the number of samples.

Range: 512 to 1E7
Increment: 1
*RST: 1000

<Frequency> float

Determines the clock rate.

Range: 400 Hz to depends on the installed options
Increment: 0.001
*RST: 1E8

Example: See Example "Creating a multi-segment waveform" on page 712

Usage: Setting only

Manual operation: See "Blank Segment" on page 204

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the default directory. See also Section 4.8.2.3, "File concept", on page 194.

Return values:

<Catalog> string

Example: see Example "Creating a multi-segment waveform" on page 712

Usage: Query only

Manual operation: See "Load List" on page 200

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk <Clock>

Defines the clock rate used for multi-segment waveform output, if the clock mode is `USER`.

Parameters:

<Clock> float

Increment: 1E-3
*RST: maximum sample rate

Example: See Example "Creating a multi-segment waveform" on page 712

Manual operation: See "User Clock Rate" on page 206

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE <Mode>

Selects the clock rate mode for the multi segment waveform. Use the command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk` to define the clock in clock mode user.

Parameters:
<Mode> UNCHanged | HIGHest | USER
*RST: UNCHanged

Example: See Example "Creating a multi-segment waveform" on page 712.

Manual operation: See "Clock" on page 205

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE] <Mode>

Selects the level mode, unchanged or equal RMS, for the multi-segment waveform.

Parameters:
<Mode> UNCHanged | ERMS
*RST: UNCHanged

Example: See Example "Creating a multi-segment waveform" on page 712.

Manual operation: See "Level" on page 205

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent <Comment>

Enters a comment for the selected configuration file.

Parameters:
<Comment> string

Example: See Example "Creating a multi-segment waveform" on page 712

Manual operation: See "Comment" on page 201

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete <Filename>

Deletes the selected configuration file.

Setting parameters:
<Filename> string

Example: See Example "Creating a multi-segment waveform" on page 712.

Usage: Setting only

Manual operation: See "Load List" on page 200

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

Defines the file name of the output multi-segment waveform.

Parameters:
<OFile> string

Example: See Example "Creating a multi-segment waveform" on page 712

Manual operation: See "Output File" on page 201
See "Create Output File/Create and Load Output File" on page 201

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend <Waveform>

Appends the specified waveform to the configuration file.

Setting parameters:
<Waveform> string

Example: see Example "Creating a multi-segment waveform" on page 712

Usage: Setting only

Manual operation: See "Append/Delete/Shift Segment Up/Shift Segment Down" on page 203

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete

Deletes the selected waveform segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 712.

Usage: Event

Manual operation: See "Append/Delete/Shift Segment Up/Shift Segment Down" on page 203

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN

Shifts the selected waveform segment down by one segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 712.

Usage: Event

Manual operation: See "Append/Delete/Shift Segment Up/Shift Segment Down" on page 203

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP

Shifts the selected waveform segment up by one segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 712.

Usage: Event

Manual operation: See "Append/Delete/Shift Segment Up/Shift Segment Down" on page 203

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect <Filename>

Selects a configuration file from the default directory. If a configuration file with the specified name does not yet exist, it is created. The file extension `*.inf_mswv` may be omitted.

Parameters:
<Filename> string

Example: see Example "Creating a multi-segment waveform" on page 712

Manual operation: See "New List" on page 200
See "Load List" on page 200

Multicarrier commands

Required options

See Section 4.9.1, "Required options", on page 223.

Common suffixes

Suffix	Value range
CARRier<ch>	1 to 512

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet 735
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog? 735
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD 736

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe....736
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt....736
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE....738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor....738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff....738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]....739
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE....739
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence....739
[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe....740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad....740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?....740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate....740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe....741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency....741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe....741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer....742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay....742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE....742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?....742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe....743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt....743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP....743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP....743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt]....744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP....744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt]....744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP....745
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt]....745
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE....746
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute....746

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all the multicarrier parameters to their default values.

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Event

Manual operation: See "Set to Default" on page 227

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

Queries the files with settings in the default directory. Listed are files with the file extension `*.arb_multcarr`.

Return values:
<Catalog> string

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Query only

Manual operation: See "Save/Recall" on page 227

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.arb_multcarr`.

Setting parameters:
<Filename> "<filename>"
Filename or complete file path; file extension can be omitted.

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Setting only

Manual operation: See "Save/Recall" on page 227

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

Saves the current settings into the selected file; the file extension (`*.arb_multcarr`) is assigned automatically.

Setting parameters:
<Filename> string
Filename or complete file path

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Setting only

Manual operation: See "Save/Recall" on page 227

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt <Count>

Sets the number of carriers in the ARB multicarrier waveform.

Parameters:
<Count> integer
Range: 1 to 512
*RST: 1

Example: See Example "To generate a multicarrier signal" on page 716.

Manual operation: See "Number of Carriers" on page 228
See "Number of Carriers" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

Sets the carrier frequency mode for the single carriers.

Parameters:

<Mode> EQUidistant | ARBitrary
*RST: EQUidistant

Example: `BB:ARB:MCAR:CARR:MODE EQU`
Sets an equidistant carrier spacing. The carrier frequency cannot be set.

Manual operation: See "Mode" on page 227

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

Sets the frequency spacing between adjacent carriers of the multicarrier waveform.

See also Section 4.9.2.1, "Defining the carrier frequency", on page 224.

Parameters:

<Spacing> float
Range: 0.0 to depends on the installed options, for example 120E6
Increment: 0.01
*RST: 0
Default unit: Hz

Example: See Example "To generate a multicarrier signal" on page 716.

Manual operation: See "Carrier Spacing" on page 228

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?

Queries the resulting file size.

Return values:

<Samples> integer
Range: 0 to INT_MAX
*RST: 0
Default unit: samples

Example: `SOURce1:BB:ARBitrary:MCARrier:SAMPles?`
Queries the file size of the currently calculated multi-carrier waveform.

Usage: Query only

Manual operation: See "File Size" on page 233

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME <Time>

Sets the user-defined signal period.

Parameters:

<Time> float

Range: 0 to 1E9
Increment: 1E-9
*RST: 0
Default unit: s

Example: `SOURce1:BB:ARBitrary:MCARrier:MODE USER`
Selects signal period mode user.
`SOURce1:BB:ARBitrary:MCARrier:TIME 10`
Sets a signal period of 10 seconds

Manual operation: See "Signal Period Mode" on page 229

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE <Mode>

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

Parameters:

<Mode> OFF | MIN | MAX

*RST: OFF

Example: `SOURce1:BB:ARBitrary:MCARrier:CFACtor:MODE OFF`
Switches off automatic crest factor optimization.

Manual operation: See "Crest Factor Mode" on page 228

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor <CFactor>

Sets the value of the desired crest factor, if baseband clipping is enabled.

A target crest factor above the crest factor of the unclipped multicarrier signal has no effect.

Parameters:

<CFactor> float

Range: -50 to 50
Increment: 0.01
*RST: 50
Default unit: dB

Example: See `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 739.

Manual operation: See "Target Crest Factor" on page 228

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff <Cutoff>

Sets the cutoff frequency of the final low pass filter, if baseband clipping is enabled.

Parameters:

<Cutoff> float

Range: 0 to 250E6
Increment: 0.01
*RST: 75E6

Example: See `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 739.

Manual operation: See "Filter Cut Off Frequency" on page 229

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SOURce1:BB:ARBitrary:MCARrier:CLIPping:STATe ON
SOURce1:BB:ARBitrary:MCARrier:CLIPping:CFACtor 37
SOURce1:BB:ARBitrary:MCARrier:CLIPping:CUToff 50
```

Manual operation: See "Clipping" on page 228

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE <Mode>

Selects the mode for calculating the resulting signal period of the multi-carrier waveform. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF).

Parameters:

<Mode> USER | LONG | SHORt | LCM

*RST: LONG

Example:

```
BB:ARB:MCAR:TIME:MODE LONG
```

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

Manual operation: See "Signal Period Mode" on page 229

[: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 230

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

Sets the output filename for the multicarrier waveform (file extension `*.wv`).

This filename is required to calculate the waveform with the commands `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` or `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate`.

Parameters:
<OFile> string

Example: See Example "To generate a multicarrier signal" on page 716.

Manual operation: See "Output File" on page 232

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates a multicarrier waveform using the current entries of the carrier table and enables the ARB.

Use the command `[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe` to define the multicarrier waveform filename. The file extension is `*.wv`.

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Event

Manual operation: See "Create/Create and Load" on page 231

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?

Queries the resulting sample rate at which the multi-carrier waveform is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers, carrier spacing, and input sample rate of the leftmost or rightmost carriers.

Return values:
<Clock> float

Range: 400 to Max
Increment: 1E-3

Example: `BB:ARB:MCAR:CLOC?`
Queries the ARB multi-carrier output clock rate.

Usage: Query only

Manual operation: See "Clock Rate" on page 232

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multicarrier waveform using the current settings of the carrier table.

Use the command `[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe` to define the multicarrier waveform filename. The file extension is `*.wv`.

Example: See Example "To generate a multicarrier signal" on page 716.

Usage: Event

Manual operation: See "Create/Create and Load" on page 231

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables the selected single carrier of the multicarrier signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To generate a multicarrier signal" on page 716.

Manual operation: See "State" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency <Frequency>

Sets or indicates the carrier frequency, depending on the selected carrier frequency mode.

Parameters:

<Frequency> integer

Range: depends on the installed options
*RST: 0

Example:
```
SOURce1:BB:ARBitrary:MCARrier:CARRier:MODE ARB
SOURce1:BB:ARBitrary:MCARrier:CARRier1:
FREQuency 5.0
```
Sets 5.0 MHz carrier frequency.

Manual operation: See "Carrier Freq. Offs. (MHz)" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe <Phase>

Sets the start phase of the selected carrier.

Parameters:

<Phase> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example:
```
SOURce1:BB:ARBitrary:MCARrier:CARRier19:PHASe
90
```
Sets a start phase.

Manual operation: See "Phase (deg)" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer <Power>

Sets the gain of the selected carrier.

Parameters:

<Power> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier15:POWer -50`
Sets the power of carrier 15 to -50 dB.

Manual operation: See "Gain (dB)" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay <Delay>

Sets the start delay of the selected carrier.

Parameters:

<Delay> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:CARR15:DEL 5us`
sets a start delay of 50 us for carrier 15.

Manual operation: See "Delay (ns)" on page 234

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE <File>

Selects the I/Q data file that contains the I/Q samples for modulation onto the selected single carrier.

Parameters:

<File> <file name>

Example: See Example "To generate a multicarrier signal" on page 716.

Manual operation: See "File" on page 235

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?

Queries carrier conflicts. A conflict arises when the carriers overlap.

Return values:
<Conflict> 1 | ON | 0 | OFF
0
No conflict
*RST: 0

Example: `BB:ARB:MCAR:CARR:CONF?`

Usage: Query only

Manual operation: See "!!!" on page 235

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

Switches all the carriers in the selected carrier range on or off.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 1

Example: `BB:ARB:MCAR:EDIT:CARR:STAT ON`
Sets all the carriers in the carrier range to ON.

Manual operation: See "Carrier State" on page 236

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP <Stop>

Selects the last carrier in the carrier range to which the settings shall apply.

Parameters:
<Stop> integer
Range: 0 to 511
*RST: 0

Example: `BB:ARB:MCAR:EDIT:CARR:STOP 4`
The carrier range stops at carrier 4.

Manual operation: See "Carrier Start" on page 236
See "Carrier Stop" on page 236

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>

Sets the step width by which the starting power of the carriers in the defined carrier range is incremented.

Parameters:
<Step> float
Range: -80 to 80
Increment: 0.01
*RST: 0
Default unit: dB

Example: BB:ARB:MCAR:EDIT:CARR:POW -80dB
Sets a power of -80 dB for the carriers in the carrier range.
BB:ARB:MCAR:EDIT:CARR:POW:STEP 1 dB
The power is incremented by 1dB for each carrier.
That is, the first carrier has -80 dB, the second -79 dB, and so on.

Manual operation: See "Gain Step" on page 236

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] <Start>

Sets the power for the individual carriers in the defined carrier range.

Parameters:

<Start> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: BB:ARB:MCAR:EDIT:CARR:POW -50 dB
sets the power of the carriers in the carrier range to -50 dB.

Manual operation: See "Gain Start" on page 236

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>

Sets the step width by which the start phases of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -359.99 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG
Sets a start phase of 90° for the carriers in the carrier range.
BB:ARB:MCAR:EDIT:CARR:PHAS:STEP 1 DEG
The start phase is incremented by 1° for each carrier. That is, the first carrier has a start phase of 90°, the second a start phase of 91°, and so on.

Manual operation: See "Phase Step" on page 237

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] <Start>

Sets the start phase for the individual carriers in the defined carrier range.

Parameters:

<Start> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG`
sets a start phase of 90° for the carriers in the carrier range.

Manual operation: See "Phase Start" on page 237

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>

Sets the step width by which the start delays of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -1 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:EDIT:CARR:DEL 5 us`
Sets a start delay of 5 us for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:DEL:STEP 1 us`
The start delay is incremented by 1us for each carrier. That is, the first carrier has a start delay of 5 us, the second a start delay of 6 us, and so on.

Manual operation: See "Delay Step" on page 237

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>

Sets the start delay for the individual carriers in the defined carrier range.

Parameters:

<Start> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:EDIT:CARR:DEL 5us`
Sets a start delay of 5 us for the carriers in the carrier range.

Manual operation: See "Delay Start" on page 237

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE <File>

Selects the input file. The data of the file are modulated onto the carriers in the defined carrier range.

Parameters:
<File> string

Example: `BB:ARB:MCAR:EDIT:CARR:FILE "/var/user/temp/IQ_wcdma"`
selects input file `IQ_wcdma`.

Manual operation: See "Input Waveform File" on page 237

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute

Adopts the settings for the selected carrier range.

Example:
```
BB:ARB:MCAR:EDIT:CARR:STAR 4
BB:ARB:MCAR:EDIT:CARR:STOP 20
BB:ARB:MCAR:EDIT:CARR:STAT ON
BB:ARB:MCAR:EDIT:CARR:EXEC
```

Usage: Event

Manual operation: See "Apply Assistant Settings" on page 237

Trigger commands

This section provides trigger commands for the `SOURce:BB:ARBitrary` subsystem.

Example: To configure trigger settings

This example provides the commands to configure the trigger settings.

```
// ***************************************************************************
// Configure for a single trigger event.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence SINGle
SOURce1:BB:ARBitrary:TRIGger:SLUNit SAMPles
SOURce1:BB:ARBitrary:TRIGger:SLENgth 200
// Outputs the first 200 samples of the waveform after the next trigger event.
SOURce1:BB:ARBitrary:TRIGger:SOURce?
// Response: "INTernal"
SOURce1:BB:ARBitrary:STATe ON

// ***************************************************************************
// Configure for an external trigger event.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence ARETrigger
// Sets the armed retrigger mode.
SOURce1:BB:ARBitrary:TRIGger:SOURce EGT1
// Expects an external trigger signal at a USER connector.
SOURce1:BB:ARBitrary:TRIGger:EXTernal:SYNChronize:OUTPut ON
```

```
// Synchronizes the baseband signal output to the external trigger event.
// Query the processing time between the input of the external trigger event
// and the output of the baseband signal.
SOURce1:BB:ARBitrary:TRIGger:PTIMe?
// Response: "0.00021"
// The processing time is 210 mircoseconds.
// Optionally, add a trigger delay.
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 200
SOURce1:BB:ARBitrary:TRIGger:EXTernal:INHibit 100
SOURce1:BB:ARBitrary:STATe ON

// ***************************************************************************
// Execute an internal trigger manually.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce1:BB:ARBitrary:STATe ON
SOURce1:BB:ARBitrary:TRIGger:EXEC
SOURce1:BB:ARBitrary:TRIGger:RMODe?
// Response: "RUN"
```

Example: To specify delay and inhibit values in time units

The following example lists the commands to configure trigger delays and trigger inhibit values. See also "To set delay and inhibit values" on page 91.

```
SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUT
SOURce1:BB:ARBitrary:TRIGger:SOURce EGT1
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT SAMP
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 100
SOURce1:BB:ARBitrary:TRIGger:EXTernal:RDELay?
// Response in samples: 100
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT TIME
SOURce1:BB:ARBitrary:TRIGger:EXTernal:TDELay 0.00001
SOURce1:BB:ARBitrary:TRIGger:EXTernal:RDELay?
// Response in seconds: 0.00001
// The actual external delay is 10 microseconds.
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT SAMP
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 10
```

Commands:

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence 748
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce 748
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? 749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth 749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit 749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute 749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute 750
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut 750
[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe? 750

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT 750
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay 751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay 751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay? 751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit 752

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode:

- `AUTO` = auto
- `RETRigger` = retrigger
- `AAUTo` = armed auto
- `ARETrigger` = armed retrigger
- `SINGle` = single

See also "About trigger modes" on page 85.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

*RST: AUTO

Example: See Example "To configure trigger settings" on page 746.

Manual operation: See "Mode" on page 100

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are the following trigger sources:

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the global connectors:
  `EGT1`: External global trigger
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMCV100B accepts this value and maps it automatically as follows:
  `EXTernal = EGT1`

Parameters:

<Source> INTernal|EXTernal

*RST: INTernal

Example: See Example "To configure trigger settings" on page 746.

Manual operation: See "Source" on page 101

[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?

Queries the status of waveform output.

Return values:

<RMode> STOP | RUN

RUN
Outputs the waveform. A trigger event occurred in the triggered mode.

STOP
No waveform output. A trigger event did not occur in the triggered modes, or waveform output was stopped/armed.

Example: See Example "To configure trigger settings" on page 746.

Usage: Query only

Manual operation: See "Running/Stopped" on page 100

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth <SLength>

Sets the length of the signal sequence that is output in the `SINGle` trigger mode.

Parameters:

<SLength> integer

The maximum value depends on the selected units `[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit` as follows:
`SAMPle`: Max = 2^{32}-1
`SEQuence`: Max = 1000

Range: 1 to dynamic
*RST: 1

Example: See Example "To configure trigger settings" on page 746.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit <SLUnit>

Sets the unit for the entry of the length of the signal sequence to be output in the `Single` trigger mode.

Parameters:

<SLUnit> SEQuence | SAMPle

*RST: SEQuence

Example: See Example "To configure trigger settings" on page 746.

Manual operation: See "Signal Duration" on page 102

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute

Stops the waveform output to arm the trigger.

Example: See Example "To manage waveform files" on page 710.

Usage: Event

Manual operation: See "Arm" on page 101

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute

Triggers signals generation manually for an internal trigger event.

Example: See Example "To configure trigger settings" on page 746.

Usage: Event

Manual operation: See "Execute Trigger" on page 101

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "To configure trigger settings" on page 746.

Manual operation: See "Sync. Output to Ext. Trigger/Sync. Output to Trigger" on page 101

[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe?

Queries the internal processing time.

The processing time is the elapsed time between the input of the external trigger event and the output of the baseband signal.

Return values:

<ArbTrigProcTime> string

Example: See Example "To configure trigger settings" on page 746.

Usage: Query only

Manual operation: See "Processing Time" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT <TrigDelUnit>

Sets the unit of the trigger delay.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "(External) Delay Unit" on page 102

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay <Delay>

Specifies the trigger delay in samples.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<Delay> float

Range: 0 to depends on the sample rate
Increment: 0.01
*RST: 0
Default unit: sample

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 102

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<ExtTimeDelay> float

Range: 0 to 2147483647 / (clock frequency)
Increment: 1E-9
*RST: 0
Default unit: s

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 102

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResTimeDelaySec> float

Range: 0 to 688
Increment: 0.25E-9
*RST: 0

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 102

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit <Inhibit>

Sets the number of samples that inhibit a restart of the signal generation.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 91.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (clock frequency)
*RST: 0
Default unit: samples

Example: See Example "To specify delay and inhibit values in time units" on page 747.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 101

Marker commands

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE 752
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency? 753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay 754
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec? 754

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE <Mode>

Sets the marker mode that is the marker signal for the selected marker output.

See also "Marker modes" on page 83.

Parameters:

<Mode> UNCHanged | RESTart | PULSe | PATTern | RATio

UNCHanged
A marker signal as defined in the waveform file (tag `'marker mode x'`) is generated.

*RST: UNCHanged

Example: See Example "To configure marker signals" on page 711.

Manual operation: See "Mode" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of samples or duration of the marker-on and marker-off periods.

Parameters:

<OffTime> integer

Range: 1 to 14913079
*RST: 1

Example: See Example "To configure marker signals" on page 711.

Manual operation: See "Mode" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Sets the bit pattern to generate the marker signal.

Parameters:

<Pattern> numeric

*RST: #H2

<BitCount> integer

0 = marker off, 1 = marker on

Range: 1 to 64
*RST: 2

Example: See Example "To configure marker signals" on page 711.

Manual operation: See "Mode" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for the pulsed marker signal.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: See Example "To configure marker signals" on page 711.

Manual operation: See "Mode" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal. The pulse frequency is the symbol rate divided by the divider.

Return values:

<Frequency> float

Increment: 0.001

Example: See Example "To configure marker signals" on page 711.

Usage: Query only

Manual operation: See "Mode" on page 153

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay <Delay>

Sets the delay between the signal on the marker outputs and the start of the signal.

Parameters:

<Delay> integer

Range: 0 to depends on other values
Increment: 0.001
*RST: 0
Default unit: Symbol

Example: See Example "To configure marker signals" on page 711.

Manual operation: See "Delay" on page 104

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec?

Queries the marker delay in microseconds.

You can define a marker delay in samples via the following command:

`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay` on page 754

Return values:

<DelayInS> float

Range: 0 to 16777215
Increment: 1E-3
*RST: 0

Example: See Example "To configure marker signals" on page 711.

Usage: Query only

Manual operation: See "Delay (Time)" on page 154

Clock commands

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "To configure clock settings" on page 711.

Manual operation: See "Clock Source" on page 105

14.16.4.4 SOURce:BB:General subsystem

The `SOURce:BB:GENeral` subsystem contains the commands for configuring basic frequency (FM), phase (PhiM), amplitude (AM) and pulse modulation (PULM) digital baseband signals.

Required options

See "Required options" on page 241.

Modulation states

You can modulate frequency and phase in parallel. But activating another baseband signal, e.g. for amplitude or pulse generation, deactivates the previous baseband modulation signal:

```
SOURce1:BB:GENeral:FM:STATe 1
SOURce1:BB:GENeral:PM:STATe 1
SOURce1:BB:GENeral:FM:STATe? 1
SOURce1:BB:GENeral:AM:STATe? 0
```

Programming examples

Example: Activate basic FM

```
SOURce1:BB:GENeral:FM:FREQuency 2000
SOURce1:BB:GENeral:FM:DEViation 1250
SOURce1:BB:GENeral:FM:PERiod? 0.0005
SOURce1:BB:GENeral:FM:SHAPe? SINE
SOURce1:BB:GENeral:FM:STATe 1
```

Example: Activate basic PM

```
SOURce1:BB:GENeral:PM:FREQuency 100000
SOURce1:BB:GENeral:PM:DEViation 286.4789 // degrees
SOURce1:BB:GENeral:PM:PERiod? 0.00001
SOURce1:BB:GENeral:PM:SHAPe? SINE
SOURce1:BB:GENeral:PM:STATe 1
```

Example: Activate basic AM

```
SOURce1:BB:GENeral:AM:DEPTh 100
SOURce1:BB:GENeral:AM:FREQuency 20000
SOURce1:BB:GENeral:AM:PERiod? 0.0005
SOURce1:BB:GENeral:AM:SHAPe? SINE
SOURce1:BB:GENeral:AM:STATe 1
```

Example: Activate PULM

```
SOURce1:BB:GENeral:PULM:MODE DOUB
SOURce1:BB:GENeral:PULM:PERiod 0.00005
SOURce1:BB:GENeral:PULM:WIDTh 0.000001
SOURce1:BB:GENeral:PULM:DOUBle:WIDTh 0.000006
SOURce1:BB:GENeral:PULM:TRANsition:TYPE SMO
SOURce1:BB:GENeral:PULM:POLarity INV
SOURce1:BB:GENeral:PULM:STATe 1
```

FM commands

[:SOURce<hw>]:BB:GENeral:FM:DEViation 756
[:SOURce<hw>]:BB:GENeral:FM:FREQuency 756
[:SOURce<hw>]:BB:GENeral:FM:PERiod 756
[:SOURce<hw>]:BB:GENeral:FM:SHAPe 757
[:SOURce<hw>]:BB:GENeral:FM[:STATe] 757

[:SOURce<hw>]:BB:GENeral:FM:DEViation <FmDeviation>

Sets the frequency modulation deviation in Hz.

Parameters:

<FmDeviation> float

Range: 0 to 4E6
Increment: 0.01
*RST: 1E3

Example: See Example "Activate basic FM" on page 755.

Manual operation: See "FM Deviation" on page 243

[:SOURce<hw>]:BB:GENeral:FM:FREQuency <FreqModFreq>

Sets the frequency of the modulation signal.

Parameters:

<FreqModFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic FM" on page 755.

Manual operation: See "Modulation Frequency" on page 242

[:SOURce<hw>]:BB:GENeral:FM:PERiod <FmPer>

Queries the period of the modulation signal.

Parameters:

<FmPer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Activate basic FM" on page 755.

Manual operation: See "Modulation Period" on page 242

[:SOURce<hw>]:BB:GENeral:FM:SHAPe <FmShape>

Queries the shape of the modulation signal.

Parameters:

<FmShape> SINE

*RST: SINE

Example: See Example "Activate basic FM" on page 755.

Manual operation: See "Modulation Shape" on page 242

[:SOURce<hw>]:BB:GENeral:FM[:STATe] <FmModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<FmModState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Activate basic FM" on page 755.

Manual operation: See "State" on page 242

AM commands

[:SOURce<hw>]:BB:GENeral:AM:DEPTh 757
[:SOURce<hw>]:BB:GENeral:AM:FREQuency 758
[:SOURce<hw>]:BB:GENeral:AM:PERiod 758
[:SOURce<hw>]:BB:GENeral:AM:SHAPe 758
[:SOURce<hw>]:BB:GENeral:AM[:STATe] 759

[:SOURce<hw>]:BB:GENeral:AM:DEPTh <AmDepth>

Sets the depth of the modulation signal in percent.

The depth is limited by the maximum peak envelope power (PEP).

Parameters:

<AmDepth> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Activate basic AM" on page 755.

Manual operation: See "AM Depth" on page 245

[:SOURce<hw>]:BB:GENeral:AM:FREQuency <AmFreq>

Sets the frequency of the modulation signal.

Parameters:

<AmFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic AM" on page 755.

Manual operation: See "Modulation Frequency" on page 245

[:SOURce<hw>]:BB:GENeral:AM:PERiod <AmPer>

Queries the period of the modulation signal.

Parameters:

<AmPer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Activate basic AM" on page 755.

Manual operation: See "Modulation Period" on page 245

[:SOURce<hw>]:BB:GENeral:AM:SHAPe <AmShape>

Queries the shape of the modulation signal.

Parameters:

<AmShape> SINE

*RST: SINE

Example: See Example "Activate basic AM" on page 755.

Manual operation: See "Modulation Shape" on page 245

[:SOURce<hw>]:BB:GENeral:AM[:STATe] <AmModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<AmModState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Activate basic AM" on page 755 .

Manual operation: See "State" on page 245

PM commands

[:SOURce<hw>]:BB:GENeral:PM:DEViation 759
[:SOURce<hw>]:BB:GENeral:PM:FREQuency 759
[:SOURce<hw>]:BB:GENeral:PM:PERiod 759
[:SOURce<hw>]:BB:GENeral:PM:SHAPe 760
[:SOURce<hw>]:BB:GENeral:PM[:STATe] 760

[:SOURce<hw>]:BB:GENeral:PM:DEViation <PmDeviation>

Sets the phase modulation deviation in radians or degrees.

Parameters:

<PmDeviation> float

Range: 0 to 6
Increment: 0.000001
*RST: 1
Default unit: rad

Example: See Example "Activate basic PM" on page 755.

Manual operation: See "PhiM Deviation" on page 244

[:SOURce<hw>]:BB:GENeral:PM:FREQuency <PhaseFreq>

Sets the frequency of the modulation signal.

Parameters:

<PhaseFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic PM" on page 755.

Manual operation: See "Modulation Frequency" on page 243

[:SOURce<hw>]:BB:GENeral:PM:PERiod <PhasePer>

Queries the period of the modulation signal.

Parameters:
<PhasePer> float
Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Manual operation: See "Modulation Period" on page 244

[:SOURce<hw>]:BB:GENeral:PM:SHAPe <PmShape>

Queries the shape of the modulation signal.

Parameters:
<PmShape> SINE
*RST: SINE

Example: See

Manual operation: See "Modulation Shape" on page 244

[:SOURce<hw>]:BB:GENeral:PM[:STATe] <PhimModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:
<PhimModState> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "State" on page 243

PULM commands

[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay....760
[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh....761
[:SOURce<hw>]:BB:GENeral:PULM:MODE....761
[:SOURce<hw>]:BB:GENeral:PULM:PERiod....761
[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE....761
[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity....762
[:SOURce<hw>]:BB:GENeral:PULM:WIDTh....762
[:SOURce<hw>]:BB:GENeral:PULM[:STATe]....762

[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay <PulmDblDel>

Sets the double pulse delay in microseconds.

Parameters:
<PulmDblDel> float
Range: 50E-9 to 100
Increment: 5E-9
*RST: 3E-6

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Double Pulse Delay" on page 247

[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh <PulmDblWidth>

Defines the double pulse width in microseconds.

Parameters:

<PulmDblWidth> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 3E-6

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Double Pulse Width" on page 247

[:SOURce<hw>]:BB:GENeral:PULM:MODE <PulmMode>

Sets the pulse mode.

You can set for single or double pulse signals.

Parameters:

<PulmMode> SINGle | DOUBle

*RST: SINGle

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Pulse Mode" on page 246

[:SOURce<hw>]:BB:GENeral:PULM:PERiod <PulsModPer>

Defines the pulse period in microseconds.

Parameters:

<PulsModPer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Pulse Period" on page 246

[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE <PulmTransType>

Sets the transition type of the pulse modulation signal.

Parameters:

<PulmTransType> FAST | SMOothed

*RST: FAST

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Transition Type" on page 247

[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity <PulsVideoPol>

Sets the video polarity.

Parameters:

<PulsVideoPol> INVerted | NORMal

*RST: NORMal

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Video Polarity" on page 247

[:SOURce<hw>]:BB:GENeral:PULM:WIDTh <PulmWidth>

Sets the pulse width in microseconds.

Parameters:

<PulmWidth> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 2E-6

Example: See Example "Activate PULM" on page 756.

Manual operation: See "Pulse Width" on page 247

[:SOURce<hw>]:BB:GENeral:PULM[:STATe] <PulmState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<PulmState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Activate PULM" on page 756.

Manual operation: See "State" on page 246

14.16.4.5 SOURce:BB:IMPairment subsystem

This subsystem contains the commands for digital I/Q impairments.

Required options

See Section 6.2.1, "Required options", on page 297.

Commands:

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] 763
[:SOURce<hw>]:BB:IMPairment:LEAKage:I 763
[:SOURce<hw>]:BB:IMPairment:LEAKage:Q 763
[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] 763
[:SOURce<hw>]:BB:IMPairment:STATe 764
[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE 764

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] <IqRatio>

Parameters:

<IqRatio> float

Range: -1 to 1
Increment: 1E-4
*RST: 0

Manual operation: See "Gain Imbalance" on page 300

[:SOURce<hw>]:BB:IMPairment:LEAKage:I <I>
[:SOURce<hw>]:BB:IMPairment:LEAKage:Q <Q>

Determines the leakage amplitude of the I or Q signal component of the corresponding stream

Parameters:

<Q> float

Range: -10 to 10
Increment: 0.01
*RST: 0

Example:

```
SOURce:BB:IMPairment:LEAKage:I 0.04
SOURce:BB:IMPairment:LEAKage:Q 4 PCT
```

Sets the leakage for the I component and Q component to 4 percent.

Manual operation: See "I/Q Offset" on page 300

[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] <Angle>

Sets a quadrature offset (phase angle) between the I and Q vectors deviating from the ideal 90 degrees.

A positive quadrature offset results in a phase angle greater than 90 degrees.

Parameters:

<Angle> float

Range: -10 to 10
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce:BB:IMPairment:QUADrature:ANGLe -5`
Sets the quadrature offset to -5 degrees.

Manual operation: See "Quadrature Offset" on page 301

[:SOURce<hw>]:BB:IMPairment:STATe <State>

Activates the impairment or correction values `LEAKage`, `QUADrature` and `IQRatio`.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `SOURce1:BB:IMPairment:STATe ON`
Activates digital impairment.

Manual operation: See "State" on page 300

[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>

Sets the optimization mode for I/Q modulation.

Parameters:
<Mode> FAST | | QHTable

FAST
Fast optimization by compensating for I/Q skew.

QHTable
Improves the frequency response while maintaining setting time, there is no signal interruption.

*RST: FAST

Example:
```
:SOURce1:IQ:SOURce?
// Response: "BASeband"
// The I/Q signal source is the internal baseband signal.
:SOURce1:BB:IMPairment:OPTimization:MODE FAST
```

Manual operation: See "Optimization Mode" on page 304

14.16.4.6 SOURce:BB:GRAPhics subsystem

This subsystem contains the commands used to setup the graphical display.

Required options

See Section 9.1, "Required options", on page 392.

[:SOURce<hw>]:BB:GRAPhics:MODE 765
[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE 765
[:SOURce<hw>]:BB:GRAPhics:SRATe:USER 765
[:SOURce]:BB:GRAPhics:CLOSe 766
[:SOURce]:BB:GRAPhics:ADD 766
[:SOURce]:BB:GRAPhics:SOURce 766

[:SOURce]:BB:GRAPhics:FFTLen 766
[:SOURce]:BB:GRAPhics:FFTFscale 767
[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce 767

[:SOURce<hw>]:BB:GRAPhics:MODE <Mode>

Selects the graphics mode of the graphical signal display.

Parameters:

<Mode> IQ | VECTor | CCDF | PSPectrum | CONStellation | EYEI | EYEQ

*RST: IQ

Example: `BB:GRAP:MODE VECT`
Selects the vector diagram graphics mode.

Manual operation: See "Mode" on page 401

[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE <Mode>

Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a diagram covering the entire signal bandwidth. The higher the resolution is, the shorter the length of the displayed signal segment will be for the specified recording depth.

Parameters:

<Mode> AUTO | FULL | USER

*RST: AUTO

Example: `BB:GRAP:SRAT:MODE FULL`
Sets the sample rate mode.

Manual operation: See "Sample Rate Mode" on page 402

[:SOURce<hw>]:BB:GRAPhics:SRATe:USER <User>

(Enabled for `BB:GRAPH:SRAT:MODE USER`)

Selects the signal bandwidth for the diagram. The setting range moves between the minimum and maximum bandwidth which is possible for the selected graphical signal display. The selection is made graphically by moving the pointer.

Parameters:

<User> float

Range: 0.01 to 100
Increment: 0.01
*RST: 10
Default unit: PCT

Example: `BB:GRAP:SRAT:USER 20`
sets the sample rate factor.

Example: `BB:GRAP:SRAT:MODE USER`
sets the sample rate mode.

Manual operation: See "Sample Rate" on page 402

[:SOURce]:BB:GRAPhics:CLOSe

Closes all graphical signal displays.

Usage: Event

Manual operation: See "Remove" on page 403

[:SOURce]:BB:GRAPhics:ADD <Size>

Adds a graphical signal display (according to the current `MODE`, `SOURce`, `SRATe:*` and `TRIGger:*` settings).

Setting parameters:

<Size> MAXimized | MINimized

Usage: Setting only

Manual operation: See "Add" on page 402

[:SOURce]:BB:GRAPhics:SOURce <Source>

Defines the signal acquisition point, that is the location in the signal flow where the displayed signal is tapped from.

See Section 9.2.2, "Signal acquisition points", on page 397.

Parameters:

<Source> STRA | BBA | RFA | BBIA | DO1 | IQO1 | STRA | BBA | RFA | BBIA | DO1

STRA
Stream A; input stream of the "IQ Stream Mapper"

BBA
Baseband signal

BBIA
Digital baseband input signals

RFA
RF signal

DO1
Digital I/Q output signals; outputs of the "IQ Stream Mapper"

*RST: STRA

Options: DO1 requieres R&S SMCVB-K19

Manual operation: See "Source" on page 401

[:SOURce]:BB:GRAPhics:FFTLen <Mode>

Sets the FFT size.

Parameters:

<Mode> LEN256 | LEN512 | LEN1024 | LEN2048 | LEN4096

*RST: LEN2048

Example: `SOURce:BB:GRAPhics:FFTLen LEN2048`

Manual operation: See "FFT Length" on page 401

[:SOURce]:BB:GRAPhics:FFTFscale <State>

Defines the normalization of the power values in the power spectrum diagram.

Parameters:

<State> 1 | ON | 0 | OFF

1
Normalized power in dBFS

0
Shows power distribution in dB/Hz

*RST: 0

Example:
```
SOURce:BB:GRAPhics:FFTFscale PSPectrum
SOURce:BB:GRAPhics:FFTFscale 1
// the power spectrum shows the normalized power in dBFS
```

Manual operation: See "Full Scale (dBFS)" on page 401

[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce <Source>

Defines the trigger for the starting time of the graphic recording.

Parameters:

<Source> SOFTware | MARKer

*RST: SOFTware

Example: `SOURce1:BB:GRAPhics:TRIGger:SOURce MARKer`
Sets the trigger source.

Manual operation: See "Trigger Source" on page 401

14.16.4.7 SOURce:BB:PROGress subsystem

In the R&S SMCV100B, some calculation processes take longer time. While operating the instrument manually, you can observe the status of an initiated process by the busy indicator. The following commands fulfill the same task in the remote control operation.

Example: Querying the status of the "Create Waveform"

The following example provides information on the status during the "Create Waveform" file processing. You can query progress information of this process.

```
:SOURce1:BB:PROGress:MCODer?
```

```
// 100 (task completed)
:SOURce1:BB:ARB:STATe ON
:SOURce1:BB:PROGress:MCODer?
// 67 (task in progress)
```

[:SOURce<hw>]:BB:PROGress:MCODer?....768
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?....768
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?....768

[:SOURce<hw>]:BB:PROGress:MCODer?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?

Queries the status of an initiated process. This process can be, for example, the calculation of a signal in accordance to a digital standard, or the calculation of a multicarrier or multi-segment waveform file.

Return values:

<WSegment> integer

Indicates the task progress in percent

Range: 0 to 100
*RST: 100

Example: See Example "Querying the status of the "Create Waveform"" on page 767.

Usage: Query only

14.16.5 SOURce:CORRection subsystem

The `SOURce:CORRection` subsystem contains the commands for defining correction values for external test assemblies.

You can acquire the correction values anytime, regardless of the modulation settings of the generator. During correction, the R&S SMCV100B adds the correction values to the output level of the respective RF frequency.

Determine the correction values in one of the following ways:

- Measure the RF output level at several frequency points and enter the value pairs manually in a table
- Connect an R&S NRP to the generator output signal and send the command `[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe` to fill the table automatically.

Save correction values to files with file extension `*.uco`.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and in a specific directory.

Programming examples

The examples in this section assume that:

- The files are stored in the default directory.
- `*RST` does not affect data lists.

Example: To create RF level correction values

The following example shows a command sequence to create and activate a list for assigning level correction values to arbitrary RF frequencies. Further hardware settings are not considered.

```
// Reset the instrument to start from an initial state
// Query the available user correction list files in the default directory
// Select a file or create a new one
// ****************************************************************
*RST; *CLS
SOURce1:CORRection:CSET:CATalog?
// Response: shows the name of available user correction files (if applicable)
// Select a file
SOURce1:CORRection:CSET:SELect "/var/user/ucor1"
// Create a new file (if not existing)
SOURce1:CORRection:CSET:SELect "/var/user/ucor2"

// Enter the frequency/level value pairs in the table;
// existing data is overwritten
// Query the number of frequency/power entries in the selected list
SOURce1:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
SOURce1:CORRection:CSET:DATA:POWer -10,-7.5,-5.0,-2.5,0,2.5
SOURce1:CORRection:CSET:DATA:FREQuency:POINts?
// 6
SOURce1:CORRection:CSET:DATA:POWer:POINTs?
// 6

// Enable user correction mode and RF output
SOURce1:CORRection:STATe 1
OUTPut1:STATe ON

// Query the currently used correction value
SOURce1:CORRection:VALue?
// -2.5

// Delete a user correction file
SOURce1:CORRection:CSET:DELEte "/var/user/ucor1.uco"
```

Example: To fill user correction data with a sensor

The following example shows a command sequence to fill a user correction list automatically supported by a connected R&S NRP.

```
// Fill a user correction list with the level values
// measured by an R&S NRP,
// store the data in a file and enable user correction.

*RST; *CLS

SOURce1:CORRection:CSET:SELect "/var/user/Ucor1_AutoFill.uco"
SOURce1:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
SOURce1:CORRection:ZERoing:STATe 1
SOURce1:CORRection:CSET:DATA:SENSor1:POWer:SONCe
// Query the number of automatically filled correction level values
SOURce1:CORRection:CSET:DATA:POWer:POINTs?
// 6
SOURce1:CORRection:STATe 1

// Query the correction value at a certain frequency
FREQ 120000000
SOURce1:CORRection:VALue?
// -52.13
```

Example: To export user correction lists

The following example shows a command sequence to export a user correction list (here the list created with the example before) into an ASCII file. Further hardware settings are not considered.

```
// Select a user correction file for exporting to file in ASCII format
// Set ASCII data parameters
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
SOURce1:CORRection:DEXChange:AFILe:CATalog?
// my_ucor
SOURce1:CORRection:CSET:CATalog?
// ucor1,Ucor1_AutoFill
SOURce1:CORRection:CSET:SELect "/var/user/Ucor1_AutoFill.uco"
SOURce1:CORRection:DEXChange:AFILe:EXTension CSV
SOURce1:CORRection:DEXChange:AFILe:SEParator:DECimal DOT
SOURce1:CORRection:DEXChange:AFILe:SEParator:COLumn COMMa

// Select source and destination
SOURce1:CORRection:DEXChange:AFILe:SELect "/var/user/ucor2ASCII"

// Export the user correction data into the ASCII file
SOURce1:CORRection:DEXChange:MODE EXPort
SOURce1:CORRection:DEXChange:EXECute

// Query the available ASCII files with extension .csv
SOURce1:CORRection:DEXChange:AFILe:CATalog?
// ucor2ASCII,my_ucor

// Import a user correction ASCII file
```

```
SOURce1:CORRection:DEXChange:MODE IMPort
SOURce1:CORRection:DEXChange:AFILE:SELect "/var/user/my_ucor"
SOURce1:CORRection:DEXChange:EXECute
```

Commands:

- Correction settings 771
- Correction data exchange 774

14.16.5.1 Correction settings

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency <Frequency>

Enters the frequency value in the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

Parameters:

<Frequency> Frequency#1[, Frequency#2, ...]
String of values with default unit Hz.

Example: See Example "To create RF level correction values" on page 769 .

Manual operation: See "Edit List Mode Data" on page 353

[:SOURce<hw>]:CORRection:CSET:DATA:POWer <Power>

Enters the level values to the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

Parameters:

<Power> Power#1[, Power#2, ...]
String of values with default unit dB.
*RST: 0

Example: See Example "To create RF level correction values" on page 769 .

Manual operation: See "Edit List Mode Data" on page 353

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts?
[:SOURce<hw>]:CORRection:CSET:DATA:POWer:POINts?

Queries the number of frequency/level values in the selected table.

Return values:

<Points> integer
Range: 0 to 10000
*RST: 0

Example: See Example "To create RF level correction values" on page 769 .

Usage: Query only

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

Fills the selected user correction table with the level values measured by the power sensor for the given frequencies.

To select the used power sensor set the suffix in key word `SENSe`.

Example: See Example "To fill user correction data with a sensor" on page 769.

Usage: Event

Manual operation: See "Fill User Correction Data with Sensor" on page 369

[:SOURce<hw>]:CORRection:CSET[:SELect] <Filename>

Selects or creates a file for the user correction data.

If the file with the selected name does not exist, a new file is created.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "To create RF level correction values" on page 769 .

Manual operation: See "UCOR Data" on page 364

[:SOURce<hw>]:CORRection:VALue?

Queries the current value for user correction.

Return values:

<Value> float

Range: -100 to 100
Increment: 0.01
*RST: 0

Example: See Example "To create RF level correction values" on page 769 .

Usage: Query only

Manual operation: See "User Correction" on page 363

[:SOURce<hw>]:CORRection:ZERoing:STATe <State>

Activates the zeroing procedure before filling the user correction data acquired by a sensor.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "To fill user correction data with a sensor" on page 769.

Manual operation: See "Fill User Correction Data with Sensor" on page 369

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

Fills the selected user correction list with the level values measured by the power sensor for the given frequencies.

Suffix:

SENSor<ch> Defines the used power sensor, i.e. the sensor whose values are used.

Example: See Example "To fill user correction data with a sensor" on page 769.

Usage: Event

[:SOURce<hw>]:CORRection[:STATe] <State>

Activates user correction with the currently selected table.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To create RF level correction values" on page 769 .

Manual operation: See "State" on page 363

[:SOURce]:CORRection:CSET:CATalog?

Queries a list of available user correction tables.

Return values:

<Catalog> string

List of list filenames, separated by commas

Example: See Example "To create RF level correction values" on page 769 .

Usage: Query only

Manual operation: See "UCOR Data" on page 364

[:SOURce]:CORRection:CSET:DELete <Filename>

Deletes the specified user correction list file.

Setting parameters:

<Filename> string

Filename or complete file path; file extension is optional.

Example: See Example "To create RF level correction values" on page 769 .

Usage: Setting only

Manual operation: See "UCOR Data" on page 364

14.16.5.2 Correction data exchange

With the following commands, you can configure user correction lists and export or import them accordingly.

[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?

Queries the available ASCII files for export or import of user correction data in the current or specified directory.

Return values:

<Catalog> string

List of ASCII files `*.txt` or `*.csv`, separated by commas.

Example: See Example "To create RF level correction values" on page 769 .

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 351

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension <Extension>

Determines the extension of the ASCII files for file import or export, or to query existing files.

Parameters:

<Extension> TXT | CSV

*RST: TXT

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

Parameters:
<Filename> string
Filename or complete file path; file extension can be omitted.

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 351

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn <Column>

Selects the separator between the frequency and level column of the ASCII table.

Parameters:
<Column> TABulator | SEMicolon | COMMa | SPACe
*RST: COMMa

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal <Decimal>

Sets the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

Parameters:
<Decimal> DOT | COMMa
*RST: DOT

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:CORRection:DEXChange:EXECute

Executes the import or export of the selected correction list, according to the previously set transfer direction with command `[:SOURce<hw>]:CORRection:DEXChange:MODE`.

Example: See Example "To export user correction lists" on page 770 .

Usage: Event

Manual operation: See "Import / Export" on page 351

[:SOURce<hw>]:CORRection:DEXChange:MODE <Mode>

Determines import or export of a user correction list.

Specify the source or destination file with the command `[:SOURce<hw>]:CORRection:DEXChange:SELect`.

Parameters:

<Mode> IMPort | EXPort

*RST: IMPort

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "Mode" on page 350

[:SOURce<hw>]:CORRection:DEXChange:SELect <Filename>

Selects the ASCII file for import or export, containing a user correction list.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "To export user correction lists" on page 770 .

Manual operation: See "Select Source/Select ASCII Destination" on page 351

14.16.6 SOURce:FREQuency subsystem

The `SOURce:FREQuency` subsystem contains the commands used to define the frequency settings for the RF sources and sweeps.

Example: Frequency configuration

```
SOURce1:FREQuency:MODE CW
SOURce1:FREQuency:CW 6000000000
SOURce1:FREQuency:OFFSet 2000000000
SOURce1:FREQuency:MULTiplier 1.5
SOURce1:FREQuency:CW?
// 11000000000

// SOURce1:FREQuency:STEP:MODE USER
// SOURce1:FREQuency:STEP:INCRement 1000000
// SOURce1:FREQuency:CW UP

SOURce1:PHASe 2
SOURce1:PHASe:REFerence
```

[:SOURce<hw>]:FREQuency:MODE....777
[:SOURce<hw>]:FREQuency[:CW|FIXed]....777
[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL....778
[:SOURce<hw>]:FREQuency:MANual....778
[:SOURce<hw>]:FREQuency:MULTiplier....779
[:SOURce<hw>]:FREQuency:OFFSet....779
[:SOURce<hw>]:FREQuency:CENTer....780
[:SOURce<hw>]:FREQuency:SPAN....780
[:SOURce<hw>]:FREQuency:STARt....780

[:SOURce<hw>]:FREQuency:STOP....781
[:SOURce<hw>]:FREQuency:STEP:MODE....781
[:SOURce<hw>]:FREQuency:STEP[:INCRement]....781

[:SOURce<hw>]:FREQuency:MODE <Mode>

Sets the frequency mode for generating the RF output signal. The selected mode determines the parameters to be used for further frequency settings.

Parameters:

<Mode> CW | FIXed | SWEep | LIST

CW|FIXed
Sets the fixed frequency mode. `CW` and `FIXed` are synonyms.
The instrument operates at a defined frequency, set with command `[:SOURce<hw>]:FREQuency[:CW|FIXed]`.

SWEep
Sets sweep mode.
The instrument processes frequency (and level) settings in defined sweep steps.
Set the range and current frequency with the commands:
`[:SOURce<hw>]:FREQuency:STARt` on page 780 and `[:SOURce<hw>]:FREQuency:STOP` on page 781,
`[:SOURce<hw>]:FREQuency:CENTer` on page 780,
`[:SOURce<hw>]:FREQuency:SPAN` on page 780,
`[:SOURce<hw>]:FREQuency:MANual` on page 778

LIST
Sets list mode.
The instrument processes frequency and level settings by means of values loaded from a list.
To configure list mode settings, use the commands of the Section 14.16.10, "SOURce:LIST subsystem", on page 788.

*RST: CW

Example: See Example "Frequency configuration" on page 776,

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "State (RF frequency sweep)" on page 338
See "State" on page 346

[:SOURce<hw>]:FREQuency[:CW|FIXed] <Fixed>

Sets the frequency of the RF output signal in the selected path.

The effect depends on the selected mode:

- In CW mode (`FREQ:MODE CW | FIXed`), the instrument operates at a fixed frequency.
- In sweep mode (`FREQ:MODE SWE`), the value applies to the sweep frequency. The instrument processes the frequency settings in defined sweep steps.

- In user mode (`FREQ:STEP:MODE USER`), you can vary the current frequency step by step.

Parameters:

<Fixed> float

The following settings influence the value range:
An offset set with the command `[:SOURce<hw>]:FREQuency:OFFSet`

Numerical value
Sets the frequency in CW and sweep mode

UP|DOWN
Varies the frequency step by step in user mode.
The frequency is increased or decreased by the value set with the command `[:SOURce<hw>]:FREQuency:STEP[:INCRement]`.

Range: (RFmin + OFFSet) to (RFmax + OFFSet)
*RST: n.a.

Example: See Example "Frequency configuration" on page 776

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Frequency" on page 311

[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL <Rcl>

Set whether the RF frequency value is retained or taken from a loaded instrument configuration, when you recall instrument settings with command `*RCL`.

Parameters:

<Rcl> INCLude | EXCLude

INCLude
Takes the frequency value of the loaded settings.

EXCLude
Retains the current frequency when an instrument configuration is loaded.

*RST: INCLude

Example:
```
SOURce1:FREQuency:CW:RCL INCLude
```

Manual operation: See "Exclude Frequency" on page 430

[:SOURce<hw>]:FREQuency:MANual <Manual>

Sets the frequency and triggers a sweep step manually if `SWEep:MODE MAN`.

Parameters:

<Manual> float

You can select any frequency within the setting range, where:

STARt is set with [:SOURce<hw>]:FREQuency:STARt
STOP is set with [:SOURce<hw>]:FREQuency:STOP
OFFSet is set with [:SOURce<hw>]:FREQuency:OFFSet

Range: (STARt + OFFSet) to (STOP + OFFSet)
Increment: 0.01Hz
*RST: 100 MHz
Default unit: Hz

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Current Frequency" on page 338

[:SOURce<hw>]:FREQuency:MULTiplier <Multiplier>

Sets the multiplication factor $N_{FREQ:MULT}$ of a subsequent downstream instrument.

The parameters offset $f_{FREQ:OFFSer}$ and multiplier $N_{FREQ:MULT}$ affect the frequency value set with the command FREQ.

The query FREQ? returns the value corresponding to the formula:

$f_{FREQ} = f_{RFout} * N_{FREQ:MULT} + f_{FREQ:OFFSer}$

See "RF frequency and level display with a downstream instrument" on page 310.

Parameters:
<Multiplier> float

Range: -10000 to 10000
Increment: 0.001
*RST: 1

Example: See Example "Frequency configuration" on page 776

Manual operation: See "Multiplier" on page 312

[:SOURce<hw>]:FREQuency:OFFSet <Offset>

Sets the frequency offset $f_{FREQ:OFFSet}$ of a downstream instrument.

The parameters offset $f_{FREQ:OFFSer}$ and multiplier $N_{FREQ:MULT}$ affect the frequency value set with the command FREQ.

The query FREQ? returns the value corresponding to the formula:

$f_{FREQ} = f_{RFout} * N_{FREQ:MULT} + f_{FREQ:OFFSer}$

See "RF frequency and level display with a downstream instrument" on page 310.

Note: The offset also affects RF frequency sweep.

Parameters:
<Offset> float

Increment: 0.01
*RST: 0

Example: See Example "Frequency configuration" on page 776

Manual operation: See "Offset" on page 312

[:SOURce<hw>]:FREQuency:CENTer <Center>

Sets the center frequency of the sweep.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Center> float

Range: 300 kHz to RFmax
Increment: 0.01 Hz
*RST: 300E6
Default unit: Hz

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Center Frequency" on page 343

[:SOURce<hw>]:FREQuency:SPAN <Span>

Sets the sapn of the frequency sweep range.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Span> float

Full freqeuncy range

Increment: 0.01
*RST: 400E6

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Span" on page 343

[:SOURce<hw>]:FREQuency:STARt <Start>

Sets the start frequency for the RF sweep.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Start> float

Range: 300kHz to RFmax
Increment: 0.01Hz
*RST: 100 MHz

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Start Frequency/Stop Frequency" on page 343

[:SOURce<hw>]:FREQuency:STOP <Stop>

Sets the stop frequency range for the RF sweep.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Stop> float

Range: 300kHz to RFmax
Increment: 0.01Hz
*RST: 500 MHz
Default unit: Hz

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Start Frequency/Stop Frequency" on page 343

[:SOURce<hw>]:FREQuency:STEP:MODE <Mode>

Defines the type of step size to vary the RF frequency at discrete steps with the commands `FREQ UP or FREQ DOWN`.

Parameters:

<Mode> DECimal | USER

DECimal
Increases or decreases the level in steps of ten.

USER
Increases or decreases the level in increments, set with the command `FREQ:STEP[:INCR]`.

*RST: DECimal

Example: See Example "Frequency configuration" on page 776.

Manual operation: See "Variation Active" on page 312

[:SOURce<hw>]:FREQuency:STEP[:INCRement] <Increment>

Sets the step width.

You can use this value to vary the RF frequency with command `FREQ UP or FREQ DOWN`.

If you have activated `FREQ:STEP:MODE USER`.

Note: This value also applies to the step width of the rotary knob on the instrument and, in user-defined step mode, increases or decreases the frequency.

Parameters:

<Increment> float

Range: 0 Hz to RFmax - 100 kHz
Increment: 0.01 Hz
*RST: 1E6

Example: See Example "Frequency configuration" on page 776

Manual operation: See "Variation Step" on page 312

14.16.7 SOURce:INPut subsystem

The `SOURce:INPut` subsystem contains the commands for configuring the inputs for external modulation signals. The instrument trigger setting influences all sweeps and is effective in the List mode (Instrument Trigger).

[:SOURce]:INPut:TRIGger:SLOPe 782

[:SOURce]:INPut:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an applied instrument trigger.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: `INP:TRIG:SLOP NEG`
Activates the falling slope of the external trigger signal at the trigger input.

Manual operation: See "Trigger Slope" on page 341

14.16.8 SOURce:IQ subsystem

The `SOURce:IQ` subsystem contains the commands for configuring the I/Q modulation.

Required options

See Section 7.1, "Required options", on page 302.

[:SOURce<hw>]:IQ:STATe 782
[:SOURce<hw>]:IQ:SWAP[:STATe] 783

[:SOURce<hw>]:IQ:STATe <State>

Enables the I/Q modulation.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `IQ:STAT ON`
Enables the I/Q modulation.

Manual operation: See "State" on page 303

[:SOURce<hw>]:IQ:SWAP[:STATe] <State>

Swaps the I and Q channel.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `IQ:SWAP ON`
swaps the I and Q channel.

Manual operation: See "I/Q Swap" on page 303

14.16.9 SOURce:IQ:OUTPut subsystem

The `SOURce:IQ:OUTPut` subsystem contains the commands for configuring digital I/Q output signals.

For information about the required options, see:

- "Required options" on page 275

14.16.9.1 SOURce:IQ:OUTPut:DIGital commands

This section describes the commands of the output of a digital I/Q signal.

Required options

See "Required options" on page 275.

Common suffixes

The following common suffixes are used in the remote commands:

Suffix	Value	Description
`CHANnel<st0>`	0	Option: R&S SMCVB-K19, fixed channel number `CHANnel0`

Example: Enabling and configuring the Dig. IQ HS x digital outputs

Option: R&S SMCVB-K19

```
SCONfiguration:OUTPut:MAPPing:DIGital:STReam1:STATe 1
SOURce1:IQ:OUTPut:DIGital:INTerface HSD
SOURce1:IQ:OUTPut:DIGital:STATe 1
SOURce1:IQ:OUTPut:DIGital:CHANnel0:NAME "CH0"
SOURce1:IQ:OUTPut:DIGital:CHANnel0:SRATe?
// Respons in Hz: "100000000"
```

```
// Query the peak power level of the channel.
SOURce1:IQ:OUTPut:DIGital:CHANnel0:POWer:PEP?
// Response in dBFS: "0"
SOURce1:IQ:OUTPut:DIGital:CHANnel0:PEP -20
// Query the RMS power level of the channel.
SOURce1:IQ:OUTPut:DIGital:CHANnel0:POWer:LEVel?
// Response in dBFS: "-20"
SOURce1:IQ:OUTPut:DIGital:CHANnel0:STATe 1
```

[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe....784
[:SOURce<hw>]:IQ:OUTPut:DIGital:INTerface....784
[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe....784
[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice?....785
[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA....785
[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:PEP....785
[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:LEVel....786
[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE....786
[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement]....786
[:SOURce<hw>]:IQ:OUTPut:DIGital:PON....787
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME....787
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe....787
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe....787
[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM?....788
[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX?....788

[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe <State>

Activates the digital I/Q signal output.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SOURce:IQ:OUTPut:DIGital:STATe ON
// activates the output connector
```

Manual operation: See "State" on page 277

[:SOURce<hw>]:IQ:OUTPut:DIGital:INTerface <BboutInterfMode>

Queries the connector at that the signal is output.

Parameters:

<BboutInterfMode> HSDin

HSDin
Dig. IQ HS x

*RST: HSDin

[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe <SRate>

Sets the sample rate of the digital I/Q output signal.

Parameters:

<SRate> float

Range: 400 to depends on options
Increment: 0.001
*RST: 1E8
Default unit: Hz
The maximum value depends on the connected receiving device. For more information, see data sheet.

Manual operation: See "Value" on page 277

[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice?

Queries information on the connected device.

Return values:

<CDevice> string

Example: `SOURce:IQ:OUTPut:DIGital:CDEVice?`

Usage: Query only

Manual operation: See "Connected Device" on page 277

[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA <Via>

Selects the respective level entry field for the I/Q output.

Parameters:

<Via> PEP | LEVel

*RST: PEP

Example: `SOURce:IQ:OUTPut:DIGital:POWer:VIA PEP`

Manual operation: See "Set Level Via" on page 280

[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:PEP <BboutPepHs>

Sets the peak level of the channel of the HS digital I/Q output signal.

The level is relative to full scale of 0.5 V (in terms of dB full scale).

Parameters:

<BboutPepHs> float

Range: -60 to 0
Increment: 0.01
*RST: 0

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Manual operation: See "Peak Level" on page 278

[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:LEVel <BboutHsLevel>

Sets the RMS level of the channel of the HS digital I/Q output signal.

The level is relative to full scale of 0.5 V (in terms of dB full scale).

Parameters:

<BboutHsLevel> float

Range: -60 to 0
Increment: 0.01
*RST: 0

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Manual operation: See "Level" on page 278

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE <Mode>

Defines the type of step size to vary the digital output power step by step.

Parameters:

<Mode> DECimal | USER

DECimal
Increases or decreases the level in steps of 10 dB.

USER
Increases or decreases the level in increments, determined with the command `[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement]`.

*RST: DECimal

Example:

```
SOURce:IQ:OUTPut:DIGital:POWer:STEP:MODE USER
SOURce:IQ:OUTPut:DIGital:POWer:STEP 5
// Activates the step width to vary the level in 5 dB steps.
```

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement] <Increment>

Sets the step width. Use this value to vary the digital I/Q output level step-by-step.

Parameters:

<Increment> float

Range: 0 to 100
Increment: 0.01
*RST: 1

Example: See `[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE` on page 786.

[:SOURce<hw>]:IQ:OUTPut:DIGital:PON <Pon>

Sets the power-on state of the selected digital I/Q output.

Parameters:
<Pon> OFF | UNCHanged
*RST: OFF

Example:
```
SOURce:IQ:OUTPut:DIGital:PON OFF
// Deactivates the output connector,
// when the instrument is switched on.
```

Manual operation: See "Power-On State" on page 280

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME <DigIqHsCHName>

Sets the channel name.

Parameters:
<DigIqHsCHName> string

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Options: R&S SMCVB-K19

Manual operation: See "Name" on page 278

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe <DigIqHsSratChan>

Sets the sample rate of the channel of the HS digital I/Q output signal.

Parameters:
<DigIqHsSratChan> float
Range: 400 to depends on options
Increment: 0.001
*RST: 100E6
The maximum value depends on the connected receiving device. For more information, see data sheet.

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Options: R&S SMCVB-K19

Manual operation: See "Sample Rate" on page 278

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe <DigIqHsOutChSta>

Activates the channel.

Parameters:
<DigIqHsOutChSta> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Options: R&S SMCVB-K19

Manual operation: See "Active" on page 279

[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM?
[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX?

Queries the maximum sample rate. The maximum value depends on the connected receiving device.

For more information, refer to the specifications document.

Return values:

<DigIqhsInSRMax> integer

Range: 400 to depends on connected device
*RST: depends on connected device

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 783.

Usage: Query only

Options: R&S SMCVB-K19

Manual operation: See "Aggregated Link Sample Rate" on page 279

14.16.10 SOURce:LIST subsystem

The `SOURce:LIST` subsystem contains all commands for defining lists and for handling of list files.

List files have the predefined file extension `*.lsw`.

Refer to Section 14.5.2, "Handling files in the default or in a specified directory", on page 591 for general information on file handling in the default and in a specific directory.

- `*RST` does not affect data lists.
- SCPI refers to the individual lists as segments.

Example: Create an RF list and activate the list mode

The following example shows a command sequence to create an RF list and to activate the list mode. Further hardware settings are not considered.

```
// Reset the instrument to start from an initial state
// Query the available list files in the default
// directory /var/user
// Select the list file or create it (if not existing)
*RST; *CLS
```

```
SOUR1:LIST:CAT?
// Response:- shows the name of available list files (if applicable)
SOUR1:LIST:SEL "/var/user/list1.lsw"

// Write the frequency/level/dwell time values in the selected list file
// existing data is overwritten
// Query the number of frequency/power/dwell time entries in the selected list
// Query the amount of free memory (in bytes) for list mode lists
SOUR1:LIST:FREQ 58 MHz, 61 MHz, 73 MHz, 86 MHz, 91 MHz, 92 MHz, 98 MHz
SOUR1:LIST:POW 13 dBm, 12 dBm, 5 dBm, 3 dBm, 0 dBm, 4 dBm, 6 dBm
SOUR1:LIST:DWEL:LIST 10000, 100000, 200000, 19000, 10000, 150000, 220000
SOUR1:LIST:FREQ:POIN?
// 7
SOUR1:LIST:POW:POINT?
// 7
SOUR1:LIST:DWEL:LIST:POIN?
// 7
SOUR1:LIST:FREE?
// 2147483647 (bytes of free memory)

// Use dwell times from list
// Configure the list mode parameters
// Enable RF output
SOUR1:LIST:MODE AUTO
SOUR1:LIST:TRIG:SOUR AUTO
SOUR1:LIST:DWEL:MODE "LIST"

OUTP1:STAT ON

// Use global dwell time
// Set only a part of the list (value pairs 3 to 5) to be processed
// Configure the list mode parameters using global dwell time
// Enable RF output
SOUR1:LIST:IND:START 2
SOUR1:LIST:IND:STOP 4
SOUR1:LIST:MODE AUTO
SOUR1:LIST:TRIG:SOUR AUTO
SOUR1:LIST:DWEL:LIST 500 ms
OUTP1:STAT ON

// Enable the list mode
// Trigger the list (depending on the mode, not needed with trigger
// mode AUTO); query the current index
// Reset the list to the starting point
SOUR1:FREQ:MODE LIST
SOUR1:LIST:TRIG:EXEC
SOUR1:LIST:RUNN?
SOUR1:LIST:IND?
// 3
// value changes when the value is queried again
SOUR1:LIST:RES
```

```
// For list mode STEP use the following commands
*RST; *CLS
// Change list mode to STEP
SOUR1:LIST:MODE STEP
// Activate RF Output1
OUTP1:STAT 1
// Activate the list mode
SOUR1:FREQ:MODE LIST
// For each step: select frequency/powerlevel pair as index from the list
SOUR1:LIST:IND 2
SOUR1:LIST:IND 3
SOUR1:LIST:IND 4

// Use the selected list for path B (with List Mode B default settings)
SOUR2:LIST:SEL "/var/user/list1.lsw"
OUTP2:STAT ON
SOUR2:FREQ:MODE LIST
SOUR2:LIST:IND?
// 2
// value canges when the value is queried again

// Deactivate the list mode
SOUR1:FREQ:MODE CW
```

Example: List mode data exchange

The following example shows a command sequence to export a list (here the RF list created with the example before) into an ASCII file. Further hardware settings are not considered.

```
*RST; *CLS
LIST:DEXC:MODE EXP

// Set ASCII data parameters
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
SOUR1:LIST:DEXC:AFIL:EXT CSV
SOUR1:LIST:DEXC:AFIL:SEP:DEC DOT
SOUR1:LIST:DEXC:AFIL:SEP:COL COMM

// Select source and destination path/directory
// Query available listfiles in default directory "/var/user"
SOUR1:LIST:CAT?
// list1
SOUR1:LIST:DEXC:AFIL:SEL "/var/user/list1ASCII"
SOUR1:LIST:DEXC:SEL "/var/user/list1"

// Export the list file data into the ASCII file
SOUR1:LIST:DEXC:EXEC
```

```
// Query the available ASCII files with extension .csv
SOUR1:LIST:DEXC:AFIL:CAT?
// Response: "list1ASCII"

// Deactivate the list mode
SOUR1:FREQ:MODE CW
```


- List mode settings 791
- List mode file operation 796
- List mode data exchange 799

14.16.10.1 List mode settings

With the following commands, you can create list mode data, select the trigger mode and determine the dwell time.

[:SOURce<hw>]:LIST:DWELl 791
[:SOURce<hw>]:LIST:DWELl:MODE 792
[:SOURce<hw>]:LIST:DWELl:LIST 792
[:SOURce<hw>]:LIST:DWELl:LIST:POINts? 792
[:SOURce<hw>]:LIST:FREQuency 793
[:SOURce<hw>]:LIST:FREQuency:POINts? 793
[:SOURce<hw>]:LIST:INDex 793
[:SOURce<hw>]:LIST:INDex:STARt 794
[:SOURce<hw>]:LIST:INDex:STOP 794
[:SOURce<hw>]:LIST:RMODe 794
[:SOURce<hw>]:LIST:MODE 794
[:SOURce<hw>]:LIST:POWer 795
[:SOURce<hw>]:LIST:POWer:POINts? 795
[:SOURce<hw>]:LIST:TRIGger:EXECute 795
[:SOURce<hw>]:LIST:TRIGger:SOURce 795
[:SOURce<hw>]:LIST:RUNNing? 796

[:SOURce<hw>]:LIST:DWELl <Dwell>

Sets the global dwell time. The instrument generates the signal with the frequency / power value pairs of each list entry for that particular period.

See also Significant parameters and functions.

Parameters:

<Dwell> float

Range: 0.5E-3 to 100
Increment: 1E-6
*RST: 0.01

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Global Dwell Time" on page 347

[:SOURce<hw>]:LIST:DWELl:MODE <DwelMode>

Selects the dwell time mode.

Parameters:

<DwelMode> LIST | GLOBal

LIST
Uses the dwell time, specified in the data table for each value pair individually.

GLOBal
Uses a constant dwell time, set with command `[:SOURce<hw>]:LIST:DWELl`.

*RST: GLOBal

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Dwell Time Mode" on page 347

[:SOURce<hw>]:LIST:DWELl:LIST <Dwell>

Enters the dwell time values in the selected list in µs.

Parameters:

<Dwell> <Dwell#1>{, <Dwell#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data. The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy. See also `:FORMat[:DATA]` on page 622 for more details.

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Edit List Mode Data" on page 353

[:SOURce<hw>]:LIST:DWELl:LIST:POINts?

Queries the number (points) of dwell time entries in the selected list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

[:SOURce<hw>]:LIST:FREQuency <Frequency>

Enters the frequency values in the selected list.

Parameters:

<Frequency> <Frequency#1>{, <Frequency#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data.
The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy.
See also `:FORMat[:DATA]`.

Range: 300 kHz to RFmax (depends on the installed options)

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Edit List Mode Data" on page 353

[:SOURce<hw>]:LIST:FREQuency:POINts?

Queries the number (points) of frequency entries in the seleced list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

[:SOURce<hw>]:LIST:INDex <Index>

Sets the list index in `LIST:MODE STEP`.

After the trigger signal, the instrument processes the frequency and level settings of the selected index.

Parameters:

<Index> integer

*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Current Index" on page 347

[:SOURce<hw>]:LIST:INDex:STARt <Start>
[:SOURce<hw>]:LIST:INDex:STOP <Stop>

Sets the start and stop index of the index range which defines a subgroup of frequency/level value pairs in the current list.

Parameters:

<Stop> integer

Index range
Only values inside this range are processed in list mode

Range: 0 to list length
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "List Range from/to" on page 349

[:SOURce<hw>]:LIST:RMODe <RMode>

Selects the run mode for processing the list.

Parameters:

<RMode> LIVE

LIVE
Generates the signal by processing the list directly.

*RST: LIVE

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Run Mode" on page 348

[:SOURce<hw>]:LIST:MODE <Mode>

Sets the list mode.

The instrument processes the list according to the selected mode and trigger source. See `LIST:TRIG:SOUR AUTO, SING or EXT` for the description of the trigger source settings.

Parameters:

<Mode> AUTO | STEP

AUTO
Each trigger event triggers a complete list cycle.

STEP
Each trigger event triggers only one step in the list processing cycle. The list is processed in ascending order.

*RST: AUTO

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Mode" on page 347

[:SOURce<hw>]:LIST:POWer <Power>

Enters the level values in the selected list. The number of level values must correspond to the number of frequency values. Existing data is overwritten.

Parameters:

<Power> <Power#1>{, <Power#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data.
The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy.
See also `:FORMat[:DATA]`.

Range: depends on the installed options
Default unit: dBm

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Edit List Mode Data" on page 353

[:SOURce<hw>]:LIST:POWer:POINts?

Queries the number (points) of level entries in the selected list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

[:SOURce<hw>]:LIST:TRIGger:EXECute

Starts the processing of a list in list mode.

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Event

Manual operation: See "Execute Single" on page 348

[:SOURce<hw>]:LIST:TRIGger:SOURce <Source>

Selects the trigger source for processing lists.

The designation of the parameters correspond to those in sweep mode. SCPI standard uses other designations for the parameters, which are also accepted by the instrument. The SCPI designation should be used if compatibility is an important consideration. For an overview, see the following table:

Rohde & Schwarz parameter	SCPI parameter	Applies to the list mode parameters:
AUTO	IMMediate	[:SOURce<hw>]:LIST:MODE AUTO
SINGle	BUS	[:SOURce<hw>]:LIST:MODE AUTO or [:SOURce<hw>]:LIST:MODE STEP
EXTernal	EXTernal	[:SOURce<hw>]:LIST:MODE AUTO or [:SOURce<hw>]:LIST:MODE STEP

Parameters:

<Source> AUTO | IMMediate | SINGle | BUS | EXTernal

AUTO|IMMediate
The trigger is free-running, i.e. the trigger condition is fulfilled continuously. The selected list is restarted as soon as it is finished.

SINGle|BUS
The list is triggered by the command [:SOURce<hw>]:LIST:TRIGger:EXECute. The list is executed once.

EXTernal
The list is triggered externally and executed once.

*RST: AUTO

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "Mode" on page 347

[:SOURce<hw>]:LIST:RUNNing?

Queries the current state of the list mode.

Return values:

<State> 1 | ON | 0 | OFF

1
Signal generation based on the list mode is active.

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

14.16.10.2 List mode file operation

The following section covers basic commands to file handling in list mode.

[:SOURce<hw>]:LIST:CATalog? 797
[:SOURce<hw>]:LIST:DELete 797
[:SOURce<hw>]:LIST:DELete:ALL 797
[:SOURce<hw>]:LIST:FREE? 798
[:SOURce<hw>]:LIST:RESet 798
[:SOURce<hw>]:LIST:SELect 798

[:SOURce<hw>]:LIST:CATalog?

Queries the available list files in the specified directory.

Return values:

<Catalog> string

List of list filenames, separated by commas

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

Manual operation: See "List Mode Data" on page 349

[:SOURce<hw>]:LIST:DELete <Filename>

Deletes the specified list.

Setting parameters:

<Filename> string

Filename or complete file path; file extension is optional.

Example: See `[:SOURce<hw>]:LIST:DELete:ALL` on page 797.

Usage: Setting only

Manual operation: See "List Mode Data" on page 349

[:SOURce<hw>]:LIST:DELete:ALL

Deletes all lists in the set directory.

This command can only be executed, if:

- No list file is selected.
- List mode is disabled.

Example:

```
SOUR1:LIST:CAT?
// list,my_list
SOUR1:LIST:DEL "/var/user/list1"
SOUR1:LIST:CAT?
// my_list
SOUR1:FREQ:MODE?
// LIST
SOUR1:LIST:SEL?
// /var/user/my_list.lsw
//deactivate list mode
SOUR1:FREQ:MODE CW
SOUR1:LIST:DELete:ALL
SOUR1:LIST:CAT?
// -
// all list files are deleted
```

Usage: Event

Manual operation: See "List Mode Data" on page 349

[:SOURce<hw>]:LIST:FREE?

Queries the amount of free memory (in bytes) for list mode lists.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Query only

[:SOURce<hw>]:LIST:RESet

Jumps to the beginning of the list.

Example: See Example "Create an RF list and activate the list mode" on page 788.

Usage: Event

Manual operation: See "Reset" on page 348

[:SOURce<hw>]:LIST:SELect <Filename>

Selects or creates a data list in list mode.

If the list with the selected name does not exist, a new list is created.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "Create an RF list and activate the list mode" on page 788.

Manual operation: See "List Mode Data" on page 349

14.16.10.3 List mode data exchange

With the following commands, you can configure lists in ASCII format and export or import them accordingly.

[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog? 799
[:SOURce<hw>]:LIST:DEXChange:EXECute 799
[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal 800
[:SOURce<hw>]:LIST:DEXChange:MODE 801
[:SOURce<hw>]:LIST:DEXChange:SELect 801

[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?

Queries the available ASCII files for export or import of list mode data in the current or specified directory.

Return values:

<Catalog> string

List of ASCII files `*.txt` or `*.csv`, separated by commas.

Example: See Example "List mode data exchange" on page 790.

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 351

[:SOURce<hw>]:LIST:DEXChange:EXECute

Executes the import or export of the selected list file, according to the previously set transfer direction with command `[:SOURce<hw>]:LIST:DEXChange:MODE`

Example: See Example "List mode data exchange" on page 790.

Usage: Event

Manual operation: See "Import / Export" on page 351

[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension <Extension>

Determines the extension of the ASCII file for import or export, or to query existing files.

Parameters:

<Extension> TXT | CSV

*RST: TXT

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 351

[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn <Column>

Selects the separator between the frequency and level column of the ASCII table.

Parameters:

<Column> TABulator | SEMicolon | COMMa | SPACe

*RST: COMMa

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal <Decimal>

Sets "." (decimal point) or "," (comma) as the decimal separator used in the ASCII data with floating-point numerals.

Parameters:

<Decimal> DOT | COMMa

*RST: DOT

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "ASCII File Settings" on page 350

[:SOURce<hw>]:LIST:DEXChange:MODE <Mode>

Determines the import or export of a list.

Specify the source or destination file with the command `[:SOURce<hw>]:LIST:DEXChange:SELect`.

Parameters:

<Mode> IMPort | EXPort

*RST: IMPort

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "Mode" on page 350

[:SOURce<hw>]:LIST:DEXChange:SELect <Filename>

Selects the ASCII file for import or export, containing a list.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "List mode data exchange" on page 790.

Manual operation: See "Select Source/Select ASCII Destination" on page 351

14.16.11 SOURce:PHASe subsystem

This subsystem contains the commands for adjusting the phase of the RF output signal relative to a reference signal of the same frequency.

Example: Programming Example

```
// change the phase relative to the current phase
SOURce1:PHASe 2 DEG
// adopt the setting as the current phase
SOURce1:PHASe:REFerence
```

The following commands are available:

[:SOURce<hw>]:PHASe 801
[:SOURce<hw>]:PHASe:REFerence 802

[:SOURce<hw>]:PHASe <Phase>

Sets the phase variation relative to the current phase.

Parameters:

<Phase> float

Range: -36000 to 36000
Increment: 0.001
*RST: 0
Default unit: DEG

Example: See Example "Programming Example" on page 801.

Manual operation: See "Delta Phase" on page 316

[:SOURce<hw>]:PHASe:REFerence

Example: See Example "Programming Example" on page 801.

Usage: Event

Manual operation: See "Reset Delta Phase Display" on page 317

14.16.12 SOURce:POWer subsystem

The `SOURce:POWer` subsystem contains the commands for setting the output level, level control and level correction of the RF signal.

The default units are dBm. To change the units, perform one of the following:

- Enter the unit after the numerical value
  Example: `:POW 0.5V`
- Set the unit with the command `:UNIT:POWer`.

Example: Power configuration

```
SOURce1:POWer;CW?
// Response -30
SOURce1:POWer:CW -25
SOURce1:POWer:OFFSet?
// Response 0
SOURce1:POWer:OFFSet 2

SOURce1:POWer:STEP:MODE?
// Response: DEC
SOURce1:POWer:STEP:MODE USER
SOURce1:POWer:STEP:INCRement 2
SOURce1:POWer:LEVel:IMMediate:AMPLitude UP
```

Example: Configure the settings for NRP power control

The example shows a command sequence to configure the parameters for a closed loop power control setup. It is assumed that you have set up the measurement with the amplifier, external coupler, the power sensor and the R&S SMCV100B as described in Section 8.10.3.3, "NRP power control", on page 376.

```
// Reset the instrument to start from an initial state
*RST; *CLS

// Select the sensor used for nrp power control
// that is e.g., connected to a second USB interface

SOURce1:POWer:SPC:SELect SENS2

// Configure the nrp power control settings
// use the measured peak power for power control
// set the unit dBm for the target level value
// set the target level, e.g. - 10 dBmM
// use the measured target level as reference level
// select single measurement mode to acquire one level value
// set the capture range for the control loop, e.g.  +/- 15 dB
// set a time delay between the sensor readings, e.g. 2 ms

SOURce1:POWer:SPC:PEAK ON
SENSe1:UNIT:POWer DMB
SOURce1:POWer:SPC:TARGet -10
SOURce1:POWer:SPC:MEASure
SOURce1:POWer:SPC:MODE SINGle
SOURce1:POWer:SPC:CRANge 15
SOURce1:POWer:SPC:DELay 2 ms

// Enable NRP power control measurement
// switch on RF output
// start the single measurement manually

Output1:STATe 1
SOURce1:POWer:SPC:STATe ON
SOURce1:POWer:SPC:SINGle

// Query if the power control works properly
:SOURce1:POWer:SPC:WARNing?
// Response: 1 -> power conrol doew not work as expected
```

[:SOURce<hw>]:POWer:ALC:SONCe 804
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE 804
[:SOURce<hw>]:POWer:EMF:STATe 805
[:SOURce<hw>]:POWer:LBEHaviour 805
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] 805
[:SOURce<hw>]:POWer:MANual 805
[:SOURce<hw>]:POWer:MODE 806
[:SOURce<hw>]:POWer:PEP? 806
[:SOURce<hw>]:POWer:POWer 807
[:SOURce<hw>]:POWer:STARt 807
[:SOURce<hw>]:POWer:STOP 807
[:SOURce<hw>]:POWer:SPC:CRANge 808
[:SOURce<hw>]:POWer:SPC:DELay 808

[:SOURce<hw>]:POWer:SPC:MEASure 808
[:SOURce<hw>]:POWer:SPC:MODE 808
[:SOURce<hw>]:POWer:SPC:PEAK 809
[:SOURce<hw>]:POWer:SPC:SELect 809
[:SOURce<hw>]:POWer:SPC:SINGle 809
[:SOURce<hw>]:POWer:SPC:STATe 809
[:SOURce<hw>]:POWer:SPC:TARGet 810
[:SOURce<hw>]:POWer:SPC:WARNing? 810
[:SOURce<hw>]:POWer:STEP:MODE 810
[:SOURce<hw>]:POWer:STEP[:INCRement] 811
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet 811
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL 812
[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] 812
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel 813
[:SOURce<hw>]:POWer:RANGe:LOWer? 813
[:SOURce<hw>]:POWer:RANGe:UPPer? 813
[:SOURce]:POWer:WIGNore 813

[:SOURce<hw>]:POWer:ALC:SONCe

Activates level control for correction purposes temporarily.

Example: `POW:ALC OFF`
Deactivates automatic level control at the RF output.
`POW:ALC:SONC`
Executes level control (once).

Usage: Event

Manual operation: See "Readjust" on page 315

[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE <Mode>

Selects the state the attenuator is to assume if the RF signal is switched off.

Parameters:

<Mode> UNCHanged | FATTenuation

FATTenuation
The step attenuator switches to maximum attenuation

UNCHanged
Retains the current setting and keeps the output impedance constant during RF off.

*RST: n.a. (factory preset: FATTenuation)

Example: `SOURce1:POWer:ATTenuation:RFOFf:MODE FATTenuation`
uses maximum attenuation when the RF output is turned off.

Manual operation: See "RF OFF Mode" on page 359

[:SOURce<hw>]:POWer:EMF:STATe <State>

Displays the signal level as voltage of the EMF. The displayed value represents the voltage over a 50 Ohm load.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example: `POW:EMF:STAT 1`
Activates voltage level display.

Manual operation: See "Display Level as Voltage of EMF" on page 455

[:SOURce<hw>]:POWer:LBEHaviour <Behaviour>

Set the RF level behaviour.

Parameters:

<Behaviour> AUTO | UNINterrupted

UNINterrupted
Do not use the uninterrupted level settings in combination with the high-quality optimization mode (see `[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 764)

*RST: AUTO

Example: `SOURce1:POWer:LBEHaviour AUTO`

Manual operation: See "Setting Characteristics" on page 315

[:SOURce<hw>]:POWer:LIMit[:AMPLitude] <Amplitude>

Limits the maximum RF output level in CW and sweep mode.

It does not influence the "Level" display or the response to the query `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

Parameters:

<Amplitude> float

Range: depends on the installed options
Increment: 0.01
*RST: n.a. (factory preset: 30)

Example: `SOURce1:POWer:LIMit:AMPLitude 10`

Manual operation: See "Limit" on page 314

[:SOURce<hw>]:POWer:MANual <Manual>

Sets the level for the subsequent sweep step if `SWE:POW:MODE MAN`.

Use a separate command for each sweep step.

Parameters:

<Manual> float

You can select any level within the setting range, where:
`STARt` is set with `[:SOURce<hw>]:POWer:STARt`
`STOP` is set with `[:SOURce<hw>]:POWer:STOP`
`OFFSet` is set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Range: (STARt + OFFSet) to (STOP + OFFSet)
Increment: 0.01
Default unit: dBm

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Current Level" on page 339

[:SOURce<hw>]:POWer:MODE <Mode>

Selects the operating mode of the instrument to set the output level.

Parameters:

<Mode> CW | FIXed | SWEep

CW|FIXed
Operates at a constant level.
`CW` and `FIXed` are synonyms.
To set the output level value, use the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

SWEep
Sets sweep mode.
Set the range and current level with the commands:
`[:SOURce<hw>]:POWer:STARt` and `[:SOURce<hw>]:POWer:STOP`,
`[:SOURce<hw>]:POWer:MANual`.

*RST: CW

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "State (RF level sweep)" on page 338

[:SOURce<hw>]:POWer:PEP?

Queries the PEP "**P**eak **E**nvelope **P**ower) of digital modulation or digital standards at the RF output. This value corresponds to the level specification, displayed in the status bar (header).

Return values:

<Pep> float

Example: POW:PEP?
Response: "4"
The PEP value of digital modulation is 4 dBm at the RF output.

Usage: Query only

Manual operation: See "PEP" on page 309

[:SOURce<hw>]:POWer:POWer <Power>

Sets the level **at the RF output** connector.

This value does not consider a specified offset.

The command [:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] sets the level of the "Level" display, that means the level containing offset.

See "RF frequency and level display with a downstream instrument" on page 310.

Parameters:

<Power> float

Level at the RF output, without level offset

Range: See specifications document.
Increment: 0.01
Default unit: dBm

Example:
```
SOURce1:POWer:POWer 15
// sets the level at the RF output.
```

Manual operation: See "Amplitude" on page 314
See "Generator Settings used for Measurement" on page 369

[:SOURce<hw>]:POWer:STARt <Start>
[:SOURce<hw>]:POWer:STOP <Stop>

Sets the RF start/stop level in sweep mode.

Parameters:

<Stop> float

Sets the setting range calculated as follows:
(Level_min + OFFSet) to (Level_max + OFFSet)
Where the values are set with the commands:
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet
[:SOURce<hw>]:POWer:STARt
[:SOURce<hw>]:POWer:STOP

Range: Minimum level to maximum level
*RST: -30 (Start)/ -10 (Stop)
Default unit: dBm

Example: See Example "Setup an RF frequency or power sweep" on page 818

Manual operation: See "Start Level / Stop Level" on page 344

[:SOURce<hw>]:POWer:SPC:CRANge <PowCntrlCRange>

Defines the capture range of the power control system.

Within the range:

Target Level +/- Catch Range

the power control locks and tries to achieve the target level. Readings outside the range are not considered.

Parameters:

<PowCntrlCRange> float

Range: 0 to 50
Increment: 0.01
*RST: 30

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "Catch Range +/-" on page 379

[:SOURce<hw>]:POWer:SPC:DELay <PowCntrlDelay>

Sets a waiting time for the generator to adjust the output level. After the delay time has elapsed, the power sensor measures the next value.

Parameters:

<PowCntrlDelay> integer

Range: 0 to 1000
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "Delay Time" on page 380

[:SOURce<hw>]:POWer:SPC:MEASure

Sets the measured power value as reference level.

Example: See Example "Configure the settings for NRP power control" on page 802

Usage: Event

Manual operation: See "Take Measurement as Target Level" on page 379

[:SOURce<hw>]:POWer:SPC:MODE <ControlMode>

Selects the measurement mode for the power sensor.

Parameters:

<ControlMode> AUTO | SINGle

AUTO
Measures the level values continuously.

SINGle
Executes one measurement, triggered by the command [:SOURce<hw>]:POWer:SPC:SINGle on page 809.

*RST: AUTO

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "Mode" on page 379

[:SOURce<hw>]:POWer:SPC:PEAK <PowCntrlPeak>

Activates power control by means of the peak power values, provided the power sensor supports this function.

Parameters:
<PowCntrlPeak> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 802

[:SOURce<hw>]:POWer:SPC:SELect <PowCntrlSelect>

Selects the power sensor used for power control.

Parameters:
<PowCntrlSelect> SENS1 | SENS2 | SENS3 | SENS4 | SENSor1 | SENSor2 | SENSor3 | SENSor4
*RST: SENS1

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "Sensor" on page 378

[:SOURce<hw>]:POWer:SPC:SINGle

Triggers the power sensor to measure the power value once.

Usage: Event

Manual operation: See "Execute Single" on page 379

[:SOURce<hw>]:POWer:SPC:STATe <PowCntrlState>

Starts power control using the selected sensor. The control loop periodically adjusts the output level of the signal generator. After switching off, the running loop is completed.

Parameters:
<PowCntrlState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "State" on page 378

[:SOURce<hw>]:POWer:SPC:TARGet <PowCntrlTarget>

Sets the target level required at the DUT. To define the unit of the power value, use command `:UNIT:POWer` on page 863.

Parameters:
<PowCntrlTarget> float
Range: -50 to 30
Increment: 0.01
*RST: -10

Example: See Example "Configure the settings for NRP power control" on page 802

Manual operation: See "Target Level" on page 379

[:SOURce<hw>]:POWer:SPC:WARNing?

Queries if the activated power control works properly.

If the power control does not work, the query returns warning state 1. On the screen, the R&S SMCV100B indicates a warning icon.

Return values:
<WarningState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 802.

Usage: Query only

[:SOURce<hw>]:POWer:STEP:MODE <Mode>

Defines the type of step width to vary the RF output power step-by-step with the commands `POW UP or POW DOWN`.

Parameters:
<Mode> DECimal | USER

DECimal
Increases or decreases the level in steps of ten.

USER
Increases or decreases the level in increments, determined with the command `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

*RST: DECimal

Example: See Example "Power configuration" on page 802.

Manual operation: See "Variation Active" on page 312

[:SOURce<hw>]:POWer:STEP[:INCRement] <Increment>

Specifies the step width in the appropriate path for `POW:STEP:MODE USER`.

To adjust the level step-by-step with this increment value, use the command `POW UP, or POW DOWN`.

Parameters:
<Increment> float

Range: 0 to 200
Increment: 0.01
*RST: 1
Default unit: dB

Example: See Example "Power configuration" on page 802.

Manual operation: See "Variation Step" on page 312

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

Sets the level offset of a downstream instrument.

The level at the RF output is not changed.

To query the resulting level, as it is at the output of the downstream instrument, use the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

See "RF frequency and level display with a downstream instrument" on page 310.

Note: The level offset also affects the RF level sweep.

Parameters:
<Offset> float

Range: -200 to 200
Increment: 0.01
*RST: 0
Default unit: dB
Level offset is always expreced in dB; linear units (V, W, etc.) are not supported

Example: `POWer:OFFSet 10`
Sets the RF level offset to 10 dB

Manual operation: See "Offset" on page 314
See "Generator Settings used for Measurement" on page 369

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL <Rcl>

Determines whether the current level is retained or if the stored level setting is adopted when an instrument configuration is loaded.

Parameters:

<Rcl> INCLude | EXCLude

INCLude
Takes the current level when an instrument configuration is loaded.

EXCLude
Retains the current level when an instrument configuration is loaded.

*RST: INCLude

Example: `POW:RCL INCL`
Takes the level value from an instrument configuration loaded with command `*RCL`.

Manual operation: See "Exclude Level" on page 430

[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] <Amplitude>

Sets the RF level applied to the DUT.

To activate the RF output use command `:OUTPut<hw>[:STATe]` ("RF On"/"RF Off").

The following applies `POWer = RF output level + OFFSet`, where:

- `POWer` is the values set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`
- RF output level is set with `[:SOURce<hw>]:POWer:POWer`
- `OFFSet` is set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Parameters:

<Amplitude> float

The following settings influence the value range:
`OFFSet` set with the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Numerical value
Sets the level

UP|DOWN
Varies the level step by step.
The level is increased or decreased by the value set with the command `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

Range: (Level_min + OFFSet) to (Level_max + OFFStet)
*RST: -30
Default unit: dBm

Example: `POWer -30`
Sets the RF level

Example: See also [:SOURce<hw>]:POWer:STEP:MODE on page 810.

Manual operation: See "Amplitude" on page 314

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel <ReferenceLevel>

Queries the reference level of the user correction.

The reference level is the sum of the amplitude and the level offset, set with the commands [:SOURce<hw>]:POWer:POWer [:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet.

Parameters:

<ReferenceLevel> float

Range: -245 to 120
Increment: 0.01
*RST: -30

Manual operation: See "Generator Settings used for Measurement" on page 369

[:SOURce<hw>]:POWer:RANGe:LOWer?
[:SOURce<hw>]:POWer:RANGe:UPPer?

Queries the current interruption-free range of the level.

Return values:

<Upper> float

Increment: 0.01
Default unit: dBm

Example:

```
SOURce1:POWer:RANGe:UPPer?
// -15
SOURce1:POWer:RANGe:LOW?
// -50
```

Usage: Query only

Manual operation: See "Level Range" on page 315

[:SOURce]:POWer:WIGNore <State>

Ignores level range warnings.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example:

```
SOURce:POWer:WIGNore 1
```

14.16.13 SOURce:ROSCillator subsystem

The `SOURce:ROSCillator` subsystem contains the commands for setting the external and internal reference frequency.

Example: Configuring the reference oscillator

```
// Using 10 MHz external reference source
SOURce:ROSCillator:SOURce EXT
SOURce:ROSCillator:EXTernal:RFOFf:STATe 1
SOURce:ROSCillator:EXTernal:FREQuency?
// Response: 10MHZ
SOURce:ROSCillator:EXTernal:SBANdwidth WIDE
SOURce:ROSCillator:INTernal:ADJust:STATe 0

// Query calibration value
CALibration:ROSCillator?
// 32767
// Set an internal source
// Activate user-defined adjustment value of 1000
SOURce:ROSCillator:SOURce INT
SOURce:ROSCillator:INTernal:ADJust:STATe 1
SOURce:ROSCillator:INTernal:ADJust:VALue 1000

// to resume calibrated state
SOURce:ROSCillator:INTernal:ADJust:VALue 0
SOURce:ROSCillator:INTernal:ADJust:STATe 0
// or
// SYSTem:FPRest
```

[:SOURce]:ROSCillator:PRESet 814
[:SOURce]:ROSCillator:SOURce 815
[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe] 815
[:SOURce]:ROSCillator:EXTernal:FREQuency 815
[:SOURce]:ROSCillator:EXTernal:SBANdwidth 815
[:SOURce]:ROSCillator:EXTernal:MLRange? 816
[:SOURce]:ROSCillator:EXTernal:NSBandwidth? 816
[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE 816
[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue 817
[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] 817

[:SOURce]:ROSCillator:PRESet

Resets the reference oscillator settings.

Example: See Example "Configuring the reference oscillator" on page 814.

Usage: Event

Manual operation: See "Set to Default" on page 318

[:SOURce]:ROSCillator:SOURce <Source>

Selects between internal or external reference frequency.

Parameters:
<Source> INTernal | EXTernal
*RST: n.a. (factory preset: INTernal)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "Source" on page 318

[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe] <State>

Determines that the RF output is turned off when the external reference signal is selected, but missing.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "Deactivate RF Output (if external reference is missing)" on page 319

[:SOURce]:ROSCillator:EXTernal:FREQuency <Frequency>

Sets the frequency of the external reference.

Parameters:
<Frequency> 10MHZ | 13MHZ
*RST: n.a. (factory preset: 10MHZ)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "External Reference Frequency" on page 319

[:SOURce]:ROSCillator:EXTernal:SBANdwidth <SBandwidth>

Selects the synchronization bandwidth for the external reference signal.

Depending on the RF hardware version and the installed options, the synchronization bandwidth varies.

For more information, refer to the specifications document.

Parameters:
<SBandwidth> WIDE | NARRow

NARRow
The synchronization bandwidth is a few Hz.

WIDE
Uses the widest possible synchronization bandwidth.

*RST: n.a. (factory preset: WIDE)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "Synchronization Bandwidth" on page 319

[:SOURce]:ROSCillator:EXTernal:MLRange?

Queries the minimum locking range for the selected external reference frequency.

Depending on the RF hardware version, and the installed options, the minimum locking range vaies.

For more information, refer to the specifications document.

Return values:
<MinLockRange> string

Example: `SOUR:ROSC:EXT:MLR?`

Usage: Query only

Manual operation: See "Minimum Locking Range" on page 320

[:SOURce]:ROSCillator:EXTernal:NSBandwidth?

Queries the nominal synchronization bandwidth for the selected external reference frequency and synchronization bandwidth.

Return values:
<NomBandwidth> string

Example: `SOUR:ROSC:EXT:NSB?`

Usage: Query only

Manual operation: See "Nominal Synchronization Bandwidth" on page 320

[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE <OutpFreqMode>

Selects the mode for the output reference frequency.

Parameters:
<OutpFreqMode> DER10M | OFF | LOOPthrough

OFF
Disables the output.

DER10M
Sets the output reference frequency to 10 MHz.
The reference frequency is derived from the internal reference frequency.

LOOPthrough
Forwards the input reference frequency to the reference frequency output.

*RST: n.a. (factory preset: DER10M)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "Reference Output" on page 321

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue <Value>

Specifies the frequency correction value (adjustment value).

Parameters:

<Value> integer

*RST: 0

Example: See `[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]` on page 817

Manual operation: See "Adjustment Value" on page 322

[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] <State>

Determines whether the calibrated (off) or a user-defined (on) **adjustment value** is used for fine adjustment of the frequency.

Parameters:

<State> 1 | ON | 0 | OFF

0
Fine adjustment with the calibrated frequency value

1
User-defined adjustment value.
The instrument is no longer in the calibrated state.
The calibration value is, however, not changed. The instrument resumes the calibrated state if you send `SOURce:ROSCillator:INTernal:ADJust:STATe 0`.

*RST: n.a. (factory preset: 0)

Example: See Example "Configuring the reference oscillator" on page 814.

Manual operation: See "Adjustment Active" on page 321

14.16.14 SOURce:SWEep subsystem

The `SOURce:SWEep` subsystem contains the commands for configuring RF sweep signals.

- The keyword [:FREQuency] can be omitted, then the commands are SCPI-compliant.
- To activate an RF sweep mode, use the following commands:
  - RF frequency sweep: SOURce:FREQuency:MODE SWEep (SOURce:FREQuency:MODE CW (off))
  - RF level sweep:SOURce:POWer:MODE SWEep (SOURce:POWer:MODE CW (off))
  - RF combined sweep: SOURce:FREQuency:MODE SWEep (SOURce:FREQuency:MODE CW (off)
- All sweeps can be set independently of each other.

See Section 8.9.1, "Signal generation and triggering in the sweep and list modes", on page 324.

Example: Setup an RF frequency or power sweep

The following example shows a command sequence to set up an RF frequency sweep, triggered by the execute command. For an RF power sweep, replace FREQuency in the SWEep commands with POWer.

Exceptions are the power spacing (defined with LINear only) and the power step width (defined with LOGarithmic only).

```
// Reset the instrument to start from an initial state
// Switch off display update to improve performance
// (especially with short dwell times)
// Set the sweep mode (first two commands) and the sweep range
// Select linear spacing
// Select the waveform shape for the frequency sweep
*RST; *CLS
SYSTem:DISPlay:UPDate OFF
TRIGger1:FSWeep:SOURce SINGle
SOURce1:SWEep:FREQuency:MODE AUTO
SOURce1:FREQuency:SPAN 300 MHz
SOURce1:FREQuency:CENTer 200 MHz
// Alternatively use
// SOURce1:FREQuency:STARt 50 MHz
// SOURce1:FREQuency:STOP 350 MHz
SOURce1:SWEep:FREQuency:SPACing LINear
SOURce1:SWEep:FREQuency:SHAPe SAWTooth

// Activate change to start frequency while waiting for next trigger
// Prerequisites: sweep mode single and sweep waveform sawtooth
SOURce1:SWEep:FREQuency:RETRace 1
// Alternatively reset all sweeps to their initial value
SOURce1:SWEep:RESet:ALL

// Set the step width and dwell time
SOURce1:SWEep:FREQuency:STEP:LINear 1 MHz
```

```
// Alternatively set the number of steps, then the sweep step width is
// set automatically
SOURce1:SWEep:FREQuency:POINts 301
SOURce1:SWEep:FREQuency:DWELl 500 ms
// With logarithmic spacing select the step width as follows
// (steps of 10 percent of the previous frequency in each instance)
SOURce1:SWEep:FREQuency:SPACing LOG
SOURce1:SWEep:FREQuency:STEP:LOGarithmic 10PCT

// Activate the sweep
// Trigger the sweep (depending on the set mode) and query the status
SOURce1:FREQuency:MODE SWEep
// Perform a one-off RF frequency sweep
SOURce1:SWEep:FREQuency:EXECute
SOURce1:SWEep:FREQuency:RUNNing?
// 1
// the frequency sweep is running

// For manual step RF sweep use the following commands
*RST; *CLS
// Activate manual step RF sweep
SOURce1:SWEep:FREQuency:MODE MANual
// Activate the RF frequency sweep.
SOURce1:FREQuency:MODE SWEep
// Activate RF Output1.
Output1:STATe 1
// Input the frequency manually for each step
SOURce1:FREQuency:MANual 200 MHz
SOURce1:FREQuency:MANual 201 MHz
// Alternatively use the UP or DOWN commands with the set step width.
SOURce1:SWEep:FREQuency:STEP:LINear 1 MHz
SOURce1:FREQuency:MANual UP
```

[:SOURce<hw>]:SWEep:POWer:DWELl....820
[:SOURce<hw>]:SWEep:POWer:MODE....820
[:SOURce<hw>]:SWEep:POWer:POINts....820
[:SOURce<hw>]:SWEep:POWer:SPACing:MODE?....821
[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic]....821
[:SOURce<hw>]:SWEep[:FREQuency]:DWELl....821
[:SOURce<hw>]:SWEep[:FREQuency]:MODE....822
[:SOURce<hw>]:SWEep[:FREQuency]:POINts....822
[:SOURce<hw>]:SWEep[:FREQuency]:SPACing....822
[:SOURce<hw>]:SWEep:POWer:SHAPe....823
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe....823
[:SOURce<hw>]:SWEep:POWer:EXECute....823
[:SOURce<hw>]:SWEep[:FREQuency]:EXECute....823
[:SOURce<hw>]:SWEep:POWer:RETRace....824
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace....824
[:SOURce<hw>]:SWEep:POWer:RUNNing?....824
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing?....824

[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic 824
[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] 824
[:SOURce<hw>]:SWEep:RESet[:ALL] 825

[:SOURce<hw>]:SWEep:POWer:DWELl <Dwell>

Sets the dwell time for a level sweep step.

Parameters:

<Dwell> float

Range: 10E-3 to 100
Increment: 100E-6
*RST: 10E-3
Default unit: s

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Dwell Time" on page 341

[:SOURce<hw>]:SWEep:POWer:MODE <Mode>

Sets the cycle mode for the level sweep.

Parameters:

<Mode> AUTO | MANual | STEP

AUTO
Each trigger triggers exactly one complete sweep.

MANual
The trigger system is not active. You can trigger every step individually with the command `[:SOURce<hw>]:POWer:MANual`. The level value increases at each step by the value that you define with `[:SOURce<hw>]:POWer:STEP[:INCRement]`. Values directly entered with the command `[:SOURce<hw>]:POWer:MANual` are not taken into account.

STEP
Each trigger triggers one sweep step only. The level increases by the value entered with `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

*RST: AUTO

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Mode" on page 339

[:SOURce<hw>]:SWEep:POWer:POINts <Points>

Sets the number of steps within the RF level sweep range.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Points> integer

Range: 2 to Max

Example: See Example "Setup an RF frequency or power sweep" on page 818.

[:SOURce<hw>]:SWEep:POWer:SPACing:MODE?

Queries the level sweep spacing. The sweep spacing for level sweeps is always linear.

Return values:

<Mode> LINear

*RST: LINear

Example: `SWE:POW:SPAC:MODE?`
queries the sweep spacing for a level sweep at RF output.
Result: `"LIN"`
linear spacing

Usage: Query only

[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic] <Logarithmic>

Sets a logarithmically determined step size for the RF level sweep. The level is increased by a logarithmically calculated fraction of the current level.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:

<Logarithmic> float

The unit `dB` is mandatory.

Range: 0.01 to 139 dB
Increment: 0.01
*RST: 1
Default unit: dB

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Step" on page 345

[:SOURce<hw>]:SWEep[:FREQuency]:DWELl <Dwell>

Sets the dwell time for a frequency sweep step.

Parameters:

<Dwell> float

Range: 1E-3 to 100
Increment: 100E-6
*RST: 10E-3
Default unit: s

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Dwell Time" on page 341

[:SOURce<hw>]:SWEep[:FREQuency]:MODE <Mode>

Sets the cycle mode for the frequency sweep.

Parameters:

<Mode> AUTO | MANual | STEP

AUTO
Each trigger event triggers exactly one complete sweep.

MANual
The trigger system is not active. You can trigger every step individually by input of the frequencies with the command `[:SOURce<hw>]:FREQuency:MANual`.

STEP
Each trigger event triggers one sweep step. The frequency increases by the value entered with `[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]` (linear spacing) or `[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic` (logarithmic spacing).

*RST: AUTO

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Mode" on page 339

[:SOURce<hw>]:SWEep[:FREQuency]:POINts <Points>

Sets the number of steps within the RF frequency sweep range.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Two separate `POINts` values are used for linear or logarithmic sweep spacing (`[:SOURce<hw>]:SWEep[:FREQuency]:SPACing LIN | LOG`). The command always affects the currently set sweep spacing.

Parameters:

<Points> integer

Range: 2 to Max

Example: See Example "Setup an RF frequency or power sweep" on page 818.

[:SOURce<hw>]:SWEep[:FREQuency]:SPACing <Spacing>

Selects the mode for the calculation of the frequency intervals, with which the current frequency at each step is increased or decreased.

The keyword [:FREQuency] can be omitted; then the command is SCPI-compliant.

Parameters:

<Spacing> LINear | LOGarithmic

LINear
Sets a fixed frequency value as step width and adds it to the current frequency.
The linear step width is entered in Hz, see [:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear].

LOGarithmic
Sets a constant fraction of the current frequency as step width and adds it to the current frequency.
The logarithmic step width is entered in %, see [:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic.

*RST: LINear

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Spacing" on page 341

[:SOURce<hw>]:SWEep:POWer:SHAPe <Shape>
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe <Shape>

Determines the waveform shape for a frequency sweep sequence.

Parameters:

<Shape> SAWTooth | TRIangle

*RST: SAWTooth

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Shape" on page 339

[:SOURce<hw>]:SWEep:POWer:EXECute
[:SOURce<hw>]:SWEep[:FREQuency]:EXECute

Executes an RF frequency sweep.

The command performs a single sweep and is therefore only effective in manual sweep mode.

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Usage: Event

Manual operation: See "Execute Single Sweep" on page 341

[:SOURce<hw>]:SWEep:POWer:RETRace <State>
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace <State>

Activates that the signal changes to the start frequency value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Retrace" on page 339

[:SOURce<hw>]:SWEep:POWer:RUNNing?
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing?

Queries the current sweep state.

Return values:
<State> 1 | ON | 0 | OFF

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Usage: Query only

[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic <Logarithmic>

Sets a logarithmically determined step width for the RF frequency sweep. The value is added at each sweep step to the current frequency.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Parameters:
<Logarithmic> float
The unit is mandatory.
Range: 0.01 to 100
Increment: 1E-3
*RST: 1
Default unit: PCT

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Step Linear/Step Logarithmic" on page 343

[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] <Linear>

Sets the step width for linear sweeps.

See Section 8.9.2.1, "Correlating parameters in sweep mode", on page 331.

Omit the optional keywords so that the command is SCPI-compliant.

Parameters:

<Linear> float

Range: 0.001 Hz to (STOP - STARt)
Increment: 0.01

Example: See Example "Setup an RF frequency or power sweep" on page 818.

Manual operation: See "Step Linear/Step Logarithmic" on page 343

[:SOURce<hw>]:SWEep:RESet[:ALL]

Resets all active sweeps to the starting point.

Usage: Event

Manual operation: See "Reset Sweep" on page 341

14.17 SYSTem subsystem

The `SYSTem` subsystem contains a series of commands for general functions which do not directly affect signal generation.

Example: Retrieving instrument specification

Note: The following values are merely an example.

```
// Retrieve information on data sheet versions.
// Query all data sheet versions saved on the instrument:
SYSTem:SPECification:VERSion:CATalog?
"04.03,04.02,04.01,04.00,03.04,03.03,03.02,03.01,03.00,02.96,02.95,02.94,
02.02,02.01,02.00,01.03,01.02,01.01,01.00"

// Query the initial data sheet version on delivery
SYSTem:SPECification:VERSion:FACTory?
// Response: "04.00"

// Select a specific data sheet version:
SYSTem:SPECification:VERSion "04.01"

// Retrieve information on parameters that belong to a particular data sheet.
// Query the IDs of all parameters listed in the selected version:
SYSTem:SPECification:VERSion "04.03"
SYSTem:SPECification:IDENtification:CATalog?
"ID_RF_FREQ_SETTING_TIME_ALC_ON_MS,ID_RF_FREQ_SETTING_TIME_MS,..."

// Query data sheet information on a specific parameter by its ID.
```

```
SYSTem:SPECification? "ID_RF_FREQ_SETTING_TIME_ALC_ON_MS"
// Returns the specified value of the parameter.
```

Example: Retrieving information on network-related settings

```
SYSTem:COMMunicate:NETWork:STATus?
// 1
SYSTem:PROTection1:STATe 0,123456

SYSTem:COMMunicate:NETWork:IPADdress:MODE STAT
SYSTem:COMMunicate:NETWork:IPADdress "10.113.0.104"
SYSTem:COMMunicate:NETWork:IPADdress:DNS "10.0.2.166"
SYSTem:COMMunicate:NETWork:COMMon:HOSTname?
// "SMCV100B-102030"
SYSTem:COMMunicate:NETWork:COMMon:WORKgroup "instrument"
SYSTem:COMMunicate:NETWork:COMMon:DOMain "rsint.net"
SYSTem:COMMunicate:NETWork:IPADdress:GATeway "10.113.0.1"
SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK "255.255.252.0"
SYSTem:COMMunicate:NETWork:MACaddress "08 00 27 a3 a1 70"
SYSTem:PROTection1:STATe 1
```

Example: Restarting the network

```
SYSTem:COMMunicate:NETWork:RESTart
// terminates the network connection and sets it up again
```

Example: Finding out VISA resource strings

```
SYSTem:COMMunicate:NETWork:RESource?
// Response: "TCPIP::10.113.0.104::inst0::INSTR"

SYSTem:COMMunicate:HISLip:RESource?
// Response: "TCPIP::10.113.0.104::hislip0::INSTR"

SYSTem:COMMunicate:SOCKet:RESource?
// Response: "TCPIP::10.113.0.104::5025::SOCKET"

SYSTem:COMMunicate:USB:RESource?
// "USB::0x0AAD::0x01df::100001::INSTR"
```

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 827 to disable or enable the LAN interface and LAN interface services individually.

a) For the first parameter of the command, enter the security password of your instrument.
The default password is 123456.

b) For the second parameter of the command, enter the state: 1 (ON), 0 (OFF)

Example: To disable the LAN interface and LAN services

```
// ******************************************************************************
// Disable the LAN interface.
// ******************************************************************************
SYSTem:SECurity:NETWork:STATe "<password>", 0

// ******************************************************************************
// Disable the LAN services individually.
// ******************************************************************************
SYSTem:SECurity:NETWork:RAW:STATe "<password>", 0
// Disables remote access over raw socket.
SYSTem:SECurity:NETWork:SOE:STATe "<password>", 0
// Disables SCPI over Ethernet/LAN communication.
SYSTem:SECurity:NETWork:VNC:STATe "<password>", 0
// Disables remote access over VNC.
SYSTem:SECurity:NETWork:HTTP:STATe "<password>", 0
// Disables remote access over HTTP.
SYSTem:SECurity:NETWork:RPC:STATe "<password>", 0
// Disables remote access over remote procedure call (RPC).
SYSTem:SECurity:NETWork:SSH:STATe "<password>", 0
// Disables SSH network protocol that is used for service purposes.
SYSTem:SECurity:NETWork:FTP:STATe "<password>", 0
//    Disables FTP for file transfer.
SYSTem:SECurity:NETWork:SMB:STATe "<password>", 0
// Disables shared access over SMB.
SYSTem:SECurity:NETWork:AVAHi:STATe "<password>", 0
// Disables Avahi service for automatic instrument configuration in the network.
SYSTem:SECurity:NETWork:SWUPdate:STATe "<password>", 0
// Disables software updates over LAN.
```

Example: Querying the error queue

```
SYSTem:ERRor:STATic?
// Response: -221,"Settings conflict", 153,"Input voltage out of range", ...
// Returns all static errors that are collected in the error queue.

SYSTem:ERRor:HISTory:ClEar
// Deletes the history entries.
```

Example: Configuring date and time

```
// Query the date and time setting of the instrument
// Query the current timezone and setting
SYSTem:DATE?
// Response: 2023,1,16;1
SYSTem:TIME?
// Response: 18,15,17;1
SYStem:TIME:ZONE?
// Response: "";1  //default UTC setting
SYSTem:TIME:PROTocol?
// Response: "OFF";1 // no protocol selected
SYSTem:NTP:STATe?
// Response: 0;1  // NTP is disabled

// Setting the timezone and NTP time protocol
SYSTem:TIME:ZONE:CATalog?
// Response: "UTC,leap-seconds.list,leapseconds,Africa/Abidjan,..."
SYSTem:TIME:ZONE "Europe/Berlin"
SYSTem:NTP:HOST "timesource.net"  // sets the NTP server address
SYSTem:NTP:STATe?
// Response: 1  // the NTP time server is enabled
```

Commands

:SYSTem:ERRor:ALL? 830
:SYSTem:ERRor:CODE:ALL? 830
:SYSTem:ERRor:CODE[:NEXT]? 831
:SYSTem:ERRor:COUNt? 831
:SYSTem:ERRor[:NEXT]? 832
:SYSTem:ERRor:GNEXt? 832
:SYSTem:ERRor:HISTory:CLEar 832
:SYSTem:ERRor:STATic? 833
:SYSTem:DLOCk 833
:SYSTem:KLOCk 833
:SYSTem:NINFormation? 833
:SYSTem:ULOCk 834
:SYSTem:LOCK:OWNer? 834
:SYSTem:LOCK:RELease:ALL 835
:SYSTem:LOCK:REQuest[:EXCLusive]? 835
:SYSTem:SAV 835
:SYSTem:RCL 835
:SYSTem:PROTect<ch>[:STATe] 836
:SYSTem:COMMunicate:HISLip:RESource? 836
:SYSTem:COMMunicate:NETWork:IPADdress 837
:SYSTem:COMMunicate:NETWork:IPADdress:MODE 837
:SYSTem:COMMunicate:NETWork:MACaddress 837
:SYSTem:COMMunicate:NETWork:RESource? 837
:SYSTem:COMMunicate:NETWork:RESTart 838
:SYSTem:COMMunicate:NETWork:STATus? 838

:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain 838
:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname 838
:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK 839
:SYSTem:COMMunicate:SOCKet:RESource? 839
:SYSTem:COMMunicate:USB:RESource? 840
:SYSTem:HELP:EXPort 840
:SYSTem:IDENtification 840
:SYSTem:IDENtification:PRESet 841
:SYSTem:IRESponse 841
:SYSTem:ORESponse 841
:SYSTem:LANGuage 842
:SYSTem:INFormation:SCPI 842
:SYSTem:SECurity:NETWork:AVAHi[:STATe] 842
:SYSTem:SECurity:NETWork:FTP[:STATe] 842
:SYSTem:SECurity:NETWork:HTTP[:STATe] 843
:SYSTem:SECurity:NETWork:RAW[:STATe] 843
:SYSTem:SECurity:NETWork:REMSupport[:STATe] 843
:SYSTem:SECurity:NETWork:RPC[:STATe] 843
:SYSTem:SECurity:NETWork:SMB[:STATe] 844
:SYSTem:SECurity:NETWork:SOE[:STATe] 844
:SYSTem:SECurity:NETWork:SSH[:STATe] 844
:SYSTem:SECurity:NETWork:SWUPdate[:STATe] 845
:SYSTem:SECurity:NETWork:VNC[:STATe] 845
:SYSTem:SECurity:NETWork[:STATe] 845
:SYSTem:SECurity:SANitize[:STATe] 845
:SYSTem:SECurity:VOLMode[:STATe] 846
:SYSTem:SPECification? 846
:SYSTem:SPECification:VERSion 847
:SYSTem:SPECification:IDENtification:CATalog? 847
:SYSTem:SPECification:PARameter? 847
:SYSTem:SPECification:VERSion:CATalog? 848
:SYSTem:SPECification:VERSion:FACTory? 848
:SYSTem:SRData? 848
:SYSTem:STARtup:COMPlete? 848
:SYSTem:DATE 849
:SYSTem:NTP:HOSTname 849
:SYSTem:NTP:STATe 849
:SYSTem:TIME 849
:SYSTem:TIME:ZONE 850
:SYSTem:TIME:ZONE:CATalog? 850
:SYSTem:TIME:PROTocol 850
:SYSTem:UPTime? 851
:SYSTem:BIOS:VERSion? 851
:SYSTem:VERSion? 851
:SYSTem:OSYStem? 851
:SYSTem:MMEMory:PATH:USER? 852
:SYSTem:DFPRint 852

:SYSTem:REBoot....852
:SYSTem:RESTart....853
:SYSTem:SHUTdown....853
:SYSTem:WAIT....853

:SYSTem:ERRor:ALL?

Queries the error/event queue for all unread items and removes them from the queue.

Return values:

<All> string

Error/event_number,"Error/event_description>[;Device-dependent info]"
A comma separated list of error number and a short description of the error in FIFO order.
If the queue is empty, the response is `0,"No error"`
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.
Volatile errors are reported once, at the time they appear. Identical errors are reported repeatedly only if the original error has already been retrieved from (and hence not any more present in) the error queue.

Example:

```
SYSTem:ERRor:ALL?
// queries all entries in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

Manual operation: See "Clear History" on page 868

:SYSTem:ERRor:CODE:ALL?

Queries the error numbers of all entries in the error queue and then deletes them.

Return values:

<All> string

Returns the error numbers. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example:
```
SYSTem:ERRor:CODE:ALL?
// queries all entries in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor:CODE[:NEXT]?

Queries the error number of the oldest entry in the error queue and then deletes it.

Return values:

<Next> string

Returns the error number. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example:
```
SYSTem:ERRor:CODE:NEXT?
// queries the oldest entry in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor:COUNt?

Queries the number of entries in the error queue.

Return values:

<Count> integer

0
The error queue is empty.

Example:
```
SYSTem:ERRor:COUNt?
// queries the number of entries in the error queue.
Response: 1
// one error has occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor[:NEXT]?

Queries the error/event queue for the oldest item and removes it from the queue.

Return values:

<Next> string

Error/event_number,"Error/event_description>[;Device-dependent info]"
Error number and a short description of the error.
If the queue is empty, the response is `0,"No error"`
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.
Volatile errors are reported once, at the time they appear. Identical errors are reported repeatedly only if the original error has already been retrieved from (and hence not any more present in) the error queue.

Example:

```
SYSTem:ERRor:NEXT?
// queries the oldest entry in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

Manual operation: See "Static Notifications/History" on page 868

:SYSTem:ERRor:GNEXt?

Similar to `:SYSTem:ERRor[:NEXT]?`, but queries the next entry from the global persistant error/event queue.

Return values:

<NextGlobalError> string

Error/event number, "Error/event description> [;Device dependent info]"
An error number and a short description of the error.
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example:

```
SYSTem:ERRor:GNEXt?
// queries the next error message from the global error queue.
```

Usage: Query only

:SYSTem:ERRor:HISTory:CLEar

Clears the error history.

Example: See Example "Querying the error queue" on page 827

Usage: Event

Manual operation: See "Clear History" on page 868

:SYSTem:ERRor:STATic?

Returns a list of all errors existing at the time when the query is started. This list corresponds to the display on the info page under manual control.

Return values:
<StaticErrors> string

Example: See Example "Querying the error queue" on page 827

Usage: Query only

Manual operation: See "Static Notifications/History" on page 868

:SYSTem:DLOCk <DispLockStat>

Disables the manual operation over the display, including the front panel keyboard of the instrument.

Parameters:
<DispLockStat> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: `SYST:DLOC ON`
Activates the display lock. The instrument cannot be operated via the display until it has been enabled with `SYST:DLOC OFF`.

Manual operation: See "User Interface" on page 495
See "Enabling a locked user interface for manual operation" on page 496

:SYSTem:KLOCk <State>

Disables the front panel keyboard of the instrument.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: `SYST:KLOC ON`
Locks the front panel and external controls.
To enable the controls, send `SYST:KLOC OFF`.

Manual operation: See "User Interface" on page 495
See "Enabling a locked user interface for manual operation" on page 496

:SYSTem:NINFormation?

Queries the oldest information message ("Error History > Level > Info") in the error/event queue.

Return values:
<NextInfo> string

Example: `:SYSTem:NINFormation?`
Queries the oldest entry in the info message queue.
`Response: 90,"Info;=== Instrument startup... ==="`
Information message containing error number 90, that states, that the instrument startup is complete.

Usage: Query only

:SYSTem:ULOCk <SecPassWord>, <Mode>

Locks or unlocks the user interface of the instrument.

Parameters:
<Mode> ENABled | DONLy | DISabled | TOFF | VNConly

ENABled
Unlocks the display, the touchscreen and all controls for the manual operation.

DONLy
Locks the touchscreen and controls for the manual operation of the instrument. The display shows the current settings.

VNConly
Locks the touchscreen and controls for the manual operation, and enables remote operation over VNC. The display shows the current settings.

TOFF
Locks the touchscreen for the manual operation of the instrument. The display shows the current settings.

DISabled
Locks the display, the touchscreen and all controls for the manual operation.

*RST: n.a. (factory preset: ENABled)

Setting parameters:
<SecPassWord> string

Example: `:SYST:ULOC "<password>", DIS`
Activates the user interface lock, including display and controls.

Manual operation: See "User Interface" on page 495
See "Enabling a locked user interface for manual operation" on page 496

:SYSTem:LOCK:OWNer?

Queries the sessions that have locked the instrument currently.

If an exclusive lock is set, the query returns the owner of this exclusive lock, otherwise it returns NONE.

Return values:
<Owner> string

Example: SYST:LOCK:OWN?
Returns the owner of locking.
Response: NONE
The instrument is not locked.

Usage: Query only

:SYSTem:LOCK:RELease:ALL

Revokes the exclusive access to the instrument.

Usage: Setting only

:SYSTem:LOCK:REQuest[:EXCLusive]?

Queries whether a lock for exclusive access to the instrument via ethernet exists. If successful, the query returns a 1, otherwise 0.

Return values:
<Success> integer

Example: SYST:LOCK:REQ?
Queries the state of exclusive locking.
Response: 1
The exclusive locking is active.

Usage: Query only

:SYSTem:SAV <Pathname>

Saves the current R&S SMCV100B settings in a file. To deteremine the file name and storage location, enter the directory and file name with the command. According to the file type, the R&S SMCV100B assigns the extension (*.savrcltxt) automatically.

Setting parameters:
<Pathname> string

Example:
```
SYSTem:SAV "/var/user/temp/Test"
// saves the file "Test.savrcltxt" in the directory /var/user/temp/.
```

Usage: Setting only

:SYSTem:RCL <Pathname>

Selects and uploads a *.savrcltxt file with previously saved R&S SMCV100B settings from the default or a specified directory.

Setting parameters:
<Pathname> string

Example:
```
SYSTem:RCL "/var/user/temp/Test"
// loads the "Test.savrcltxt" file from the directory /var/user/temp/.
```

Usage: Setting only

:SYSTem:PROTect<ch>[:STATe] <State>[, <Key>]

Activates and deactivates the specified protection level.

Suffix:
<ch> Indicates the protection level.
See also "Protection" on page 490

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 1)

Setting parameters:
<Key> integer
The respective functions are disabled when the protection level is activated. No password is required for activation of a level.
A password must be entered to deactivate the protection level.
The default password for the first level is 123456.
This protection level is required to unlock internal adjustments for example.

Example:
To activate protection level:
```
SYSTem:PROTect1:STATe 1
```
Internal adjustments or hostname cannot be changed.
To unlock protection level 1:
```
SYSTem:PROTect1:STATe 0,123456
```
Internal adjustments are accessible.

Manual operation: See "Protection Level/Password" on page 492

:SYSTem:COMMunicate:HISLip:RESource?

Queries the VISA resource string. This string is used for remote control of the instrument with HiSLIP protocol.

Return values:
<Resource> string

Example: See Example "Finding out VISA resource strings" on page 826.

Usage: Query only

Manual operation: See "HISLIP" on page 526

:SYSTem:COMMunicate:NETWork:IPADdress <IpAddress>

Sets the IP address.

Parameters:
<IpAddress> string
Range: 0.0.0.0. to ff.ff.ff.ff

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "IP Address" on page 524

:SYSTem:COMMunicate:NETWork:IPADdress:MODE <Mode>

Selects manual or automatic setting of the IP address.

Parameters:
<Mode> AUTO | STATic
*RST: n.a. (factory preset: AUTO)

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "Address Mode" on page 524

:SYSTem:COMMunicate:NETWork:MACaddress <MacAddress>

Queries the MAC address of the network adapter.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<MacAddress> string

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "MAC Address" on page 525

:SYSTem:COMMunicate:NETWork:RESource?

Queries the visa resource string for Ethernet instruments.

Return values:
<Resource> string

Example: See Example "Finding out VISA resource strings" on page 826.

Usage: Query only

Manual operation: See "VXI11" on page 526

:SYSTem:COMMunicate:NETWork:RESTart

Restarts the network.

Example: See Example "Restarting the network" on page 826.

Usage: Event

Manual operation: See "Restart Network" on page 523

:SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Return values:
<State> 1 | ON | 0 | OFF

Example: See Example "Retrieving information on network-related settings" on page 826.

Usage: Query only

Manual operation: See "Network Status" on page 523

:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain <Domain>

Determines the primary suffix of the network domain.

Parameters:
<Domain> string

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "DNS Suffix" on page 525

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname <Hostname>

Sets an individual hostname for the R&S SMCV100B.

Note: We recommend that you do not change the hostname to avoid problems with the network connection. If you change the hostname, be sure to use a unique name.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<Hostname> string

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "Hostname" on page 524

:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup <Workgroup>

Sets an individual workgroup name for the instrument.

Parameters:
<Workgroup> string

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "Workgroup" on page 524

: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 826.

Manual operation: See "DNS Server" on page 525

:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway <Gateway>

Sets the IP address of the default gateway.

Parameters:
<Gateway> string
Range: 0.0.0.0 to ff.ff.ff.ff

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "Default Gateway" on page 525

:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>

Sets the subnet mask.

Parameters:
<Mask> string

Example: See Example "Retrieving information on network-related settings" on page 826.

Manual operation: See "Subnet Mask" on page 524

:SYSTem:COMMunicate:SOCKet:RESource?

Queries the visa resource string for remote control via LAN interface, using TCP/IP socket protocol.

Return values:
<Resource> string

Example: See Example "Finding out VISA resource strings" on page 826.

Usage: Query only

Manual operation: See "Socket" on page 526

:SYSTem:COMMunicate:USB:RESource?

Queries the visa resource string for remote control via the USB interface.

Return values:
<Resource> string

Example: See Example "Finding out VISA resource strings" on page 826.

Usage: Query only

:SYSTem:HELP:EXPort

Saves the online help as zip archive in the user directory.

Example:
```
:SYSTem:HELP:EXPort
MMEM:CDIR?
// "/var/user"
MMEM:CAT?
// ..,"Log,DIR,4096","help.tgz,BIN,69836600"
// confirms that help zip archive is saved.
```

Usage: Event

Manual operation:: "Setup > Help > Export Help to User Path"

:SYSTem:IDENtification <Identification>

Selects the mode to determine the "IDN String" and the "OPT String" for the instrument, selected with command `:SYSTem:LANGuage`.

Note: While working in an emulation mode, the R&S SMCV100B specific command set is disabled, that is, the SCPI command `SYST:IDEN` is discarded.

Parameters:
<Identification> AUTO | USER

AUTO
Automatically determines the strings.

USER
User-defined strings can be selected.

*RST: n.a. (factory preset: AUTO)

Example: `SYST:IDEN AUTO`
Automatically assigns the OPT and IDN strings according to the selected instrument language.

Manual operation: See "Mode" on page 527

:SYSTem:IDENtification:PRESet

Sets the `*IDN` and `*OPT` strings in user defined mode to default values.

Example:
```
SYST:IDEN USER
SYST:IDEN:PRES
```

Usage: Event

Manual operation: See "Set to Default" on page 527

:SYSTem:IRESponse <IdnResponse>

Defines the user defined identification string for `*IDN`.

Note: While working in an emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYST:IRES` is discarded.

Parameters:
<IdnResponse> string

Example:
```
SYST:IDEN USER
// Selects a user-defined identification
SYST:IRES "Test Device"
// Defines identification string 'test device'
*IDN?
// Response: 'test device'
```

Manual operation: See "IDN String" on page 528

:SYSTem:ORESponse <OResponse>

Defines the user defined response string for `*OPT`.

Note: While working in an emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYST:ORES` is discarded.

Parameters:
<OResponse> string

Example:
```
SYST:IDEN USER
// Selects a user-defined identification
SYST:ORES "Test Option"
// Defines the OPT string 'test option'
*OPT?
// Response: 'test option'
```

Manual operation: See "OPT String" on page 528

:SYSTem:LANGuage <Language>

Sets the remote control command set.

Parameters:
<Language> string

Example:
```
SYSTem:LANGuage "SCPI"
// selects SCPI command set
```

Manual operation: See "Language" on page 527

:SYSTem:INFormation:SCPI <InfoString>

Inserts system information in recorded SCPI command lists, for example information on a missing command.

Parameters:
<InfoString> string

Example:
```
SYST:INF:SCPI "missing command"
```
enters the information into a recorded SCPI command list.

:SYSTem:SECurity:NETWork:AVAHi[:STATe] <SecPassWord>, <AvahiState>

Disables the Avahi service for automatic configuration of the instrument in a network.

Parameters:
<AvahiState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 827.

Manual operation: See "LAN Services" on page 498

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

Manual operation: See "LAN Services" on page 498

: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 827.

Manual operation: See "LAN Services" on page 498

:SYSTem:SECurity:NETWork:VNC[:STATe] <SecPassWord>, <VncState>

Disables the VNC interface for remote control of the instrument.

Parameters:
<VncState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 827.

Manual operation: See "LAN Services" on page 498

: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 827

Manual operation: See "LAN" on page 498

:SYSTem:SECurity:SANitize[:STATe] <SecPassWord>, <MmemProtState>

Sanitizes the internal memory.

Parameters:
<MmemProtState> 0 | 1 | OFF | ON
*RST: 0

Setting parameters:
<SecPassWord> string

Example: `SYSTem:SECurity:SANitize[:STATe] 1`

Manual operation: See "Sanitize" on page 494

: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 493

:SYSTem:SPECification? <Id>

Retrieves data sheet information for a specific parameter.

Setting parameters:
<Id> string
Identifies the name of the entry in the data sheet, as queried with the command `:SYSTem:SPECification:IDENtification:CATalog?` on page 847

Return values:
<ValList> float
Comma-separated list with the specified and, if available, the typical value of the parameter, as specified in the data sheet.

Example: See Example "Retrieving instrument specification" on page 825.

Usage: Query only

:SYSTem:SPECification:VERSion <Version>

Selects a data sheet version from the data sheets saved on the instrument.

Further queries regarding the data sheet parameters (`<Id>`) and their values refer to the selected data sheet.

To query the list of data sheet versions, use the command `:SYSTem:SPECification:VERSion:CATalog?` on page 848.

Parameters:

<Version> string

Example: See `:SYSTem:SPECification?` on page 846.

:SYSTem:SPECification:IDENtification:CATalog?

Queries the parameter identifiers (`<Id>`) available in the data sheet.

Return values:

<IdList> string

Comma-separated string of the parameter identifiers (`<Id>`)

Example: See `:SYSTem:SPECification?` on page 846.

Usage: Query only

:SYSTem:SPECification:PARameter? <Id>[, <Parameter>]

Retrieves data sheet information for a specific parameter.

Setting parameters:

<Id> string

Identifies the name of the entry in the data sheet.
Query the data sheet parameters with the command `:SYSTem:SPECification:IDENtification:CATalog?`.

<Parameter> float

An additional value the result (`ValList`) depends on.

Return values:

<ValList> float

Comma-separated list with the specified and, if available, the typical value of the parameter, as specified in the data sheet.

Example: **Note:** The following values are merely an example. Your instrument may not support the same parameters.

```
SYST:SPEC:PAR? "ID_RF_FREQ_SETTING_TIME_MS",0.1
SYST:SPEC:PAR? "ID_RF_LEVEL_MAX_GENERAL_DBM",
0.1
```

Usage: Query only

:SYSTem:SPECification:VERSion:CATalog?

Queries all data sheet versions stored in the instrument.

Return values:
<VersCatalog> string

Example: See :SYSTem:SPECification? on page 846.

Usage: Query only

:SYSTem:SPECification:VERSion:FACTory?

Queries the data sheet version of the factory setting.

Return values:
<Version> string

Example: See :SYSTem:SPECification? on page 846.

Usage: Query only

Manual operation: See "Versions" on page 874

:SYSTem:SRData?

Queris the SCPI recording data from the internal file.

This feature enables you to transfer an instrument configuration to other test environments, as e.g. laboratory virtual instruments.

Return values:
<FileData> block data

Example:
```
SYSTem:SRData?
// #3118:SOURce1:ROSCillator:SOURce EXT
// :SOURce1:FREQuency:CW 4000000000
// :SOURce1:FREQuency:OFFSet 1000000
// :SOURce1:AM1:STATe 1
// :OUTPut1:STATe 1
```

Usage: Query only

:SYSTem:STARtup:COMPlete?

Queries if the startup of the instrument is completed.

Return values:
<Complete> 1 | ON | 0 | OFF
*RST: 0

Example:
```
SYSTem:STARtup:COMPlete?
Response: 1
// the instrument has started and is ready for operation.
```

Usage: Query only

:SYSTem:DATE <Year>, <Month>, <Day>

Queries or sets the date for the instrument-internal calendar.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:

<Year> integer

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "Configuring date and time" on page 828.

Manual operation: See "Date" on page 882

:SYSTem:NTP:HOSTname <NTPName>

Sets the address of the NTP server. You can enter the IP address, or the hostname of the time server, or even set up an own vendor zone. See the Internet for more information on NTP.

Parameters:

<NTPName> string

Manual operation: See "NTP Address" on page 883

:SYSTem:NTP:STATe <UseNtpState>

Activates clock synchronization via NTP.

Parameters:

<UseNtpState> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: See Example "Configuring date and time" on page 828.

Manual operation: See "NTP Address" on page 883

:SYSTem:TIME <Hour>, <Minute>, <Second>

Queries or sets the time for the instrument-internal clock.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See Example "Configuring date and time" on page 828.

Manual operation: See "Time" on page 882

:SYSTem:TIME:ZONE <TimeZone>

Sets the timezone. You can query the list of the available timezones with `:SYSTem:TIME:ZONE:CATalog?`.

Parameters:
<TimeZone> string

Example: See Example "Configuring date and time" on page 828.

Manual operation: See "Timezone" on page 883

:SYSTem:TIME:ZONE:CATalog?

Querys the list of available timezones.

Return values:
<Catalog>

Example: See Example "Configuring date and time" on page 828.

Usage: Query only

Manual operation: See "Timezone" on page 883

:SYSTem:TIME:PROTocol <TimeProtocol>

Sets the date and time of the operating system.

Parameters:
<TimeProtocol> OFF | NONE | 0 | NTP | ON | 1

NONE
Sets the date and time according to the selected timezone, see `:SYSTem:TIME:ZONE:CATalog?` on page 850 and `:SYSTem:TIME:ZONE` on page 850.

NTP
Sets the date and time derived from the network time protocol. To select the NTP time server, use the commands `:SYSTem:NTP:HOSTname` on page 849 and `:SYSTem:NTP:STATe` on page 849.

*RST: n.a. (factory preset: NONE)

Example: See Example "Configuring date and time" on page 828.

Manual operation: See "Time Protocol" on page 883

:SYSTem:UPTime?

Queries the up time of the operating system.

Return values:
<UpTime> "<ddd.hh:mm:ss>"

Example:
```
SYSTem:UPTime?
```
Response: `"0.08:11:00"`

Usage: Query only

:SYSTem:BIOS:VERSion?

Queries the BIOS version of the instrument.

Return values:
<Version> string

Example:
```
SYST:BIOS:VERS?
```
queries the BIOS version.
```
Response: 123456
```

Usage: Query only

:SYSTem:VERSion?

Queries the SCPI version the instrument's command set complies with.

Return values:
<Version> string

Example:
```
SYSTem:VERSion
// queries the SCPI version.
Response: "1996"
// the instrument complies with the SCPI version from 1996.
```

Usage: Query only

:SYSTem:OSYStem?

Queries the operating system of the instrument.

Return values:
<OperSystem> string

Example:
```
SYSTem:OSYStem?
Response: "Linux"
```

Usage: Query only

:SYSTem:MMEMory:PATH:USER?

Queries the user directory, that means the directory the R&S SMCV100B stores user files on.

Return values:
<PathUser> string

Example:
```
SYSTem:MMEMory:PATH:USER?
Response: "'/var/user/"
```

Usage: Query only

:SYSTem:DFPRint <Directory>

Creates a file with the device footprint of the product.

The content is formatted in machine-readable form, suitable for automatic further processing.

The generic file name is composed of `DeviceFootprint_<SerialNumber>_<Date>_<Time>.xml`. R&S SMCV100B saves the file in the definable directory. If the directory is not specified, it saves the footprint file in the internal default directory (`/var/lib/Rohde-Schwarz/DeviceFootprint`).

You can download the file by using the SCPI commands of the `MMEMory` subsystem.

Setting parameters:
<Directory> string

Path to the directory for saving the device footprint file.
Ensure that you have the permission to write into the directory.

Return values:
<DeviceFootprint> string

Information on the product type, identification and the installed hardware, software and further service-related information on the product's configuration.

Example:
```
SYSTem:DFPRint "/var/user/devicefootprint"

SYSTem:DFPRint?
// MMEM:DATA?
// returns the device footprint information saved with SYST:DFPRint
```

:SYSTem:REBoot

Reboots the instrument including the operating system.

Usage: Event

:SYSTem:RESTart

Restarts the instrument without restarting the operating system.

Usage: Event

:SYSTem:SHUTdown

Shuts down the instrument.

Usage: Event

:SYSTem:WAIT <TimeMs>

Delays the execution of the subsequent remote command by the specified time.

This function is useful, for example to execute an SCPI sequence automatically but with a defined time delay between some commands.

See Section 12.4.4, "How to assign actions to the [★ (User)] key", on page 474.

Setting parameters:

<TimeMs> integer

Wait time in ms

Range: 0 to 10000
*RST: 0

Example:

```
SYSTem:WAIT 10000
// Waits 10s before resetting the instrument.
*RST
```

Usage: Setting only

14.18 STATus subsystem

This system contains the commands for the status reporting system. See also Section 13.4, "Status reporting system", on page 517 for detailed information.

*RST on page 586 has no effect on the status registers.

Value ranges

- Queries return the current value of the respective register, which permits a check of the device status.
  Return values: A decimal value in the range 0 to 32767 (=2^{15}-1)
- The configuration commands set the respective register thus determining which status changes of the R&S SMCV100B cause the status registers to be changed.
  Setting values: A decimal value in the range 0 to 32767 (=2^{15}-1)

:STATus:OPERation:CONDition?....854
:STATus:OPERation:ENABle....854
:STATus:OPERation[:EVENt]....854
:STATus:OPERation:NTRansition....855
:STATus:OPERation:PTRansition....855
:STATus:PRESet....855
:STATus:QUEStionable:CONDition....855
:STATus:QUEStionable:ENABle....856
:STATus:QUEStionable[:EVENt]....856
:STATus:QUEStionable:NTRansition....856
:STATus:QUEStionable:PTRansition....856
:STATus:QUEue[:NEXT]?....857

:STATus:OPERation:CONDition?

Quieries the content of the CONDition part of the STATus:OPERation register.

This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out because it indicates the current hardware status.

Return values:
<Condition> string

Example: `:STATus:OPERation:CONDition?`

Usage: Query only

:STATus:OPERation:ENABle <Enable>

Sets the bits of the ENABle part of the STATus:OPERation register. This setting determines which events of the Status-Event part are forwarded to the sum bit in the status byte. These events can be used for a service request.

Parameters:
<Enable> string

Example: `:STAT:OPER:ENAB 32767`
all events are forwarded to the sum bit of the status byte.

:STATus:OPERation[:EVENt] < >

Queries the content of the EVENt part of the STATus:OPERation register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENt part is deleted after being read out.

Parameters:
< > string

Example: `:STAT:OPER:EVEN?`
queries the STATus:OPERation:EVENt register.

:STATus:OPERation:NTRansition <Ntransition>

Sets the bits of the NTRansition part of the STATus:OPERation register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register. The disappearance of an event in the hardware is thus registered, for example the end of an adjustment.

Parameters:
<Ntransition> string

Example: `:STAT:OPER:NTR 0`
a transition from 1 to 0 in the condition part of the Status:Operation register does not cause an entry to be made in the EVENt part.

:STATus:OPERation:PTRansition <Ptransition>

Sets the bits of the PTRansition part of the STATus:OPERation register. If a bit is set, a transition from 0 to 1 in the condition part causes an entry to be made in the EVENt part of the register. A new event in the hardware is thus registered, for example the start of an adjustment.

Parameters:
<Ptransition> string

Example: `:STAT:OPER:PTR 32767`
all transitions from 0 to 1 in the condition part of the Status:Operation register cause an entry to be made in the EVENt part.

:STATus:PRESet <Preset>

Resets the status registers. All PTRansition parts are set to FFFFh (32767), i.e. all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, i.e. a transition from 1 to 0 in a CONDition bit is not detected. The ENABle parts of STATus:OPERation and STATus:QUEStionable are set to 0, i.e. all events in these registers are not passed on.

Parameters:
<Preset> string

Example: `STAT:PRES`
resets the status registers.

:STATus:QUEStionable:CONDition <Condition>

Queries the content of the CONDition part of the STATus:QUEStionable register. This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out since it indicates the current hardware status.

Parameters:
<Condition> string

Example: `:STATus:QUEStionable:CONDition?`
queries the Status:Questionable:Condition register.

:STATus:QUEStionable:ENABle <Enable>

Sets the bits of the ENABle part of the STATus:QUEStionable register. The enable part determines which events of the STATus:EVENt part are enabled for the summary bit in the status byte. These events can be used for a service request.

If a bit in the ENABle part is 1, and the correesponding EVENt bit is true, a positive transition occurs in the summary bit. This transition is reportet to the next higher level.

Parameters:
<Enable> string

Example: `STAT:QUES:ENAB 1`
Problems when performing an adjustment cause an entry to be made in the sum bit.

:STATus:QUEStionable[:EVENt] < >

Queries the content of the EVENt part of the `STATus:QUEStionable` register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENt part is deleted after being read out.

Parameters:
< > string

Example: `STAT:QUES:EVEN?`
queries the Status:Questionable:Event register.

:STATus:QUEStionable:NTRansition <Ntransition>

Sets the bits of the NTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register.

Parameters:
<Ntransition> string

Example: `STAT:QUES:NTR 0`
a transition from 1 to 0 in the condition part of the STATus:QUEStionable register does not cause an entry to be made in the EVENt part

---

:STATus:QUEStionable:PTRansition <PTransition>

Sets the bits of the NTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register.

Parameters:
<PTransition> string

Example: `STAT:QUES:PTR 32767`
all transitions from 0 to 1 in the condition part of the STATus:QUEStionable register cause an entry to be made in the EVENt part

---

:STATus:QUEue[:NEXT]?

Queries the oldest entry in the error queue and then deletes it. Positive error numbers denote device-specific errors, and negative error numbers denote error messages defined by SCPI. If the error queue is empty, 0 ("No error") is returned.

The command is identical to `:SYSTem:ERRor[:NEXT]?` on page 832.

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

14.19 TEST subsystem

The `TEST` subsystem contains the commands for performing test routines directly at the hardware assemblies.

The selftetst responses with a `0` if the test is performed successfully, otherwise a value other than `0` is returned. None of the commands of this system has a `*RST` value.

Example: Testing the screen display

```
// show the check screen
:TEST:PIXel:WINdow 1
// selct the color for the display, e.g. blue
TEST:PIXel:COLor BLUE
// select the sequence for changing the color automatically
TEST:PIXel:COLor AUTO //(~3s per color)
// select a specific RGB color, e.g. black
TEST:PIXel:RGBA 0,0,0,255
// turn on the gradient
TEST:PIXel:GRADient 1
// switch to text mode
 :TEST:PIXel:TEXT 1
// set the point size of the text
:TEST:PIXel:POINtsize 600
// exit the check screen
:TEST:PIXel:WINdow 0
```

:TEST<hw>:ALL:STARt 858
:TEST<hw>:ALL:RESult? 858
:TEST:PIXel:COLor 859
:TEST:PIXel:GRADient 859
:TEST:PIXel:POINtsize 859
:TEST:PIXel:RGBA 859
:TEST:PIXel:TEXT 859
:TEST:PIXel:WINDow 860

:TEST<hw>:ALL:STARt

Usage: Event

Manual operation: See "Run Module Test" on page 892

Starts the selftest. Use the command `:TEST<hw>:ALL:RESult?` to query the result.

:TEST<hw>:ALL:RESult?

Queries the result of the performed selftest. Start the selftest with `:TEST<hw>:ALL:STARt`.

Return values:

<Result> 0 | 1 | RUNning | STOPped
*RST: STOPped

Usage: Query only

Manual operation: See "Result" on page 892
See "Last Full Test" on page 893
See "Test table" on page 893

:TEST:PIXel:COLor <PixTestColor>

Selects the color of the screen.

"AUTO" switches from one color to the next in tme intervals of approximately 3 s per color.

Setting parameters:

<PixTestColor> RED | BLUE | WHITe | GREen | AUTO | GR25 | GR50 | GR75 | BLACk

*RST: RED

Example: See Example "Testing the screen display" on page 858.

Usage: Setting only

Manual operation: See "Check Display Screen" on page 887

:TEST:PIXel:GRADient <PixTestGradStat>

Activates the gradient for display screen test.

Parameters:

<PixTestGradStat> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Testing the screen display" on page 858.

Manual operation: See "Check Display Screen" on page 887

:TEST:PIXel:POINtsize <PixTestGradStat>

Sets the point size of the test text.

Parameters:

<PixTestGradStat> integer

Range: 0 to 999

*RST: n.a. (no preset. default: 0)

Example: See Example "Testing the screen display" on page 858.

Manual operation: See "Check Display Screen" on page 887

:TEST:PIXel:RGBA

Sets a specific RGBA color for the screen.

Example: See Example "Testing the screen display" on page 858.

Manual operation: See "Check Display Screen" on page 887

:TEST:PIXel:TEXT <PixTestGradStat>

Activats the test text mode.

Parameters:
<PixTestGradStat> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Testing the screen display" on page 858.

Manual operation: See "Check Display Screen" on page 887

:TEST:PIXel:WINDow <PixTestWindow>

Activates the check display screen.

Setting parameters:
<PixTestWindow> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Testing the screen display" on page 858.

Usage: Setting only

Manual operation: See "Check Display Screen" on page 887

14.20 TRIGger subsystem

The `TRIGger` system contains the commands for selecting the trigger source for the RF sweep.

You can work with an internal or with an externally applied trigger signal. In this case, use the commands in the `SOURce:INPut` subsystem to configure the signal.

The trigger system of the R&S SMCV100B is a simplified implementation of the SCPI trigger system. The `TRIGger` system differs from the SCPI system as follows:

- No `INITiate` command; the instrument behaves as if `INITiate:CONTinuous ON` were set.
- Under `TRIGger` several sweep subsystems exist.
- The trigger source names correspond directly to the various settings of manual control. SCPI uses different names which are also accepted by the instrument. The SCPI names should be used if compatibility is an important consideration.

In addition to these commands, see more trigger-related commands in the modulation and RF signal subsystems.

Table 14-2: Cross-reference between the manual and remote control

R&S proprietary value name	SCPI conform value name	Parameter in manual control
AUTO	IMMediate	"Auto" mode
SINGle	BUS	"Single" mode.
EXTernal	EXTernal	"Ext Single" and "Ext Step" mode.
EAUTo	-	"Ext Start/Stop" mode.

:TRIGger<hw>:FSWeep:SOURce....861
:TRIGger<hw>:PSWeep:SOURce....861
:TRIGger<hw>[:SWEep]:SOURce....861
:TRIGger<hw>:FSWeep[:IMMediate]....862
:TRIGger<hw>:PSWeep[:IMMediate]....862
:TRIGger<hw>[:SWEep][:IMMediate]....862

:TRIGger<hw>:FSWeep:SOURce <Source>
:TRIGger<hw>:PSWeep:SOURce <Source>
:TRIGger<hw>[:SWEep]:SOURce <Source>

Selects the trigger source for the corresponding sweeps:

- `FSWeep` - RF frequency
- `PSWeep` - RF level
- `SWEep` - all sweeps

The source names of the parameters correspond to the values provided in manual control of the instrument. They differ from the SCPI-compliant names, but the instrument accepts both variants.

Use the SCPI name, if compatibility is an important issue. Find the corresponding SCPI-compliant commands in Cross-reference between the manual and remote control.

Setting parameters:

<Source> AUTO | IMMediate | SINGle | BUS | EXTernal | EAUTo

AUTO [IMMediate]
Executes a sweep automatically.
In this free-running mode, the trigger condition is met continuously. I.e. when a sweep is completed, the next one starts immediately.

SINGle [BUS]
Executes one complete sweep cycle.
The following commands initiate a trigger event:
`*TRG` on page 587
`[:SOURce<hw>]:SWEep:POWer:EXECute`
`[:SOURce<hw>]:SWEep[:FREQuency]:EXECute`
`:TRIGger<hw>[:SWEep][:IMMediate]`, `:TRIGger<hw>:PSWeep[:IMMediate]` and `:TRIGger<hw>:FSWeep[:IMMediate]`.
Set the sweep mode with the commands:
`[:SOURce<hw>]:SWEep:POWer:MODE`AUTO|STEP
`[:SOURce<hw>]:SWEep[:FREQuency]:MODE`AUTO|STEP
In step mode (`STEP`), the instrument executes only one step.

EXTernal
An external signal triggers the sweep.

EAUTo
An external signal triggers the sweep. When one sweep is finished, the next sweep starts.
A second trigger event stops the sweep at the current frequency, a third trigger event starts the trigger at the start frequency, and so on.

*RST: AUTO

Example: See Section 14.16.14, "SOURce:SWEep subsystem", on page 817.

Usage: Setting only

:TRIGger<hw>:FSWeep[:IMMediate]
:TRIGger<hw>:PSWeep[:IMMediate]
:TRIGger<hw>[:SWEep][:IMMediate]

Performs a single sweep and immediately starts the activated, corresponding sweep:

- `FSWeep` - RF frequency
- `PSWeep` - RF level
- `SWEep` - all sweeps

Effective in the following configuration:

- `TRIG:FSW|PSW|[:SWE]:SOUR` **`SING`**
- `SOUR:SWE:FREQ|POW:MODE` **`AUTO`**

Alternatively, you can use the `IMMediate` command instead of the respective `SWEep:[FREQ:]|POW:EXECute` command.

Example: `TRIG`
Starts all active sweeps.

Usage: Event

Manual operation: See "Execute Single Sweep" on page 341

14.21 UNIT subsystem

The `UNIT` subsystem is used to set default units for parameters if no unit is indicated in a command. These settings are valid for the entire instrument.

Example: Setting default units for remote control

```
UNIT:POW V
UNIT:ANGL DEG
```

Sets V (volts) as unit of all power parameters, DEG (degrees) for the phase modulation angle and KMH for the speed.

:UNIT:ANGLe....863
:UNIT:POWer....863

:UNIT:ANGLe <Angle>

Sets the default unit for phase modulation angle. The command affects no other parameters, such as RF phase, or the manual control or display.

Parameters:

<Angle> DEGree | DEGRee | RADian

*RST: RADian

:UNIT:POWer <Power>

Sets the default unit for all power parameters. This setting affects the GUI, as well as all remote control commands that determine power values.

Parameters:

<Power> V | DBUV | DBM

*RST: DBM

15 Troubleshooting and notifications

Handling R&S SMCV100B start-up issues

If the product does not start, a blown fuse in the power supply can be the cause. Contact the Rohde & Schwarz customer service to confirm the fault symptoms. If the power supply has a blown fuse, you must return the product to the Rohde & Schwarz customer service to have the power supply replaced. Follow the instructions from the Rohde & Schwarz customer service.

If you need to transport or ship the instrument, see Section 16, "Transporting", on page 878.

Understanding R&S SMCV100B notifications

The R&S SMCV100B distinguishes between various notifications caused by events or functions. It displays a notification in the "Info" line on the screen temporarily, and saves all notifications in a history list. In addition, an event initiates an entry in the event/error queue of the status reporting system.

See:

- Section 13.4, "Status reporting system", on page 517
- Section 15.4, "Querying notifications", on page 867

15.1 Notifications

Notifications inform about operation states of the instrument, and point out deviations, deficiencies or imperfection of functions that initiate an event in the instrument. The instrument distinguishes the notifications according to the significance of the events by different icons.

Some events require that you eliminate the deviation to make sure that the instrument operates correctly.

To access the notifications and history list dialog, see Section 15.4, "Querying notifications", on page 867. In remote control mode, you can query the notifications using the command `:SYSTem:ERRor:ALL?` on page 830.

15.1.1 Volatile notifications

Volatile notifications report automatic settings in the instrument (e.g. switching off incompatible types of modulation) or on entries that are not accepted by the instrument (e.g. range violations).

Volatile notifications do not normally demand user actions and disappear automatically after a short period of time. They are saved in the history list, however.

Remote command:

`:SYSTem:ERRor:ALL?` or

`:SYSTem:ERRor:CODE[:NEXT]?`

15.1.2 Permanent notifications

Permanent notifications are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signaled by a permanent notification must be eliminated before correct instrument operation can be continued.

The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

Remote command:

`:SYSTem:ERRor:STATic?`

15.2 SCPI notifications

The SCPI notifications are similar for all SCPI instruments. Detailed information and an overview of all notifications as defined in the SCPI standard can be found in the corresponding documentation.

SCPI notifications have negative codes (numbers). The error text being entered into the error/event queue or being displayed is printed in bold face on the left together with the error code. Below the error text, there is an explanation to the respective error.

15.3 Device-specific notifications

The following table contains all error messages specific for the instrument, marked by positive error codes in numerical order and an explanation of the error situation.

The device-specific error messages set bit 3 in the ESR register.

The index provides a list of the error messages sorted according to their error codes.

Error code	Error	Description	Remedy
50	External reference out of range or disconnected	The configured reference frequency source is external but there is no physical external signal or this signal is out of range.	In the "RF Frequency" > "Reference Frequency" dialog, set the correct reference signal source.
140	This modulation forces other modulations off	The instrument disables a modulation because you enabled another modulation.	

Error code	Error	Description	Remedy
180	Adjustment failed	The instrument cannot execute an adjustment.	Generate the adjustment data and load it into the device.
182	Adjustment data missing	Adjustment data is missing.	Generate the adjustment data and load it into the device.
183	Adjustment data invalid	Adjustment data is invalid.	Generate the adjustment data and load it into the device.
200	Cannot access hardware	The data transmission to a module was unsuccessful.	The module is not installed, not properly installed or missing.
201	Hardware revision out of date	You cannot execute a specific function because of a too old hardware version. The driver does not support the installed version of a hardware module.	Consider installing a newer hardware module or downgrading the driver version
202	Cannot access the EEPROM	An error occurs when writing or reading a EEPROM.	The EEPROM is possibly defective. Replace it.
203	Invalid EEPROM data	Reading a EEPROM is possible, however the data are inconsistent.	
204	Driver initialization failed	Initialization of a driver fails when booting the instrument firmware.	The driver is not compatible with the hardware or software configuration of the instrument.
241	No current list	There is no list file selected to execute the required operation.	Select a list file with the correct file extension. If no list files is available, create a list file.
242	Unknown list type specified	The list type selected is not valid for the required operation.	Check the selected list type.
261	Waveform protected	You cannot transfer a waveform file to an Rohde & Schwarz instrument because the file is encrypted. For example, the simulation software R&S WinIQSIM2 creates protected waveform files.	Install the related waveform file software option or select an unprotected waveform file.
300	Reference PLL unlocked	The configured reference frequency source is external but there is no physical external signal.	In the "RF Frequency" > "Reference Frequency" dialog, set a valid reference frequency source and frequency: • Set "Source" > "Internal". • Set "Source" > "External". Connect a 10 MHz or 13 MHz reference source at the connector Ref In.
300	Overload (Reverse Power) detected	The connected load feeds in a voltage at the RF output connector RF 50 Ω. You can also trigger the reverse power protection without a connected DUT, if there is a too high RF level and an open RF output.	Remove the overload and switch on the RF output via "RF" > "On".
300	Over-temperature protection shut-down	The R&S SMCV100B overheats, for example, if you cover the fan openings.	Relocate the R&S SMCV100B to cool down and remove all coverings from the R&S SMCV100B. After cooling down switch on the R&S SMCV100B. If you still encounter problems, contact the Rohde & Schwarz customer support.

Error code	Error	Description	Remedy
460	Cannot open file	You or the application cannot open the selected file.	Check the file path and filename.
461	Cannot write file	You or the application cannot edit or write the selected file.	Check if the file is read-only.
462	Cannot read file	You or the application cannot read the selected file.	Check if the file contents are compatible with the file type.
463	Filename missing	You cannot execute a task because the filename is missing.	Enter the filename.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension.
465	File contains invalid data	The file with its file extension contains invalid data. The file extension is wrong for the expected data. For example, if you change the standard file extension of a waveform file from `*.wv` to `*.txt`, the instrument cannot read the waveform file anymore.	Check the file extension.

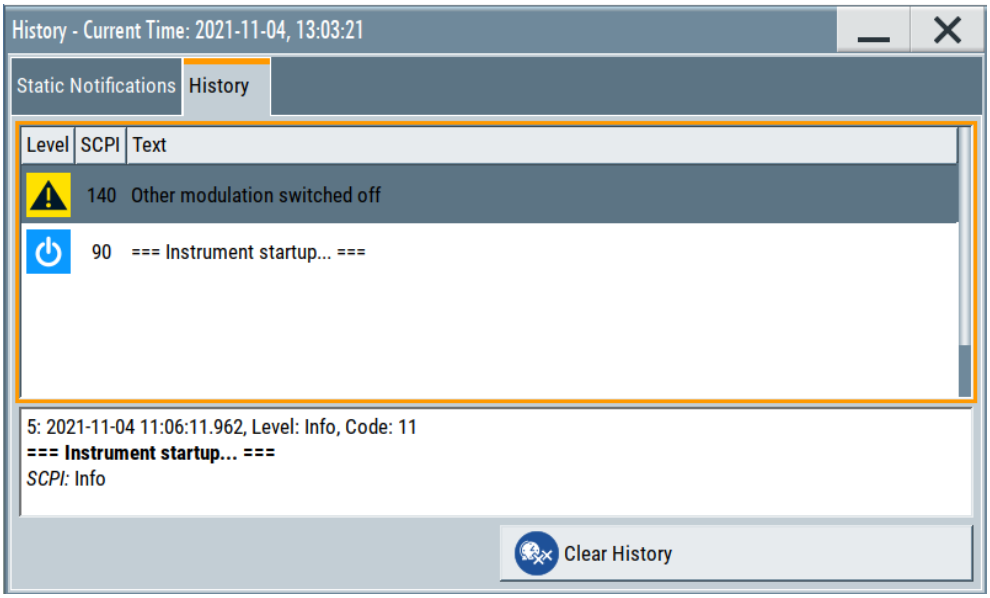
15.4 Querying notifications

The R&S SMCV100B monitors the functions performed and automatically detects irregularities. The instrument displays corresponding notifications in the "Info" line and collects all notifications in a history with a detailed description.

Find details to the system notifications in Section 15, "Troubleshooting and notifications", on page 864.

To monitor static notifications and history

► In the taskbar, select the "System Config > Info/Notifications".



- The "Static Notifications" dialog lists the recently monitored notifications chronologically and displays additional information on the highlighted message.
- The "History" dialog lists the accumulated messages with a short description. The software reports volatile notifications once. The "Info" line displays identical errors repeatedly only if the original error disappeared. Selecting this info line also opens the "Static Notifications" dialog.

Handling permanent notifications

If any critical error occurs, the R&S SMCV100B automatically shows the warning icon in the taskbar. Select the icon to obtain information on the error and the number of occurrences.

The icon is assigned to permanent notifications. The notification and icon are displayed until the error is eliminated.

Static Notifications/History
Toggles between "Static Notifications" and the "History" tab in the info dialog.

Remote command:
`:SYSTem:ERRor[:NEXT]?` on page 832
Each time a `SYST:ERR:NEXT?` query is sent, the eldest entry in the error queue is returned and at the same time cleared in the list.
`:SYSTem:ERRor:STATic?` on page 833
Queries the list of all errors.

Clear History
Clears all messages in the "History" tab.

Remote command:
:SYSTem:ERRor:ALL? on page 830
Each time a SYST:ERR:ALL? query is sent, the error queue is returned and at the same time cleared.
:SYSTem:ERRor:HISTory:CLEar on page 832
Clears the messages in the "History" view.

15.5 Resolving network connection failures

Several issues may cause failures in the network connection to the instrument. This section lists the most likely reasons and the recommended solutions.

Common reasons for network connection failures

- Network connecting cables and cable connectors of poor quality
- Incompatibility between the network interface of the R&S SMCV100B and certain switches or routers available on the market
- An invalid IP address assigned to the instrument

Possible solutions to network connection failures

1. **NOTICE!** Risk of network failure. Connecting to the network can cause network failure. Errors can affect the entire network.

   Consult your network administrator before performing the following tasks:
   - Connecting the instrument to the network
   - Configuring the network
   - Changing IP addresses

2. Try out the following to resolve network connection failures:
   - Exchange connecting cables, if obvious damage is visible.
     See also "Cable selection and electromagnetic interference (EMI)" on page 26.
   - If a link failure is detected, connect the instrument to a different device port or to a different network device.
   - Check whether the LAN interface and the required LAN services are enabled.
   - If the IP address is set manually (no DHCP) or obtained with the Zeroconf (Avahi) protocol:
     – Check whether the IP address of the instrument is within the network's address range.
     – Check whether the IP address is valid.

15.6 Resolving errors during internal adjustments

Internal adjustments can fail for various reasons, e.g. if the adjustment data is invalid or missing, or if any error causes process to abort.

To resolve a failed adjustment process, you have the following options:

- Abort on error (default setting), see "To resolve aborted internal adjustments" on page 870
- Continue on error, see "To continue internal adjustments on error" on page 870

To resolve aborted internal adjustments

If an error occurs, the R&S SMCV100B displays a notification in the "Information" field and saves the notification in the history list.

1. Select "System Config > Info / Notifications".
2. Look up the error code of the notification in the overview of device-specific notifications.
   See Section 15.3, "Device-specific notifications", on page 865.

   The overview provides a brief explanation of all notifications and information on how to fix an error.
3. To resolve an adjustment failure, generate adjustment data and load it into the instrument.
4. Restart internal adjustments as described in "Running internal adjustments" on page 890

   If the error persists:
   Contact the Rohde & Schwarz customer support, see Section 15.9, "Collecting information for technical support", on page 874.

To continue internal adjustments on error

If the failed internal adjustments has no significant effect on your application, you can skip it and continue the calibration despite the error message. This function is password-protected.

1. Select "System Config > Setup > Security > Protection".
2. Unlock protection level 1, see"Protection Level/Password" on page 492.
3. Select "System Config > Setup > Internal Adjustment > Configuration > Continue Adjustment on Error > On".
4. Proceed as described in "Running internal adjustments" on page 890.

15.7 Measuring USB cable quality

To check the quality of the USB cable, see the service manual of the R&S SMCV100B.

15.8 Checking the instrument configuration

The R&S SMCV100B uses various hardware and software components. To get an overview, you can check the instrument assemblies, hardware options, software options and the firmware version. The "Hardware Config" and "Versions/Options" dialogs list all components according to their hardware configuration, software options and connected Rohde & Schwarz equipment, like R&S NRP power sensors.

Installing software and hardware options

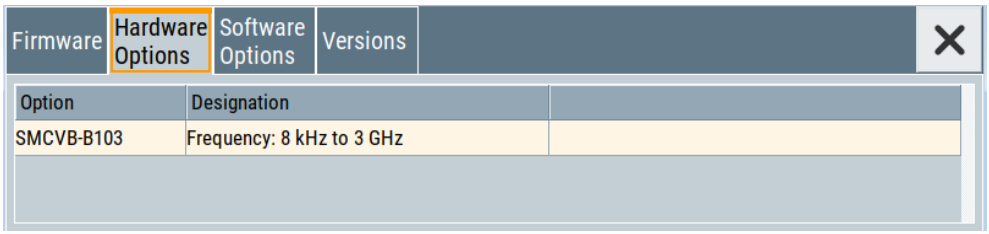
Activate newly purchased software options with a keycode. After purchase, the keycode is part of the delivery of the software option. See also Section 12.5, "Managing licenses and license keys", on page 474.

For installing newly purchased hardware options, contact Rohde & Schwarz customer support.

Checking the installed hardware options

To find out the installed options:

1. Select "System Config" > "Setup" > "Instrument Assembly" > "Versions / Options".
2. Select "Hardware Options".



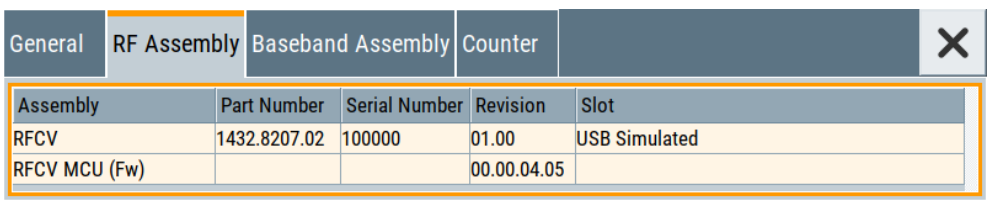
The dialog lists installed hardware options on the R&S SMCV100B.

Proceed the same way to get information on the firmware or the installed software options in the corresponding tab.

Checking the RF hardware assembly

To find out the installed RF hardware:

1. Select "System Config" > "Setup" > "Instrument Assembly" > "Hardware Config".
2. Select "RF Assembly".



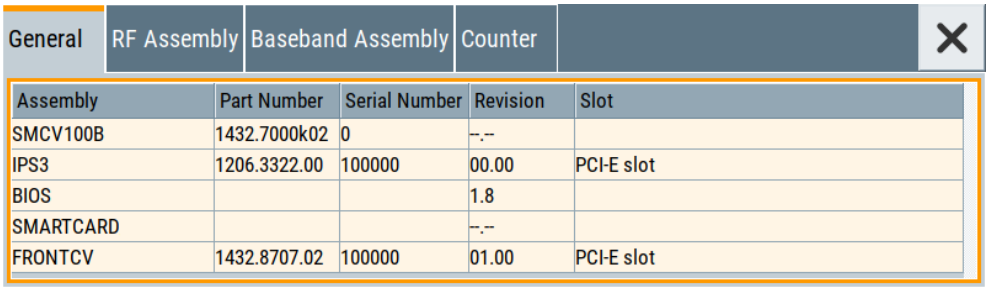
The dialog lists the installed RF hardware components installed on the R&S SMCV100B.

Proceed the same way to get information on general or baseband hardware modules or on the operating times of the R&S SMCV100B in the corresponding tab.

15.8.1 Hardware configuration settings

Access:

► Select "System Config" > "Setup" > "Instrument Assembly" > "Hardware Config".



Assembly	Part Number	Serial Number	Revision	Slot
SMCV100B	1432.7000k02	0	--.--	
IPS3	1206.3322.00	100000	00.00	PCI-E slot
BIOS			1.8	
SMARTCARD			--.--	
FRONTCV	1432.8707.02	100000	01.00	PCI-E slot

The "Hardware Config" dialog lists all installed assemblies and connected external instruments with information on their part and serial numbers, and revision states. Also, it lists the BIOS version. A firmware update does not update the BIOS version. The "Counter" tab provides information on the operation time, the number of times that the instrument was powered on and the last factory calibration of the instrument.

The remote commands required to query the hardware configuration are described in Section 14.7, "DIAGnostic subsystem", on page 606.

Assembly
The tables in the tabs show characteristics of the installed assemblies.

"Assembly" Assembly designation.

"Part Number" Part number of the assembly.

"Serial Number" Serial number of the assembly.

"Revision" Revision state of the assembly.

"Slot" Indicates whether the assembly is connected to the serial bus or PCI bus.

Remote command:
`:DIAGnostic<hw>:BGINfo?` on page 607

Counter
Displays information on the operation times of the R&S SMCV100B.

Operation Time / h ← Counter
Displays the operation time in hours so far.

Remote command:
`:DIAGnostic:INFO:OTIMe?` on page 608

Power On Count ← Counter
Displays the number the instrument has been turned on.

Remote command:
`:DIAGnostic:INFO:POCount?` on page 608

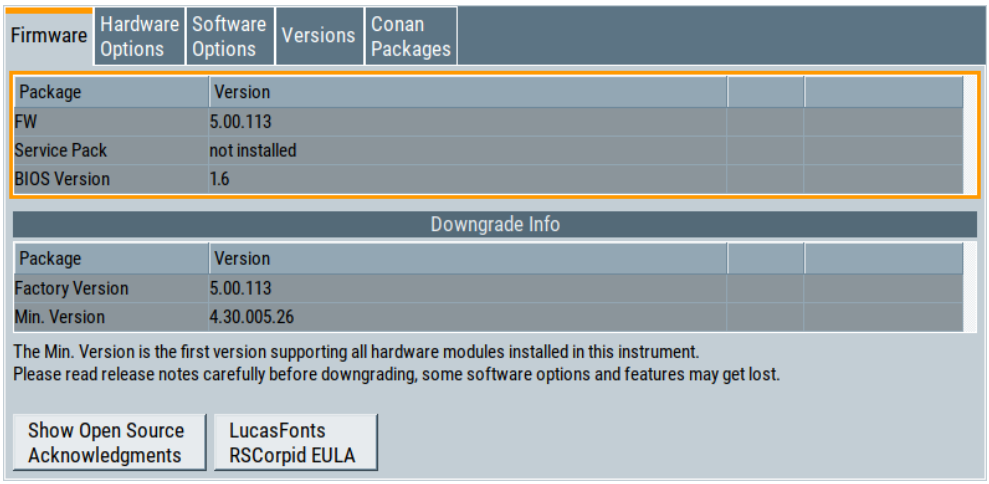
Last Factory Calibration ← Counter
Displays the date of the last factory calibration.

Remote command:
`:CALibration:DATA:FACTory:DATE?` on page 604

15.8.2 Versions and options settings

Access:

► Select "System Config" > "Setup" > "Instrument Assembly" > "Versions / Options".



The "Versions / Options" dialog shows the version of the installed instrument firmware, the hardware and software options, the data sheet and the software components of the firmware. The BIOS version is also listed; firmware updates do not update the BIOS version.

The remote commands required to query the hardware configuration are described in Section 14.7, "DIAGnostic subsystem", on page 606.

Firmware
Shows the firmware version and the version of the software platform.

Note: Your instrument is delivered with the latest firmware version available.

You can download firmware updates and the "Release Notes" that describe the modifications and the firmware update procedure.

Remote command:
n.a.

Downgrade Info
Shows downgrade information, like factory firmware version and minimum firmware version to that the instrument can be downgraded.

Remote command:
n.a.

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

LucasFonts RSCorpid EULA
Accesses copyright information on LucasFonts font type RSCorpid EULA.

Hardware Options/Software Options
The tables in the "Hardware" and "Software" tabs list the installed hardware and software options.

"Option" Short name of option

"Designation" Name of option

"Expiration Date"
For regular options, "Permanent" is indicated in this column.

Remote command:
`*OPT?` on page 585
`*IDN?` on page 585

Versions
The "Versions" tab shows the versions of the technical specification of the R&S SMCV100B and of the software components that comprise the firmware.

"Package" Name of the component.

"Version" Current issue of the component.

Remote command:
`:SYSTem:SPECification:VERSion:FACTory?` on page 848

15.9 Collecting information for technical support

If you encounter problems that you cannot solve yourself, contact your Rohde & Schwarz support center at www.rohde-schwarz.com/support. Our support center staff is optimally trained to assist you in solving problems.

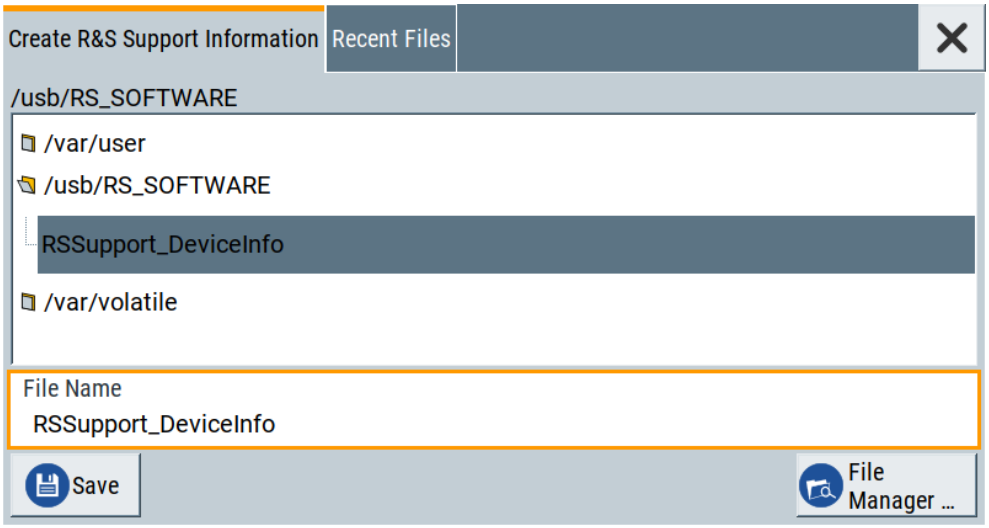
The support center finds solutions more quickly and efficiently if you provide them with information on the instrument and an error description.

- The following dialog boxes in the "Setup > Instrument Assembly" menu provide useful information:
  - **Hardware Configuration:** hardware assemblies
  - **Software and Options:** the status of all software and hardware options installed on your instrument
- **System Messages:** displayed in the "Info" line and provide information on any errors that have occurred
- **Support file:** a special file (`*.tar.gz` file) with important support information that can be created automatically.
  The support `*.tar.gz` file has a user-definable name and contains the following files and information:
  - `SgErrors.txt`: chronological record of errors
  - `SystemRestaurationSMCV100B.savrcltxt`: instrument settings at the last correct shutdown of the instrument
  - `UndoHistSuppInfo.xml`: list of the last user interactions
  - `DeviceFootprint_<SerialNumber>_<Date>_<Time>.xml`: service-related information on the instrument's configuration.
  - `crashlog.txt`, `coredump`: Postmortem debug info
  - Several files with information on the last performed adjustment and self-test.

See also the description of error messages Section 15.1, "Notifications", on page 864.

To collect error information in a support file

1. Connect a USB device to the R&S SMCV100B.
2. Select "System Config > Setup > Maintenance > Create R&S Support Information".
3. In the "Create R&S Support Information" dialog, navigate to the `/usb` directory.
   Enter the support filename, for example `RSSupport_DeviceInfo`.



The error information and further required data are collected automatically.
The support file `RSSupport_DeviceInfo.tar.gz` is created and stored in the `/usb` directory.
Collect the error information and attach it to an email in which you describe the problem. Send the email to the customer support address as listed on the Internet (www.rohde-schwarz.com/support).

To remove sensitive data

► For information on how to handle or remove the sensitive data from your instrument, refer to the description "R&S SMCV100B Instrument Security Procedures".

To pack and transport the instrument

► If you need to transport or ship the instrument, see Section 16, "Transporting", on page 878.

15.10 Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



Figure 15-1: QR code to the Rohde & Schwarz support page

16 Transporting

Lifting and carrying

For safety information, see:

- "Lifting and carrying the product" on page 16

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 SMCV100B in a vehicle or using transporting equipment, make sure that the R&S SMCV100B is properly secured. Only use items intended for securing objects.

Transport altitude

The maximum transport altitude without pressure compensation is specified in the specifications document.

17 Maintenance, storage and disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable to check the nominal data from time to time.

17.1 Cleaning

How to clean the product is described in "Cleaning the product" on page 17.

Do not use any liquids for cleaning. Cleaning agents, solvents, acids and bases can damage the front panel labeling, plastic parts and display.

17.2 Changing fuses

If the product does not start, it is possible that a blown fuse is the cause. The power connector of the product is protected by two line fuses F1 and F2 (order number 0020.7630.00). The two line fuses are in the socket of the power supply on the rear panel.

To check fuse characteristics

► To find out fuse characteristics, check the label to the right of the power switch on the rear panel. See Figure 17-1.



Figure 17-1: Fuse label

The label lists the characteristics of the fuses. For an explanation of these characteristics, see Table 17-1.

Table 17-1: Fuse characteristics

Label	Description
F1/F2	Name of the fuse. The number relates to the location of the fuse in the fuse holder.
IEC60127-2/5	Standard that the fuse complies with.
T	Triggering characteristic
6.3 A	Rated current
H	Breaking capacity
250 V	Rated power level

For more information, refer to the specifications document.

To change the fuses

1. **WARNING!** The fuse is part of the AC power supply. Handling the fuse while the power is on can lead to electric shock.

   Before changing the fuse:

   a) Set the switch on the power supply to position [0] (**3** in Figure 17-2).

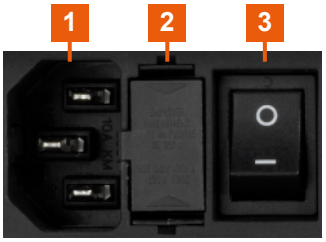


Figure 17-2: Power supply

1 = Power connector: power outlet with ground contact
2 = Fuse holder
3 = Power switch

   b) Disconnect the product from the power source (**1**).

2. Open the cover of the fuse holder (**2**) with a screw driver size 1 or similar.
3. Pull out the fuse holder with a screw driver size 3 or similar.
4. Check the condition of the fuse.
5. Replace the blown fuse. Only use a fuse of the specified type.

   The fuse type and its characteristics are indicated next to the fuse holder, see Table 17-1.
6. Insert the fuse holder into the mains power inlet.
7. Close the cover of the fuse holder.

17.3 Storage

Protect the product against dust. Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the specifications document.

17.4 Performing maintenance tasks

The R&S SMCV100B is accurate due to integrated adjustment procedures and the following additional capabilities that assure correct functioning:

- Internal adjustments
  Internal adjustments are integrated self-calibration routines, which you can execute directly on the instrument.

How to: See Section 17.4.4.3, "How to use the internal adjustments", on page 890.
Self-calibration routines that require additional equipment are performed at an authorized Rohde & Schwarz service center. For description, see the R&S SMCV100B service manual.

- Self-test
  A self-test is provided for service purposes. We recommend that you perform a selftest, if the instrument does not respond as expected.
  How to: Section 17.4.5.2, "How to run hardware module selftests on the R&S SMCV100B", on page 894
- Test points
  If necessary for service purposes, internal test points can be queried. For description, see the R&S SMCV100B service manual.

- Date and time....881
- Check front panel....884
- Check display screen....886
- Internal adjustments....887
- Selftest....892
- FPGA/uC update settings....895

17.4.1 Date and time

The R&S SMCV100B uses an internal real-time clock to determine the date and time. It adjusts the time and date to the timezone of your location automatically, by providing a selection list of continents and cities.

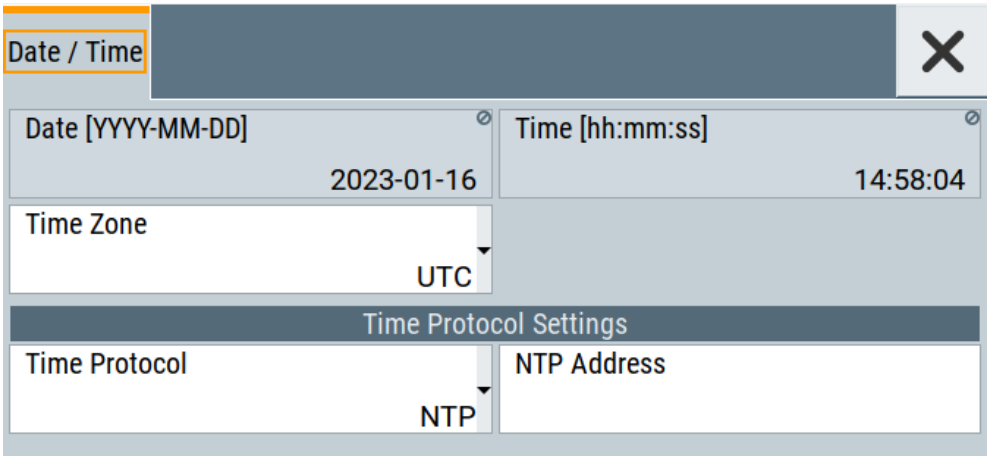
The instrument records the time whenever you create or modify files on your instrument or you use timed licenses. By default, the instrument is set to the UTC timezone, but you can select the timezone according to your location.

Moreover, the instrument supports NTP protocol for synchronizing all connected instruments and computer systems to minimize time delays in the network.

17.4.1.1 Date and time settings

Access:

► Select "System Config" > "Setup" > "Maintenance" > "Date / Time".



The "Date / Time" dialog contains the time and data settings of the operating system.
This function is password-protected. Unlock the protection level 1 to access it.
You can also set the time zone for your location, and select a time protocol controlled by a time server for synchronization.

The required remote commands are described in Section 14.17, "SYSTem subsystem", on page 825.

Settings:

Date....882
Time....882
Timezone....883
Time Protocol....883
NTP Address....883

Date
Displays the date set in the operating system in the format [yyyy.mm.dd].

Remote command:
`:SYSTem:DATE` on page 849

Time
Displays the time set in the operating system in the format [hh.mm.ss].

The time setting corresponds to the selected Timezone.

Remote command:
`:SYSTem:TIME` on page 849

Timezone
Selects the timezone in the date and time settings of the operating system.

You can select the timezone according to the major cities on the respective continents.

Tip: By typing the first letter, you can quickly navigate through the lists to find the desired destination.

Remote command:
`:SYSTem:TIME:ZONE` on page 850
`:SYSTem:TIME:ZONE:CATalog?` on page 850

Time Protocol
Enables the instrument to refer to a network time protocol.

A network time protocol synchronizes the system clocks of all participating devices in a computer network (Ethernet). A time server in the network provides the time base for the connected devices that refer to this time to synchronize events.

You can select a high-precision time protocol to achieve high clock accuracy and thus reduce the impact of varying network delays.

"None" Refers to the selected timezone, see "Timezone" on page 883.

"NTP" Uses the network time protocol (NTP).

Remote command:
`:SYSTem:TIME:PROTocol` on page 850

NTP Address
Sets the IP address or host name of the NTP server.

When the server is detected and verified, the instrument enables the connection automatically.

Remote command:
`:SYSTem:NTP:HOSTname` on page 849
`:SYSTem:NTP:STATe` on page 849

17.4.1.2 How to set date and time

To select the timezone

1. Select "System Config > Setup".
2. Select "Maintenance > Date /Time > Timezone".
3. Select continent and city of your location.
   Tip: By typing the first letter, you can quickly navigate through the lists to find the desired destination.
4. Close the dialogs.

   The instrument adjusts the time according to the selected location.

To set the date and time

1. Select "System Config > Setup".
2. Select "Security > Protection".
3. Enable the "Protection Level 1".
   The default password is *123456*.
4. Select "Setup > Maintenance > Date / Time".
5. Adjust the settings.
6. Close the dialogs.

   The instrument sets the new date and time.

17.4.2 Check front panel

Within this dialog, you can verify the functionality of the control keys.

How To: See Section 17.4.2.2, "How to test the front panel", on page 884

17.4.2.1 Check front panel settings

Access:

► Select "System Config > Setup > Maintenance > Check Front Panel".

Reflecting the front panel, the "Check Front Panel" dialog contains all functions to test the operating elements of the instrument.

17.4.2.2 How to test the front panel

See:

- "Testing the key panel" on page 884
- "Testing the touchscreen" on page 885
- "Terminating the test" on page 886
- "Debugging" on page 886

Testing the key panel

To perform the key panel test, you operate the keys at the front panel, and check the response of the instrument in the "Check Front Panel" dialog. To perform this test properly, check each key of the front panel. The test is only completed, when you have verified all keys.

During the test, the actual functions of the keys are disabled.

1. Select "System Config > Setup".
2. Select "Maintenance > Check Front Panel"

The "Check Front Panel" dialog opens.

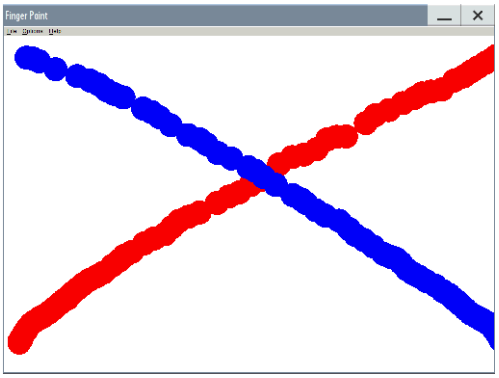
3. Press a key on the front panel.
   Check if the corresponding key in the "Check Front Panel" dialog turns green.
4. Press the same key a second time.
   Check that the key in the dialog turns red.
   Note: Pressing the same key again has no further effect, except for the [Esc] key. Pressing this key a third time, terminates the test procedure.
5. Continue with the next key on the front panel and repeat step 3 to step 5 until all keys are tested.

   The test is completed, when each key is verified successfully, confirmed by a "Test passed" message.

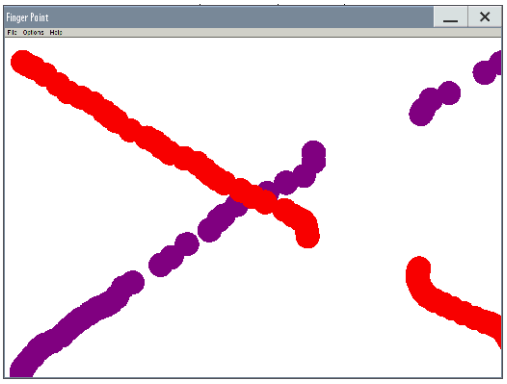
Testing the touchscreen

1. Select "System Config > Setup > Check Touch Panel".
2. Drag with your finger one or more lines, for example diagonally across the screen.
   The test traces the movements of your finger on the screen.

   The following results are expected:
   - If the lines are uninterrupted, the touchscreen works properly.



   - If there are any gaps, the touch-sensitive functionality is damaged.



   - To return to the "Check Front Panel" dialog, press [Esc].

Terminating the test

► Press the [Esc] key.

Exits the "Check Front Panel" dialog.

Debugging

1. If you detect a malfunction, for example, when you press the front panel key for the first time, and the color of the button in the dialog turns red (instead of green), the front panel key has probably stuck.
2. Contact the Rohde & Schwarz customer support, see Section 15.9, "Collecting information for technical support", on page 874.

17.4.3 Check display screen

Using this function, you can verify the color depth and gradient, pixels and the text display of the screen.

Access:

► Select "System Config > Setup > Maintenance > Check Display Screen".

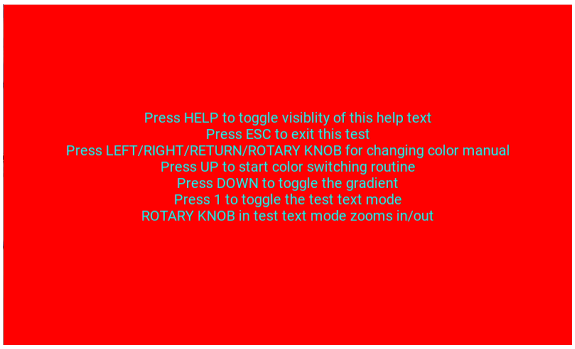
The R&S SMCV100B fades out the current display and indicates the screen in red. Short instructions on the screen explain how to execute the test.

The remote commands required to define these settings are described in Section 14.19, "TEST subsystem", on page 857.

Testing the display screen

To test the screen display on the R&S SMCV100B manually, you need a keypad with cursor and numeric keys.

1. Connect an external keyboard to the USB interface.
2. Select "System Config" > "Setup" > "Maintenance" > "Check Display Screen".
3. Test the color and gradient of the display screen:



a) Use the [Help] key to hide the indicated text.
b) To toggle between the provided colors manually, use the [Left/Right] cursor keys.
The R&S SMCV100B provides the colors red, green, blue, white, three levels of gray shades and black.
c) To switch between the screen colors automatically, use the [Up] key.
d) To toggle the gradient, use the [Down] key.

4. Check if the R&S SMCV100B indicates the text correctly:
   a) Press [1] on the numeric keypad.
   The R&S SMCV100B displays a test text over the entire screen.
   b) To inspect the text in detail, you can use the rotary knob to zoom it out.
5. To exit the test, press the [Esc] key.

Check Display Screen.....887

Check Display Screen
Opens the test window with instructions on how to perform the test.

Remote command:
`:TEST:PIXel:WINDow` on page 860
`:TEST:PIXel:COLor` on page 859
`:TEST:PIXel:RGBA` on page 859
`:TEST:PIXel:GRADient` on page 859
`:TEST:PIXel:TEXT` on page 859
`:TEST:PIXel:POINtsize` on page 859

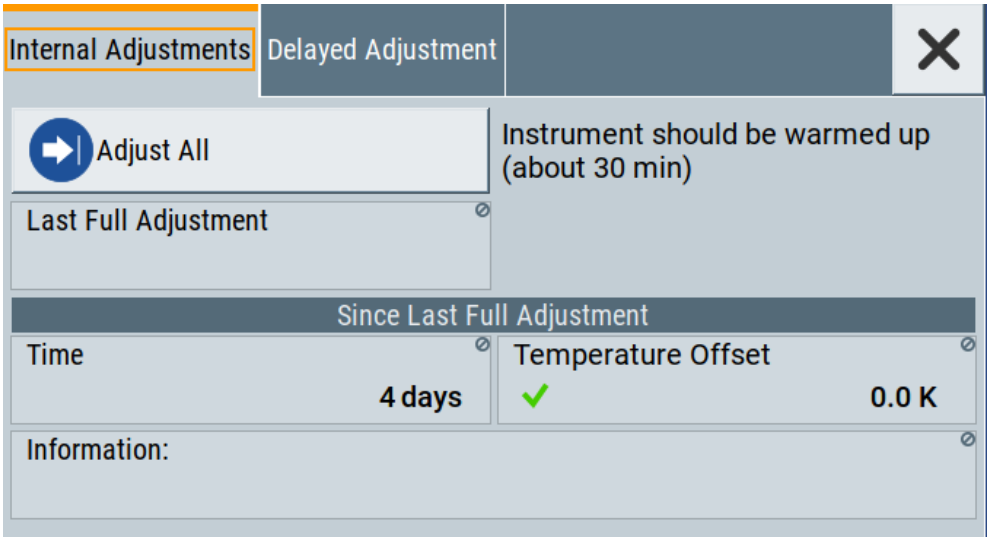
17.4.4 Internal adjustments

Using the integrated adjustment procedures, you can start the calibration directly on the instrument.

17.4.4.1 Internal adjustment settings

Access:

► Select "System Config > Setup > General > Internal Adjustments".



In this dialog, you can perform internal calibration routines, and get information on the last performed calibration.
The "Temperature Offset" indicates the deviation of the current temperature of the instrument, compared to the temperature of the last adjustment.

The remote commands required to define these settings are described in Section 14.6, "CALibration subsystem", on page 602.

How to: See Section 17.4.4.3, "How to use the internal adjustments", on page 890.

Settings

Adjust All
Executes all available internal calibration routines of the instrument.

Note: Before you start the internal adjustment, make sure that you have connected a termination resistor, if necessary.

Remote command:
`:CALibration:ALL[:MEASure]?` on page 602

Last Full Adjustment
Displays the date of the last fully performed adjustment.

Remote command:
`:CALibration<hw>:ALL:DATE?` on page 603

Time
Displays the elapsed time since the last full adjustment.

Remote command:
:CALibration<hw>:ALL:TIME? on page 604

Temperature Offset
Displays the temperature difference, comparing the temperature of the last adjustment to the current instrument temperature.

A green checkmark indícates that the offset is within the permitted range. If the temperature deviates more than ±5 K, the instrument indicates a warning icon.

Remote command:
:CALibration<hw>:ALL:TEMP? on page 603

Information
Displays information to the current adjustment state.

Remote command:
:CALibration<hw>:ALL:INFormation? on page 603

Continue Adjustment on Error
Continues the calibration even though an error was detected. By default adjustments are aborted on error.

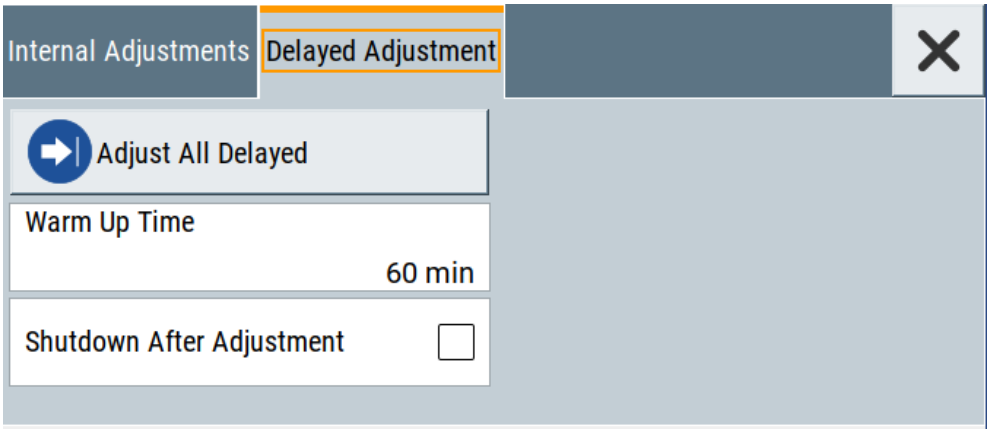
This function is password-protected. Unlock the protection level 1 to access it.

Remote command:
:CALibration<hw>:CONTinueonerror on page 604

17.4.4.2 Delayed adjustment settings

Access:

► Select "System Config > Setup > General > Delayed Adjustment".



In this dialog, you can set the internal adjustments to start automatically after the selected warm up time and to switch off the instrument after calibration.

The remote commands required to define these settings are described in Section 14.6, "CALibration subsystem", on page 602.

Settings

Adjust All Delayed 890
Warm Up Time 890
Shutdown After Adjustment 890

Adjust All Delayed
Performs all available internal calibration routines of the instrument.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay[:MEASure]?` on page 605

Warm Up Time
Sets the time for warming up the instrument before the calibration starts automatically.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay:MINutes` on page 605

Shutdown After Adjustment
Enables the automatic shutdown after internal adjustments.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay:SHUTdown[:STATe]` on page 605

17.4.4.3 How to use the internal adjustments

Deciding whether to run internal adjustments

1. Select "System Config > Setup > Internal Adjustment".
2. Check the status and color indication in the section "Since Last Full Adjustment".

   Green: internal adjustments are not required.
   Red: internal adjustments are required. Observe also the indication in the "Information" field.
3. We recommend that you run internal adjustments in the following cases:
   - Before starting any application that requires a maximum of level accuracy.
   - When a long period of time has passed since the last adjustments.
   - If the ambient temperature of the instrument significantly differs from the one of the last adjustments.
4. Proceed as described in "Running internal adjustments" on page 890.

Running internal adjustments

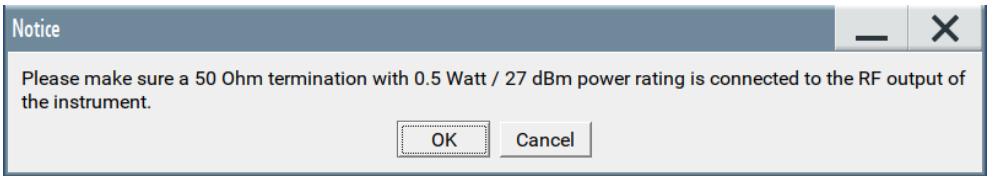
1. After switching on, the R&S SMCV100B requires up to 30 minutes to warm up. Wait until the instrument has reached operating temperature to achieve accurate adjustments.

2. **NOTICE!** High output power can damage the DUT. For instruments shipped with firmware versions up to FW 5.00.122.24, high power at the RF 50 Ω output can destroy a connected device under test.

   Connect a 50 Ohm terminating resistor with 0.5 W / 27 dBm power rating to the RF 50 Ω output. Terminate the RF output each time before you execute internal adjustments.

3. Select "System Config > Setup > Internal Adjustment > Adjust All".

   For instruments that have been shipped with FW 5.10.122.24 and earlier, a warning message prompts you to confirm that you have terminated the RF output.



4. Confirm with "Ok".

   The adjustment process starts.

   The adjustment process takes some time depending on the equipment of the instrument.
   If any error occurs, the process aborts. To resolve adjustment issues, see Section 15.6, "Resolving errors during internal adjustments", on page 869.

Starting internal adjustments automatically

The delayed adjustment function executes the adjustments automatically. You can set the warm-up time and shut down after the adjustment process finishes. Using this function, you can execute adjustments without being on-site and start measurements directly when back.

1. If necessary, terminate the RF 50 Ω output. See "Running internal adjustments" on page 890.
2. Select "System Config > Setup > General > Internal Adjustment".
3. Select "Delayed Adjustment".
4. Set the "Warm Up Time", e.g. *40 min*.

   The R&S SMCV100B requires a warm-up time of at least 30 min.

5. Enable "Shut Down After Adjustment"
6. Select "Adjust All Delayed".

   The process starts with warming up the instrument, indicating the progress in a status dialog. In this dialog, you can abort the process again, if necessary.
   After warming up, the R&S SMCV100B executes the internal adjustments and shuts down when finished.

17.4.5 Selftest

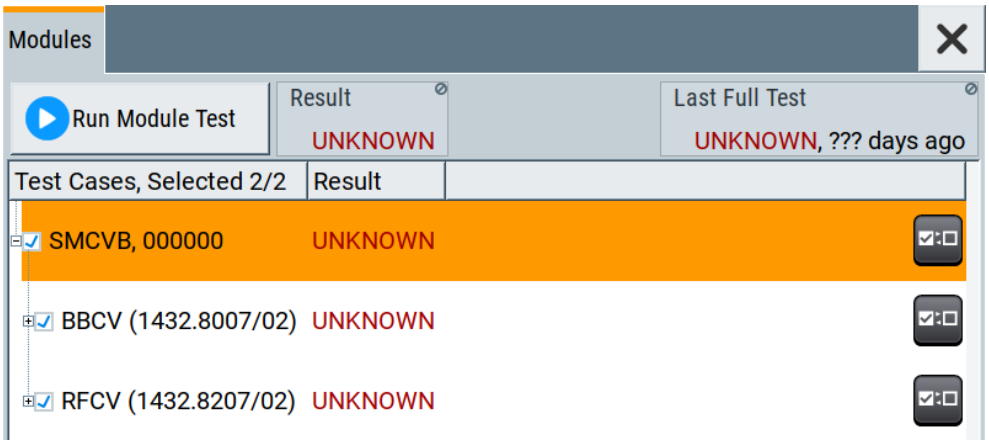
Self-test is provided for service purposes.

17.4.5.1 Selftest modules settings

Access:

► Select "System Config > Setup > Maintenance > Selftest".

The "Modules" dialog opens.



The dialog contains parameters for testing the baseband and RF hardware modules of the R&S SMCV100B.

The remote commands required to define these settings are described in Section 14.19, "TEST subsystem", on page 857.

Run Module Test 892
Result 892
Last Full Test 893
Test table 893

Run Module Test
Runs selftests of the hardware modules selected in the test table.

You can run seftests for the "BBCV" baseband module and the "RFCV" RF module. Also you can execute the tests separately.

Remote command:
`:TEST<hw>:ALL:STARt` on page 858

Result
Displays the result of the hardware module selftests.

Remote command:
`:TEST<hw>:ALL:RESult?` on page 858

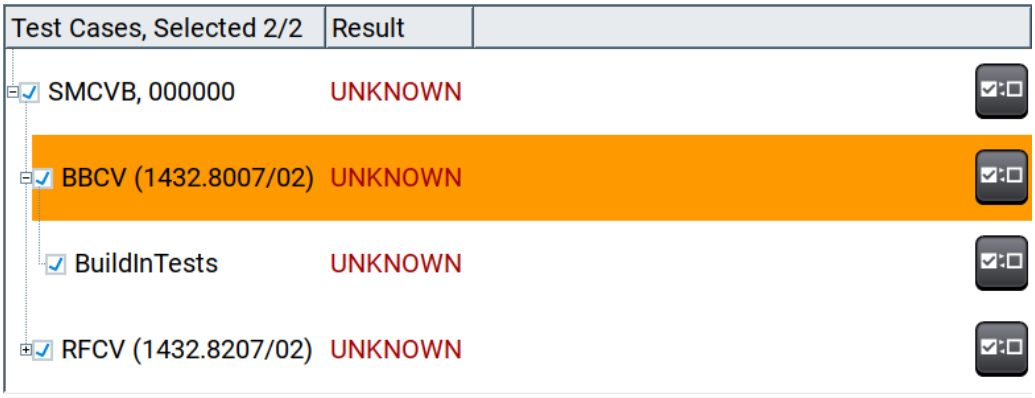
Last Full Test
Displays the result and date of the last hardware module test run including the elapsed time since the last test run.

For example, "PASS, 4 Jul 20, 10 days ago" implies a successful test on July 04, 2020.

Remote command:
`:TEST<hw>:ALL:RESult?` on page 858

Test table
Displays hardware module selftests available on the R&S SMCV100B.

The table displays the R&S SMCV100B, its serial number, available test cases, test types and test case results.



"Instrument, Serial number"
Displays the instrument and its serial number, e.g., "SMCVB, 123456".
Click ⊞ to monitor installed test cases and test types.

"Test cases, Test types"
Displays the test case name and part number installed on the R&S SMCV100B including the test type. The following test cases are available:

Test case	Part number	Test types
"BBCV"	1432.8007/02	"BuildInTests"
"RFCV"	1432.8207/02	"BuildInTests"

"Result"
The column displays the selftest results for the instrument, the test cases and the test types.

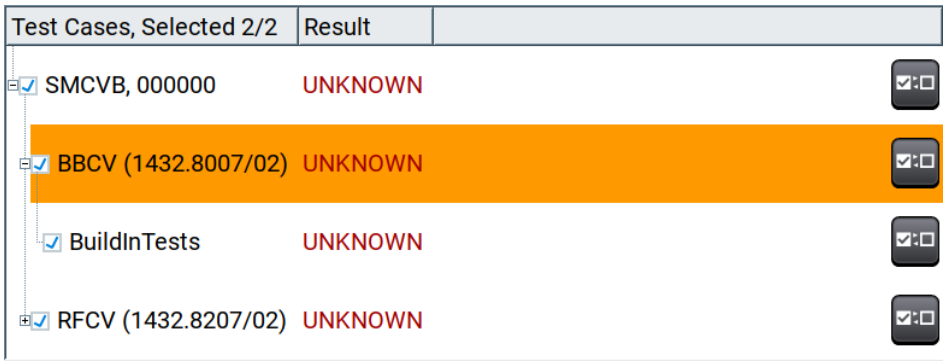
- "UNKNOWN": No test result available. Select the test and click "Run Module Test" to get test results.
- "PASS": The test is successful.
- "ERROR/FAIL": The test is erroneous.
  If you receive an error result, contact the R&S Support, see Section 15.10, "Contacting customer support", on page 876.

Remote command:
`:TEST<hw>:ALL:RESult?` on page 858

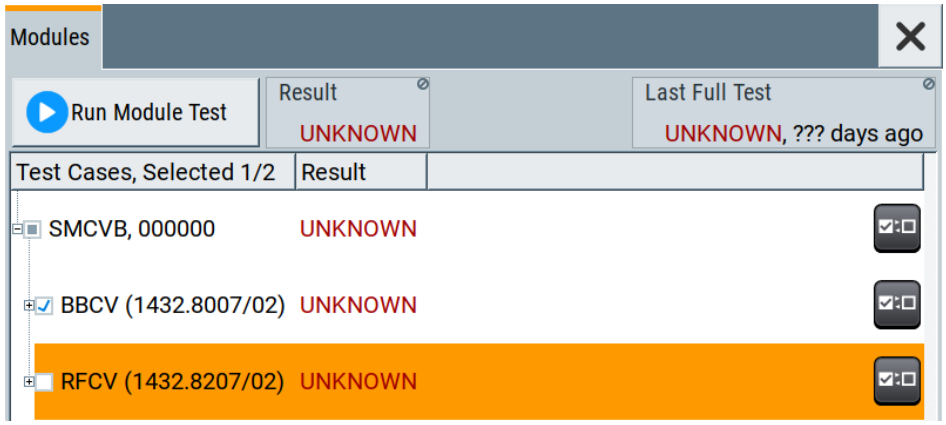
17.4.5.2 How to run hardware module selftests on the R&S SMCV100B

For related settings, see Section 17.4.5.1, "Selftest modules settings", on page 892.

1. Select "System Config > Setup > Maintenance > Selftest > Modules".
2. In the test table, select test cases that you want to execute. By default, the "BBCV" and "RFCV" test cases are selected.
   a) To view test types included in the test case, click ⊞ on the left of the test case. The "BBCV" and "RFCV" offer build-in tests.

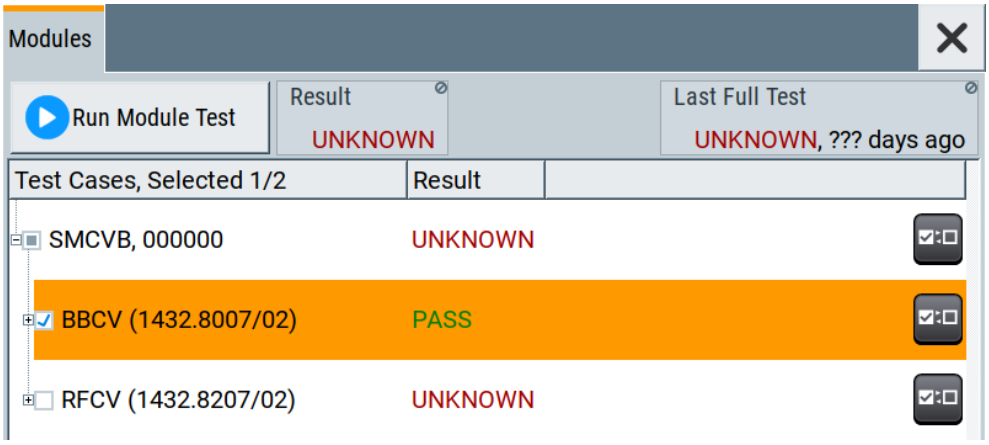


   b) To deselect a test case, click ☑ on the right of the test case. For example, deselect "RFCV".

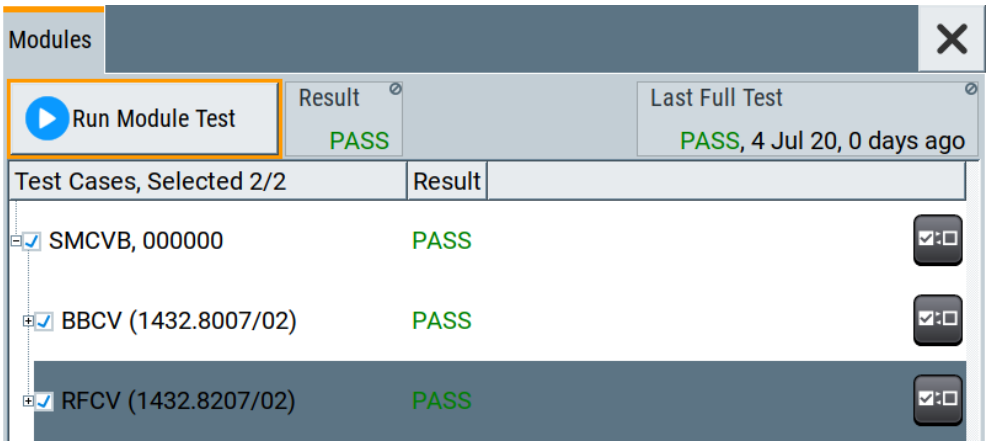


3. Click "Run Module Test".

   The selected test case tests are executed. After the test run, results with "PASS" or "FAIL" information are available. "UNKNOWN" indicates, that no results are available.



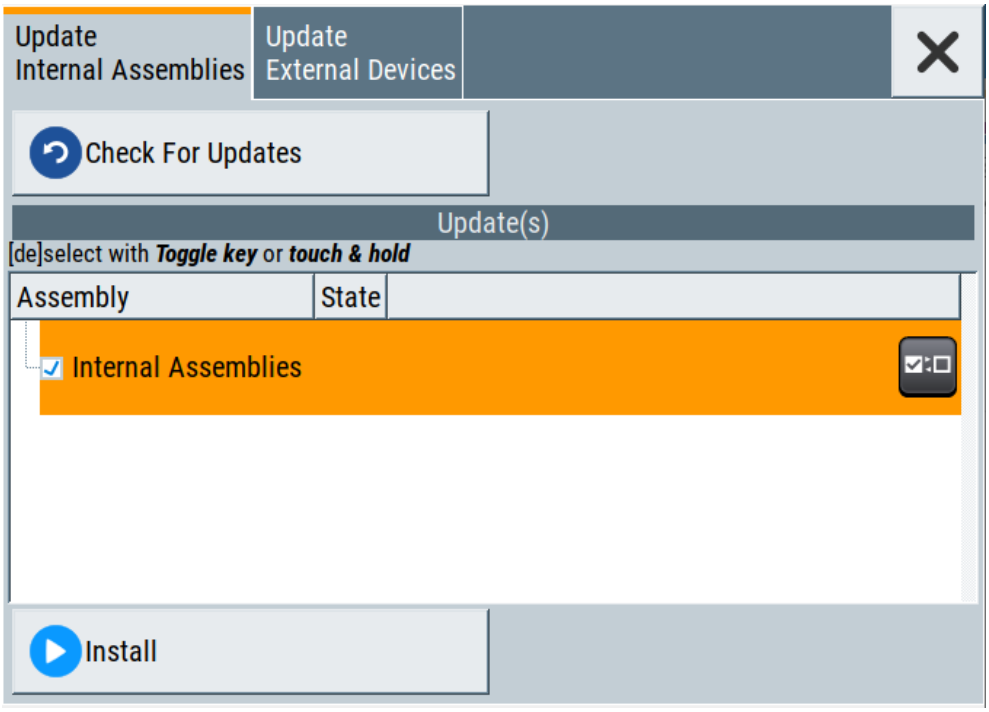
4. To retrieve composite result information, select all test cases and click "Run Module Test".
   To the right of the "Run Module Test" button, the full selftest "Result" and "Last Full Test" including the test result and the date of the last full test and the elapsed time since the last test run.



17.4.6 FPGA/uC update settings

Access:

► Select "System Config > Setup > Maintenance > FPGA/µC Update".



This dialog enables you to check for internal assembly updates and perform updates.

Settings:

Check For Updates 896
Assembly 896
Install 896
Update External Devices 896
└ Check For Updates 897

Check For Updates
Check for updates of the FPGA/µC.

Remote command:
n.a.

Assembly
The table shows the installed assemblies and their states.

"Assembly" Assembly designation.

"State" Indicates the current state of installed assemblies.

Install
Install all available updates for the FPGA/µC.

Remote command:
n.a.

Update External Devices
This dialog shows the update options of external devices connected to the instrument.

Check For Updates ← Update External Devices
Check for updates of external devices.

Remote command:
n.a.

17.5 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

Disposing of electrical and electronic equipment

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.



Figure 17-3: Labeling in line with EU directive WEEE

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

Annex

A Available user files and file extensions

The table Table A-1 lists available file extensions for user files on the instrument. Some files depend on the installed options.

For more information, refer to the specifications document.

Table A-1: User files and file extensions on the instrument

Context or function	Content type	File contents	File extension
Instrument state	Settings	Instrument settings	`*.savrcltxt`
User menu	Settings	User-defined favorite settings	`*.user_menu`
License key	License	License key	`*.xml`
User correction	List	User-defined level correction values	`*.uco`
List Mode	List	User-defined frequency/level value pairs	`*.lsw`
Power sensing	Settings	R&S NRP settings	`*.nrp`, `*.rsu`
SCPI command list	List	Export file containing list of SCPIs	`*.iec`
SCPI command script	Command script	SCPI script file formats: Plain SCPI, MATLAB, NICVI, Python3	`*.txt`, `*.m`, `*.c`, `*.py`
R&S support information	Support file	Automatically collected support information	`*.tar.gz`
Tutorials	Tutorial files	Lists containing SCPIs and explanations	`*.tut`
ARB	Waveform	ARB waveforms ARB multi-segment waveforms	`*.wv`
ARB	I/Q data files	I/Q data	`*.iq.tar`, `*.csv`, `*.mat`
ARB	Waveform	ARB multicarrier settings	`*.arb_multcarr`
ARB	Configuration data	Configuration file for creation of multisegment ARB waveforms	`*.inf_mswv`
ARB	Play List	ARB Sequencing List	`*.wvs`
Baseband filtering	Settings	User Filter	`*.dat`
I/Q data file	Settings	User-defined I/Q-File	`*.iqw`
Custom digital modulation	Data List	Digital modulation data	`*.dm_iqd` `*.tdm`
Custom digital modulation	Control List	Data to control digital modulation	`*.dm_iqc`
Custom digital modulation	Settings	Digital modulation settings	`*.dm`
Custom digital modulation	User standard	Digital modulation user standard	`*.dm_stu`

Context or function	Content type	File contents	File extension
Custom digital modulation	User mapping	Digital modulation user mapping	*.vam
Custom digital modulation	User Filter	Digital modulation user filter	*.vaf

B ARB *.csv file format

The `*.csv` file format and structure is sufficient for loading into the ARB application of the R&S SMCV100B.

```
# Saved by Rohde & Schwarz (version 0.4.0)
MandatoryData
    Name;TestImportInSMW
    Comment;test to import csv in siggen.
    DateTime;2024-2-2T18:47:33
    Format;complex
    DataType;float32
    NumberOfChannels;1
    Ch1_ChannelName;Kanal0
    Ch1_Samples;6
    Ch1_Clock[Hz];2.20E+9
    Ch1_CenterFrequency[Hz];1.33E+9
    DataImportExport_EndHeaderSection
    Kanal0_I;Kanal0_Q
        I_1;Q_1
        ..
        I_n;Q_n
```

C Unit shortcuts

When specifying units or quantities during data entry, the R&S SMCV100B provides the following shortcuts for simplified input.

Shortcut	Designation	Context	Unit
a, A	ampere	Current	A
	atto-	Area, surface	am^2
c, C	centi-	Distance, length	cm
d, D	deci-	Distance, length	dm
		Level, power	dB, dBFS, dBm, dBU, dBW
	degree	Phase, polar/spherical coordinates	deg
e, E	exa-	Area, surface	em^2
f, F	femto-	Area, surface	fm^2
g, G	giga-	Area, surface	Gm^2
		Data rate, sample rate, symbol rate	Gbit/s, Gsample/s, Gsymbol/s, Gchip/s
		Frequency	GHz
		Impedance, resistance	GΩ
h, H	hertz	Frequency	Hz
k, K	kilo-	Area, surface	km^2
		Data rate, sample rate, symbol rate	kbit/s, ksample/s, ksymbol/s, kchip/s
		Distance, length	km
		Frequency	kHz
		Impedance, resistance	kΩ
		Velocity	km/h
m, M	milli-	Area, surface	mm^2
		Current	mA
		Distance, length	mm
		Electromagnetic force, level	mV
		Power	mW
		Time, period, etc.	ms
	mega-	Area, surface	Mm^2
		Data rate, sample rate, symbol rate	Mbit/s, Msample/s, Msym/s, Mchip/s
		Frequency	MHz
		Impedance, resistance	MΩ

Shortcut	Designation	Context	Unit
n, N	nano-	Area, surface	nm^2
		Current	nA
		Distance, length	nm
		Electromagnetic force, level	nV
		Power	nW
		Time, period, etc.	ns
o, O	ohm	Impedance, resistance	Ω
p, P	peta-	Area, surface	pm^2
	percent	Level, ratio	%
	pico-	Area, surface	pm^2
		Current	pA
		Electromagnetic force, level	pV
		Power	pW
		Time, period, etc.	ps
r, R	radiant	Phase, polar/spherical coordinates	rad
s, S	second	Time, period, etc.	s
t, T	terra-	Area, surface	Tm^2
		Data rate, sample rate, symbol rate	Tbit/s, Tsample/s, Tsym/s, Tchip/s
		Frequency	THz
		Impedance, resistance	TΩ
u, U	micro-	Current	µA
		Distance, length	µm
		Electromagnetic force, level	µV
		Power	µW
		Time, period, etc.	µs
v, V	volt	Level, voltage	V
w, W	watt	Level, power	W

Glossary: Terms and abbreviations

Symbols

/hdd: Provided for backward compatibility with R&S SMBV in remote control; internally mapped to /var/user/.

A

Avahi: A licensed Zeroconf networking feature, including DNS service. The feature enables a device to self-configure an IP address and subnet mask automatically, when a DHCP server in the LAN is not available.

B

Base unit: This term describes a R&S SMCV100B equipped with baseband generator and R&S SMCVB-B103.

Baseband: The baseband signal, i.e. the I/Q stream at the output of the "Baseband" block.
In rear cases, the term Baseband is used as abbreviation of a "Baseband" block itself.

Baseband domain: A common term for signal processing up to the I/Q modulation. The signal in the baseband domain of the R&S SMCV100B is digital.

Baseband signal: Baseband

BS: Base station

C

Channel (digital Input, Digital Output): The signal provided at a digital interface connector or the output stream at the digital output interface can consist of several multiplexed channels. Do not mistake the term *channel* used here with the term signal path. A digital channel is a part of an I/Q stream.

Clock: A mandatory reference clock signal for generating the timing pulse in the instrument.

Complete file path: The complete file path specifies the root directory and all subdirectories that contain a file or folder.
Synonyms to this expression are "full file path" and "absolute file path".
See also Section 14.5.2, "Handling files in the default or in a specified directory", on page 591.

Computer name: Hostname

Continuous Wave Mode: CW/Mod

CW/Mod: An internally generated control signal that turns off/on digital modulation, i.e. the signal is generated in unmodulated form.

D

Daisy chain: A connection scheme in which instruments are connected together in sequence, i.e. an output of the first one is connected to an input of the second one, etc.

DHCP: Dynamic Host Configuration Protocol

DNS: Domain Name System server

E

e.g.: For example

F

File transfer: The transmission of files from or to the instrument by a remote client. The instrument supports the standard methods File Transfer Protocol (FTP) and file sharing according to Server Message Protocol (SAMBA/SMB).

G

Glossary: List of the often used terms and abbreviations

GUI: Graphical User Interface

H

Hostname: An unambiguous indication of the instrument in a LAN that uses a DNS server.
The default hostname follows the syntax `SMCV100B-<serial number>`, e.g. *SMCV100B-102030*.
See Serial number.
Synonym: Computer name

HUMS: Health and utilization monitoring system.

I

i.e.: That is

I/Q Stream: Stream

L

Level: In the Baseband domain, a term describing the signal level of the independent I and Q signals during signal processing (e.g. baseband signal leveling, modulation, etc.).

LSB: Least significant bit

M

Marker: User-defined digital signal for synchronizing external devices to the generated data stream.
Do not mistake the term *marker (signal)* used here with the term Marker (graphical signal display).

Marker (graphical signal display): Markers are tools for numerical readout of measured data in diagrams.

Marker signal: Marker

MIMO: Multiple Input Multiple Outputs

mSata: Memory that holds the operating system, the firmware, and used data. Throughout this description, this memory is referred as an internal memory.

MSB: Most significant bit

MxN: Representation of a MIMO system, where M is the number of the transmitting Tx antennas and N the number of the receiving Rx antennas.

N

NTP: (Network Time Protocol)
A networking protocol for highly accurate clock synchronization between computer systems and instruments in local area networks, or over the public Internet.

P

PC: Personal computer

PN sequence: PRBS generator

Power: A term describing the signal level in the RF domain or defining the length of the I/Q vector in the Baseband domain.

PRBS generator: Delivers pseudo-random binary sequences of differing length and duration. They are known as maximum length sequences, and are generated with the aid of ring shift registers with feedback points determined by the polynomial.

Primary-secondary instrument mode: Setup with one or two R&S SMCV100B connected to one R&S SMW. In this multi-instrument setup, the R&S SMCV100B operates as secondary instrument.
The primary instrument generates and outputs a dedicated synchronization signal (Sync Out), that has to be fed into the secondary instruments.
See Section 10, "Configuring a multi-instrument setup", on page 411.

Product page: A designation of the R&S SMCV100B product page www.rohde-schwarz.com/product/SMCV100B.html

R

Remote access: Remote operation

Remote control: The operation of the R&S SMCV100B by remote control commands or programs to perform automated tests. The instrument is connected to a system controller via LAN/VXI-11 or USB using Virtual Instrument Software Architecture (VISA). The instrument is controlled either directly, or supported by instrument drivers.

Remote device: External device controls the R&S SMCV100B in remote operation mode, see Remote operation.
Synonyms: External controller, Client device,

Remote operation: Allows you to operate the R&S SMCV100B from a remote device via VNC.
Both the R&S SMCV100B and the remote device are connected in a LAN.
Synonym: Remote access

Removable memory: General term describing mass memory that can be unmounted from the instrument.

RF: Radio Frequency

S

Serial number: Unique instrument identification, provided on the rear panel of the instrument and required to build the Computer name.
The serial number are the last 6 digits in the string `<stock no.>-<serial number>`, e.g. `SMCV100B-102030`.
See Figure 3-4.

SISO: Single Input Single Output

Smart device: A mobile, cordless device, such as a smartphone or tablet, capable of Internet browsing.
Synonyms: Smartphone, Tablet

Star configuration: A connection scheme for several instruments that consists of one central instrument and several other instruments, all connected to the central one.

Stream: An I/Q stream describes the signal at the input of the "I/Q Stream Mapper" up to the output connectors of the instrument.

Symbol Clock: Represents the frequency and exact timing of the transmission of the individual symbols

Symbol Rate: Calculated as follows:
"Symbol Rate" = "Bit Rate" / Number of bits transmitted with each symbol

Sync signal: In primary-secondary instrument mode, this term describes the signal generated by the primary instrument and fed to the secondary instruments.
The synchronization signal is a precise signal that facilitates the time alignment between the instruments and acts as trigger signal.

System drive: The system drive is a µSD card that holds the operating system, the firmware, and the user data.
Throughout this description, the system drive is referred as an internal memory.

T

Trigger: Internally generated or externally supplied signal which starts signal generation at a particular point in time.

Trigger event: A trigger event is caused by the received trigger signal or executed manual trigger.

U

UE: User equipment

USBTMC: (USB Test & Measurement Class)
A protocol built on top of USB for communication with USB devices. Using VISA library, it supports service request, triggers, and other specific operations.

User directory: Describes the default file storage location for user data.
In the file system, user directory is indicated as **`/var/user/`**.
It is physically located on the internal memory or on the removable memory.

W

Waveform: A file with settings provided for repeatable tests with the same test signal.

Z

Zeroconf: Zero-configuration, see Avahi.

Glossary: Publications and references

Symbols

1EF85: Rohde & Schwarz application note x "Recording and Converting of R&S I/Q Data Files"
www.rohde-schwarz.com/appnote/1MA074

1GP141: Rohde & Schwarz application note "Using R&S® Power Sensors with R&S®Signal Generators"
www.rohde-schwarz.com/appnote/1GP141

1MA074: Rohde & Schwarz application note "RSCommander"
www.rohde-schwarz.com/appnote/1MA074

1MA99: Rohde & Schwarz application note "Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment"
www.rohde-schwarz.com/appnote/1MA99

1MA100: Rohde & Schwarz application note "Test Port Adapter, R&S Interchangeable Port Connector"
www.rohde-schwarz.com/appnote/1MA100

R

R&S iq-tar: Rohde & Schwarz manual "Rohde & Schwarz iq-tar File Format Specification"
For example available at:
www.rohde-schwarz.com/manual/fsw/

List of remote commands (base unit)

:CALibration:ALL[:MEASure]? 602
:CALibration:DATA:EXPort 604
:CALibration:DATA:FACTory:DATE? 604
:CALibration:DELay:MINutes 605
:CALibration:DELay:SHUTdown[:STATe] 605
:CALibration:DELay[:MEASure]? 605
:CALibration:ROSCillator[:DATA] 605
:CALibration<hw>:ALL:DATE? 603
:CALibration<hw>:ALL:INFormation? 603
:CALibration<hw>:ALL:TEMP? 603
:CALibration<hw>:ALL:TIME? 604
:CALibration<hw>:CONTinueonerror 604
:DEVice:PRESet 589
:DIAGnostic:INFO:OTIMe? 608
:DIAGnostic:INFO:POCount? 608
:DIAGnostic<hw>:BGINfo:CATalog? 607
:DIAGnostic<hw>:BGINfo? 607
:DIAGnostic<hw>:POINt:CATalog? 609
:DIAGnostic<hw>[:MEASure]:POINt? 609
:DISPlay:ANNotation:AMPLitude 619
:DISPlay:ANNotation:FREQuency 619
:DISPlay:ANNotation[:ALL] 620
:DISPlay:BRIGhtness 618
:DISPlay:BUTTon:BRIGhtness 619
:DISPlay:DIALog:CLOSe 621
:DISPlay:DIALog:CLOSe:ALL 621
:DISPlay:DIALog:ID? 620
:DISPlay:DIALog:OPEN 621
:DISPlay:PSAVe:HOLDoff 618
:DISPlay:PSAVe[:STATe] 618
:DISPlay:UPDate[:STATe] 619
:FORMat:BORDer 622
:FORMat:SREGister 622
:FORMat[:DATA] 622
:FPANel:KEYBoard:LAYout 628
:HCOPy:DATA? 624
:HCOPy:DEVice:LANGuage 624
:HCOPy:FILE[:NAME] 625
:HCOPy:FILE[:NAME]:AUTO:DIRectory 626
:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar 626
:HCOPy:FILE[:NAME]:AUTO:FILE? 626
:HCOPy:FILE[:NAME]:AUTO:STATe 627
:HCOPy:FILE[:NAME]:AUTO? 626
:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer? 627
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix 628

:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe....628
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe....627
:HCOPy:IMAGe:FORMat....624
:HCOPy:REGion....625
:HCOPy[:EXECute]....625
:INITiate<hw>[:POWer]:CONTinuous....637
:KBOard:LAYout....628
:MEMory:HFRee?....601
:MMEMory:CATalog:LENGth?....595
:MMEMory:CATalog?....595
:MMEMory:CDIRectory....595
:MMEMory:COPY....596
:MMEMory:DATA....596
:MMEMory:DATA:UNPRotected....597
:MMEMory:DCATalog:LENGth?....599
:MMEMory:DCATalog?....598
:MMEMory:DELete....599
:MMEMory:LOAD:STATe....599
:MMEMory:MDIRectory....600
:MMEMory:MOVE....600
:MMEMory:MSIS....600
:MMEMory:RDIRectory....600
:MMEMory:RDIRectory:RECursive....601
:MMEMory:STORe:STATe....601
:OUTPut:ALL[:STATe]....629
:OUTPut:USER<ch>:DIRection....663
:OUTPut:USER<ch>:SIGNal....664
:OUTPut<hw>:AFIXed:RANGe:LOWer?....631
:OUTPut<hw>:AFIXed:RANGe:UPPer?....631
:OUTPut<hw>:AMODe....630
:OUTPut<hw>:IMPedance?....630
:OUTPut<hw>:PROTection:CLEar....631
:OUTPut<hw>:PROTection:TRIPped?....631
:OUTPut<hw>[:STATe]....629
:OUTPut<hw>[:STATe]:PON....630
:READ<ch>[:POWer]?....638
:SCONfiguration:EXTernal:ACONnect....652
:SCONfiguration:EXTernal:DISPlay....652
:SCONfiguration:EXTernal:HSDigital<ch>:DIRection?....653
:SCONfiguration:EXTernal:HSDigital<ch>:INAMe?....653
:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe?....653
:SCONfiguration:EXTernal:HSDigital<ch>:RCONnection:STATe?....653
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:CONNect....658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect?....657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DISConnect....659
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ICONnect....658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?....658
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INITialization:FILE....659
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:ISELect....657
:SCONfiguration:EXTernal:HSDigital<ch>:REMote:SEND....660

:SCONfiguration:EXTernal:HSDigital<ch>:RF:COUPling 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency:OFFSet 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer 654
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer:OFFSet 655
:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe 655
:SCONfiguration:EXTernal:PBEHaviour 652
:SCONfiguration:EXTernal:REMote:ADD 656
:SCONfiguration:EXTernal:REMote:CLEan 660
:SCONfiguration:EXTernal:REMote:CONNect[:ALL] 652
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL] 652
:SCONfiguration:EXTernal:REMote:INITialization:CATalog? 659
:SCONfiguration:EXTernal:REMote:LIST? 656
:SCONfiguration:EXTernal:REMote:PURGe 659
:SCONfiguration:EXTernal:REMote:REName 657
:SCONfiguration:EXTernal:REMote:SCAN 655
:SCONfiguration:EXTernal:REMote:SCAN:STATe? 655
:SCONfiguration:MULTiinstrument:MODE 649
:SCONfiguration:MULTiinstrument:STATe 649
:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization? 650
:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe 650
:SCONfiguration:OUTPut:MAPPing:RF:STReam<st>:STATe 650
:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset 650
:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset 651
:SENSe<ch>:UNIT[:POWer] 639
:SENSe<ch>[:POWer]:APERture:DEFault:STATe 639
:SENSe<ch>[:POWer]:APERture:TIMe 639
:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST? 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect 640
:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe 640
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority 640
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe 641
:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO? 641
:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] 641
:SENSe<ch>[:POWer]:FILTer:NSRatio 642
:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe 642
:SENSe<ch>[:POWer]:FILTer:SONCe 642
:SENSe<ch>[:POWer]:FILTer:TYPE 643
:SENSe<ch>[:POWer]:FREQuency 643
:SENSe<ch>[:POWer]:LOGGing:STATe 644
:SENSe<ch>[:POWer]:OFFSet 644
:SENSe<ch>[:POWer]:OFFSet:STATe 644
:SENSe<ch>[:POWer]:SNUMber? 645
:SENSe<ch>[:POWer]:SOURce 645
:SENSe<ch>[:POWer]:STATus[:DEVice]? 645
:SENSe<ch>[:POWer]:TYPE? 646
:SENSe<ch>[:POWer]:ZERO 646
:SLISt:CLEar:LAN 636
:SLISt:CLEar:USB 636
:SLISt:CLEar[:ALL] 637

:SLISt:ELEMent<ch>:MAPPing 637
:SLISt:SCAN:LSENsor 635
:SLISt:SCAN:USENsor 636
:SLISt:SCAN[:STATe] 635
:SLISt:SENSor:MAP 637
:SLISt[:LIST]? 635
:SOURce<hw>:PRESet 589
:STATus:OPERation:CONDition? 854
:STATus:OPERation:ENABle 854
:STATus:OPERation:NTRansition 855
:STATus:OPERation:PTRansition 855
:STATus:OPERation[:EVENt] 854
:STATus:PRESet 855
:STATus:QUEStionable:CONDition 855
:STATus:QUEStionable:ENABle 856
:STATus:QUEStionable:NTRansition 856
:STATus:QUEStionable:PTRansition 856
:STATus:QUEStionable[:EVENt] 856
:STATus:QUEue[:NEXT]? 857
:SYSTem:BIOS:VERSion? 851
:SYSTem:COMMunicate:HISLip:RESource? 836
:SYSTem:COMMunicate:NETWork:IPADdress 837
:SYSTem:COMMunicate:NETWork:IPADdress:MODE 837
:SYSTem:COMMunicate:NETWork:MACaddress 837
:SYSTem:COMMunicate:NETWork:RESource? 837
:SYSTem:COMMunicate:NETWork:RESTart 838
:SYSTem:COMMunicate:NETWork:STATus? 838
:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain 838
:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname 838
:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway 839
:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK 839
:SYSTem:COMMunicate:SOCKet:RESource? 839
:SYSTem:COMMunicate:USB:RESource? 840
:SYSTem:DATE 849
:SYSTem:DFPRint 852
:SYSTem:DLOCk 833
:SYSTem:ERRor:ALL? 830
:SYSTem:ERRor:CODE:ALL? 830
:SYSTem:ERRor:CODE[:NEXT]? 831
:SYSTem:ERRor:COUNt? 831
:SYSTem:ERRor:GNEXt? 832
:SYSTem:ERRor:HISTory:CLEar 832
:SYSTem:ERRor:STATic? 833
:SYSTem:ERRor[:NEXT]? 832
:SYSTem:FPReset 589
:SYSTem:HELP:EXPort 840
:SYSTem:IDENtification 840
:SYSTem:IDENtification:PRESet 841

:SYSTem:INFormation:SCPI....842
:SYSTem:IRESponse....841
:SYSTem:KLOCk....833
:SYSTem:LANGuage....842
:SYSTem:LOCK:OWNer?....834
:SYSTem:LOCK:RELease:ALL....835
:SYSTem:LOCK:REQuest[:EXCLusive]?....835
:SYSTem:MMEMory:PATH:USER?....852
:SYSTem:NINFormation?....833
:SYSTem:NTP:HOSTname....849
:SYSTem:NTP:STATe....849
:SYSTem:ORESponse....841
:SYSTem:OSYStem?....851
:SYSTem:PRESet....589
:SYSTem:PROTect<ch>[:STATe]....836
:SYSTem:RCL....835
:SYSTem:REBoot....852
:SYSTem:RESTart....853
:SYSTem:SAV....835
:SYSTem:SECurity:NETWork:AVAHi[:STATe]....842
:SYSTem:SECurity:NETWork:FTP[:STATe]....842
:SYSTem:SECurity:NETWork:HTTP[:STATe]....843
:SYSTem:SECurity:NETWork:RAW[:STATe]....843
:SYSTem:SECurity:NETWork:REMSupport[:STATe]....843
:SYSTem:SECurity:NETWork:RPC[:STATe]....843
:SYSTem:SECurity:NETWork:SMB[:STATe]....844
:SYSTem:SECurity:NETWork:SOE[:STATe]....844
:SYSTem:SECurity:NETWork:SSH[:STATe]....844
:SYSTem:SECurity:NETWork:SWUPdate[:STATe]....845
:SYSTem:SECurity:NETWork:VNC[:STATe]....845
:SYSTem:SECurity:NETWork[:STATe]....845
:SYSTem:SECurity:SANitize[:STATe]....845
:SYSTem:SECurity:VOLMode[:STATe]....846
:SYSTem:SHUTdown....853
:SYSTem:SPECification:IDENtification:CATalog?....847
:SYSTem:SPECification:PARameter?....847
:SYSTem:SPECification:VERSion....847
:SYSTem:SPECification:VERSion:CATalog?....848
:SYSTem:SPECification:VERSion:FACTory?....848
:SYSTem:SPECification?....846
:SYSTem:SRData?....848
:SYSTem:STARtup:COMPlete?....848
:SYSTem:TIME....849
:SYSTem:TIME:PROTocol....850
:SYSTem:TIME:ZONE....850
:SYSTem:TIME:ZONE:CATalog?....850
:SYSTem:ULOCk....834
:SYSTem:UPTime?....851
:SYSTem:VERSion?....851
:SYSTem:WAIT....853

:TEST:PIXel:COLor ... 859
:TEST:PIXel:GRADient ... 859
:TEST:PIXel:POINtsize ... 859
:TEST:PIXel:RGBA ... 859
:TEST:PIXel:TEXT ... 859
:TEST:PIXel:WINDow ... 860
:TEST<hw>:ALL:RESult? ... 858
:TEST<hw>:ALL:STARt ... 858
:TRIGger<hw>:FSWeep:SOURce ... 861
:TRIGger<hw>:FSWeep[:IMMediate] ... 862
:TRIGger<hw>:PSWeep:SOURce ... 861
:TRIGger<hw>:PSWeep[:IMMediate] ... 862
:TRIGger<hw>[:SWEep]:SOURce ... 861
:TRIGger<hw>[:SWEep][:IMMediate] ... 862
:UNIT:ANGLe ... 863
:UNIT:POWer ... 863
[:SOURce]:BB:GRAPhics:ADD ... 766
[:SOURce]:BB:GRAPhics:CLOSe ... 766
[:SOURce]:BB:GRAPhics:FFTFscale ... 767
[:SOURce]:BB:GRAPhics:FFTLen ... 766
[:SOURce]:BB:GRAPhics:SOURce ... 766
[:SOURce]:CORRection:CSET:CATalog? ... 773
[:SOURce]:CORRection:CSET:DELete ... 774
[:SOURce]:INPut:TRIGger:SLOPe ... 782
[:SOURce]:INPut:USER:CLOCk:IMPedance ... 664
[:SOURce]:INPut:USER:CLOCk:LEVel ... 664
[:SOURce]:INPut:USER:CLOCk:SLOPe ... 665
[:SOURce]:INPut:USER:TRIGger:IMPedance ... 664
[:SOURce]:INPut:USER:TRIGger:LEVel ... 664
[:SOURce]:INPut:USER:TRIGger:SLOPe ... 665
[:SOURce]:INPut:USER<ch>:DIRection ... 663
[:SOURce]:INPut:USER<ch>:SIGNal ... 663
[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:LEVel ... 786
[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CHANnel<st0>:POWer:PEP ... 785
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME ... 787
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe ... 787
[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe ... 787
[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA ... 785
[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX? ... 788
[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM? ... 788
[:SOURce]:POWer:WIGNore ... 813
[:SOURce]:ROSCillator:EXTernal:FREQuency ... 815
[:SOURce]:ROSCillator:EXTernal:MLRange? ... 816
[:SOURce]:ROSCillator:EXTernal:NSBandwidth? ... 816
[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe] ... 815
[:SOURce]:ROSCillator:EXTernal:SBANdwidth ... 815
[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE ... 816
[:SOURce]:ROSCillator:PRESet ... 814
[:SOURce]:ROSCillator:SOURce ... 815
[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue ... 817

[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] 817
[:SOURce<hw>]:AWGN:BRATe 670
[:SOURce<hw>]:AWGN:BWIDth 668
[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe] 669
[:SOURce<hw>]:AWGN:BWIDth:NOISe? 669
[:SOURce<hw>]:AWGN:BWIDth:RATio 669
[:SOURce<hw>]:AWGN:CNRatio 671
[:SOURce<hw>]:AWGN:DISP:MODE 670
[:SOURce<hw>]:AWGN:ENRatio 671
[:SOURce<hw>]:AWGN:FREQuency:RESult? 673
[:SOURce<hw>]:AWGN:FREQuency:TARGet 673
[:SOURce<hw>]:AWGN:MODE 668
[:SOURce<hw>]:AWGN:POWer:CARRier 671
[:SOURce<hw>]:AWGN:POWer:MODE 670
[:SOURce<hw>]:AWGN:POWer:NOISe 671
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? 672
[:SOURce<hw>]:AWGN:POWer:RMODe 670
[:SOURce<hw>]:AWGN:POWer:SUM:PEP? 672
[:SOURce<hw>]:AWGN:POWer:SUM? 672
[:SOURce<hw>]:AWGN:STATe 668
[:SOURce<hw>]:BB:ARBitrary:CLOCk 724
[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce 754
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt 736
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE 737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing 737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict? 742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay 742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE 742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency 741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe 741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer 742
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe 741
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE 738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor 738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff 738
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] 739
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad 740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk? 740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate 740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP 745
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] 745
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute 746
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE 746
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP 744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] 744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP 743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] 744
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt 743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe 743
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP 743

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe....740
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence....739
[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet....735
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?....735
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD....736
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe....736
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME....737
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE....739
[:SOURce<hw>]:BB:ARBitrary:PRESet....717
[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE....718
[:SOURce<hw>]:BB:ARBitrary:STATe....717
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute....749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT....750
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute....750
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay....754
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec?....754
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE....752
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime....753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime....753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern....753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider....753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?....753
[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe?....750
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?....749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth....749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit....749
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe....730
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce....748
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay....751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit....752
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay?....751
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut....750
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay....751
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate....721
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed....720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I....718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q....718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude....718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate....721
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed....720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency....718
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet....719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles....719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate....721
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed....720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency....719
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe....720
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles....720
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth?....722

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?....721
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk....725
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA....723
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DELete....722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE?....722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?....724
[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe....725
[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts?....723
[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect....722
[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG?....724
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad....729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk....731
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]....732
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment....730
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment....730
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE....729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?....728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN....733
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP....734
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect....734
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate....729
[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe....727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?....726
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT....727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute....727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce....727
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend....728
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect....728
[:SOURce<hw>]:BB:ARBitrary:WSEGment?....726
[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence....748
[:SOURce<hw>]:BB:CFACtor?....682
[:SOURce<hw>]:BB:DM:APSK16:GAMMa....693
[:SOURce<hw>]:BB:DM:APSK32:GAMMa....694
[:SOURce<hw>]:BB:DM:AQPSk:ANGLe....692
[:SOURce<hw>]:BB:DM:ASK:DEPTh....692
[:SOURce<hw>]:BB:DM:CLISt:CATalog?....703
[:SOURce<hw>]:BB:DM:CLISt:COPY....706
[:SOURce<hw>]:BB:DM:CLISt:DATA....707
[:SOURce<hw>]:BB:DM:CLISt:DELete....704
[:SOURce<hw>]:BB:DM:CLISt:FREE?....705
[:SOURce<hw>]:BB:DM:CLISt:POINts?....705
[:SOURce<hw>]:BB:DM:CLISt:SELect....703

[:SOURce<hw>]:BB:DM:CLISt:TAG? 708
[:SOURce<hw>]:BB:DM:CLOCk:SOURce 703
[:SOURce<hw>]:BB:DM:CODing 691
[:SOURce<hw>]:BB:DM:DLISt:CATalog? 703
[:SOURce<hw>]:BB:DM:DLISt:COPY 706
[:SOURce<hw>]:BB:DM:DLISt:DATA 707
[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend 708
[:SOURce<hw>]:BB:DM:DLISt:DELete 704
[:SOURce<hw>]:BB:DM:DLISt:FREE? 705
[:SOURce<hw>]:BB:DM:DLISt:POINts 706
[:SOURce<hw>]:BB:DM:DLISt:SELect 704
[:SOURce<hw>]:BB:DM:DLISt:TAG? 708
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff] 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine 690
[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase 690
[:SOURce<hw>]:BB:DM:FILTer:TYPE 689
[:SOURce<hw>]:BB:DM:FLISt:CATalog? 703
[:SOURce<hw>]:BB:DM:FLISt:DELete 704
[:SOURce<hw>]:BB:DM:FLISt:FREE? 705
[:SOURce<hw>]:BB:DM:FLISt:POINts? 706
[:SOURce<hw>]:BB:DM:FLISt:SELect 703
[:SOURce<hw>]:BB:DM:FORMat 692
[:SOURce<hw>]:BB:DM:FSK:DEViation 693
[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation 693
[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE 693
[:SOURce<hw>]:BB:DM:MLISt:CATalog? 703
[:SOURce<hw>]:BB:DM:MLISt:DELete 704
[:SOURce<hw>]:BB:DM:MLISt:FREE? 705
[:SOURce<hw>]:BB:DM:MLISt:POINts? 706
[:SOURce<hw>]:BB:DM:MLISt:SELect 704
[:SOURce<hw>]:BB:DM:PATTern 687
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation 696
[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe] 696
[:SOURce<hw>]:BB:DM:PRAMp:FDELay 695
[:SOURce<hw>]:BB:DM:PRAMp:RDELay 695
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe 695
[:SOURce<hw>]:BB:DM:PRAMp:SOURce 694
[:SOURce<hw>]:BB:DM:PRAMp:TIME 695
[:SOURce<hw>]:BB:DM:PRAMp[:STATe] 696
[:SOURce<hw>]:BB:DM:PRBS[:LENGth] 688
[:SOURce<hw>]:BB:DM:PRESet 686
[:SOURce<hw>]:BB:DM:SETTing:CATalog? 688

[:SOURce<hw>]:BB:DM:SETTing:DELete....689
[:SOURce<hw>]:BB:DM:SETTing:LOAD....689
[:SOURce<hw>]:BB:DM:SETTing:STORe....688
[:SOURce<hw>]:BB:DM:SOURce....687
[:SOURce<hw>]:BB:DM:SRATe....686
[:SOURce<hw>]:BB:DM:STANdard....687
[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog?....688
[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete....689
[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD....689
[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe....688
[:SOURce<hw>]:BB:DM:STATe....686
[:SOURce<hw>]:BB:DM:SWITching:STATe....694
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute....698
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT....699
[:SOURce<hw>]:BB:DM:TRIGger:EXECute....699
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut....698
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay....702
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE....701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime....701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime....701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern....701
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider....702
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?....702
[:SOURce<hw>]:BB:DM:TRIGger:RMODe?....698
[:SOURce<hw>]:BB:DM:TRIGger:SLENgth....697
[:SOURce<hw>]:BB:DM:TRIGger:SOURce....697
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay....699
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit....700
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay?....700
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay....699
[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence....697
[:SOURce<hw>]:BB:FOFFset....681
[:SOURce<hw>]:BB:GENeral:AM:DEPTh....757
[:SOURce<hw>]:BB:GENeral:AM:FREQuency....758
[:SOURce<hw>]:BB:GENeral:AM:PERiod....758
[:SOURce<hw>]:BB:GENeral:AM:SHAPe....758
[:SOURce<hw>]:BB:GENeral:AM[:STATe]....759
[:SOURce<hw>]:BB:GENeral:FM:DEViation....756
[:SOURce<hw>]:BB:GENeral:FM:FREQuency....756
[:SOURce<hw>]:BB:GENeral:FM:PERiod....756
[:SOURce<hw>]:BB:GENeral:FM:SHAPe....757
[:SOURce<hw>]:BB:GENeral:FM[:STATe]....757
[:SOURce<hw>]:BB:GENeral:PM:DEViation....759
[:SOURce<hw>]:BB:GENeral:PM:FREQuency....759
[:SOURce<hw>]:BB:GENeral:PM:PERiod....759
[:SOURce<hw>]:BB:GENeral:PM:SHAPe....760
[:SOURce<hw>]:BB:GENeral:PM[:STATe]....760
[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay....760
[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh....761
[:SOURce<hw>]:BB:GENeral:PULM:MODE....761

[:SOURce<hw>]:BB:GENeral:PULM:PERiod 761
[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE 761
[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity 762
[:SOURce<hw>]:BB:GENeral:PULM:WIDTh 762
[:SOURce<hw>]:BB:GENeral:PULM[:STATe] 762
[:SOURce<hw>]:BB:GRAPhics:MODE 765
[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE 765
[:SOURce<hw>]:BB:GRAPhics:SRATe:USER 765
[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce 767
[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] 763
[:SOURce<hw>]:BB:IMPairment:LEAKage:I 763
[:SOURce<hw>]:BB:IMPairment:LEAKage:Q 763
[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE 764
[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] 763
[:SOURce<hw>]:BB:IMPairment:STATe 764
[:SOURce<hw>]:BB:POFFset 681
[:SOURce<hw>]:BB:POWer:PEAK? 682
[:SOURce<hw>]:BB:POWer:RMS? 683
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier? 768
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment? 768
[:SOURce<hw>]:BB:PROGress:MCODer? 768
[:SOURce<hw>]:BB:ROUTe 682
[:SOURce<hw>]:BBIN:ALEVel:EXECute 679
[:SOURce<hw>]:BBIN:CDEVice? 675
[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe 675
[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS 676
[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe 677
[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe 678
[:SOURce<hw>]:BBIN:DIGital:INTerface 675
[:SOURce<hw>]:BBIN:FOFFset 681
[:SOURce<hw>]:BBIN:MODE 677
[:SOURce<hw>]:BBIN:MPERiod 679
[:SOURce<hw>]:BBIN:POFFset 681
[:SOURce<hw>]:BBIN:POWer:CFACtor 679
[:SOURce<hw>]:BBIN:POWer:PEAK 680
[:SOURce<hw>]:BBIN:POWer:RMS? 680
[:SOURce<hw>]:BBIN:ROUTe 682
[:SOURce<hw>]:BBIN:SRATe:MAX? 678
[:SOURce<hw>]:BBIN:SRATe:SOURce 677
[:SOURce<hw>]:BBIN:SRATe:SUM? 678
[:SOURce<hw>]:BBIN:SRATe[:ACTual]? 678
[:SOURce<hw>]:BBIN:STATe 675
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency 771
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts? 771
[:SOURce<hw>]:CORRection:CSET:DATA:POWer 771
[:SOURce<hw>]:CORRection:CSET:DATA:POWer:POINts? 771
[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe 772

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe ... 773
[:SOURce<hw>]:CORRection:CSET[:SELect] ... 772
[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog? ... 774
[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension ... 774
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect ... 774
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn ... 775
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal ... 775
[:SOURce<hw>]:CORRection:DEXChange:EXECute ... 775
[:SOURce<hw>]:CORRection:DEXChange:MODE ... 775
[:SOURce<hw>]:CORRection:DEXChange:SELect ... 776
[:SOURce<hw>]:CORRection:VALue? ... 772
[:SOURce<hw>]:CORRection:ZERoing:STATe ... 772
[:SOURce<hw>]:CORRection[:STATe] ... 773
[:SOURce<hw>]:DM:FILTer:PARameter ... 691
[:SOURce<hw>]:FREQuency:CENTer ... 780
[:SOURce<hw>]:FREQuency:MANual ... 778
[:SOURce<hw>]:FREQuency:MODE ... 777
[:SOURce<hw>]:FREQuency:MULTiplier ... 779
[:SOURce<hw>]:FREQuency:OFFSet ... 779
[:SOURce<hw>]:FREQuency:SPAN ... 780
[:SOURce<hw>]:FREQuency:STARt ... 780
[:SOURce<hw>]:FREQuency:STEP:MODE ... 781
[:SOURce<hw>]:FREQuency:STEP[:INCRement] ... 781
[:SOURce<hw>]:FREQuency:STOP ... 781
[:SOURce<hw>]:FREQuency[:CW|FIXed] ... 777
[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL ... 778
[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice? ... 785
[:SOURce<hw>]:IQ:OUTPut:DIGital:INTerface ... 784
[:SOURce<hw>]:IQ:OUTPut:DIGital:PON ... 787
[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE ... 786
[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement] ... 786
[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe ... 784
[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe ... 784
[:SOURce<hw>]:IQ:STATe ... 782
[:SOURce<hw>]:IQ:SWAP[:STATe] ... 783
[:SOURce<hw>]:LIST:CATalog? ... 797
[:SOURce<hw>]:LIST:DELete ... 797
[:SOURce<hw>]:LIST:DELete:ALL ... 797
[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog? ... 799
[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension ... 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect ... 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn ... 800
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal ... 800
[:SOURce<hw>]:LIST:DEXChange:EXECute ... 799
[:SOURce<hw>]:LIST:DEXChange:MODE ... 801
[:SOURce<hw>]:LIST:DEXChange:SELect ... 801
[:SOURce<hw>]:LIST:DWELl ... 791
[:SOURce<hw>]:LIST:DWELl:LIST ... 792
[:SOURce<hw>]:LIST:DWELl:LIST:POINts? ... 792
[:SOURce<hw>]:LIST:DWELl:MODE ... 792

[:SOURce<hw>]:LIST:FREE? 798
[:SOURce<hw>]:LIST:FREQuency 793
[:SOURce<hw>]:LIST:FREQuency:POINts? 793
[:SOURce<hw>]:LIST:INDex 793
[:SOURce<hw>]:LIST:INDex:STARt 794
[:SOURce<hw>]:LIST:INDex:STOP 794
[:SOURce<hw>]:LIST:MODE 794
[:SOURce<hw>]:LIST:POWer 795
[:SOURce<hw>]:LIST:POWer:POINts? 795
[:SOURce<hw>]:LIST:RESet 798
[:SOURce<hw>]:LIST:RMODe 794
[:SOURce<hw>]:LIST:RUNNing? 796
[:SOURce<hw>]:LIST:SELect 798
[:SOURce<hw>]:LIST:TRIGger:EXECute 795
[:SOURce<hw>]:LIST:TRIGger:SOURce 795
[:SOURce<hw>]:PHASe 801
[:SOURce<hw>]:PHASe:REFerence 802
[:SOURce<hw>]:POWer:ALC:SONCe 804
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE 804
[:SOURce<hw>]:POWer:EMF:STATe 805
[:SOURce<hw>]:POWer:LBEHaviour 805
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] 805
[:SOURce<hw>]:POWer:MANual 805
[:SOURce<hw>]:POWer:MODE 806
[:SOURce<hw>]:POWer:PEP? 806
[:SOURce<hw>]:POWer:POWer 807
[:SOURce<hw>]:POWer:RANGe:LOWer? 813
[:SOURce<hw>]:POWer:RANGe:UPPer? 813
[:SOURce<hw>]:POWer:SPC:CRANge 808
[:SOURce<hw>]:POWer:SPC:DELay 808
[:SOURce<hw>]:POWer:SPC:MEASure 808
[:SOURce<hw>]:POWer:SPC:MODE 808
[:SOURce<hw>]:POWer:SPC:PEAK 809
[:SOURce<hw>]:POWer:SPC:SELect 809
[:SOURce<hw>]:POWer:SPC:SINGle 809
[:SOURce<hw>]:POWer:SPC:STATe 809
[:SOURce<hw>]:POWer:SPC:TARGet 810
[:SOURce<hw>]:POWer:SPC:WARNing? 810
[:SOURce<hw>]:POWer:STARt 807
[:SOURce<hw>]:POWer:STEP:MODE 810
[:SOURce<hw>]:POWer:STEP[:INCRement] 811
[:SOURce<hw>]:POWer:STOP 807
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet 811
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL 812
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel 813
[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] 812
[:SOURce<hw>]:SWEep:POWer:DWELl 820
[:SOURce<hw>]:SWEep:POWer:EXECute 823
[:SOURce<hw>]:SWEep:POWer:MODE 820
[:SOURce<hw>]:SWEep:POWer:POINts 820

[:SOURce<hw>]:SWEep:POWer:RETRace 824
[:SOURce<hw>]:SWEep:POWer:RUNNing? 824
[:SOURce<hw>]:SWEep:POWer:SHAPe 823
[:SOURce<hw>]:SWEep:POWer:SPACing:MODE? 821
[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic] 821
[:SOURce<hw>]:SWEep:RESet[:ALL] 825
[:SOURce<hw>]:SWEep[:FREQuency]:DWELl 821
[:SOURce<hw>]:SWEep[:FREQuency]:EXECute 823
[:SOURce<hw>]:SWEep[:FREQuency]:MODE 822
[:SOURce<hw>]:SWEep[:FREQuency]:POINts 822
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace 824
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing? 824
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe 823
[:SOURce<hw>]:SWEep[:FREQuency]:SPACing 822
[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic 824
[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] 824
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{CLOCK: frequency} 179
{COMMENT: string} 177
{CONTROL LENGTH: ControlLength} 179
{CONTROL LENGTH: ControlLength} 190
{CONTROL LIST WIDTH4–Length: #m0m1…mx…mM-1} 188
{COPYRIGHT: string} 178
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{DATA BITLENGTH: BitLength} 189
{DATA LIST-Length: #d0d1...dx...dN-1…} 190
{DATE: yyyy-mm-dd;hh:mm:ss} 178
{EMPTYTAG-Length: #EmptySequence} 180
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB} 181
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 182
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1} 191
{MARKER MODE [#]: GENERATOR} 181
{MWV_SEGMENT_CLOCK_MODE: Mode} 186
{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1} 186
{MWV_SEGMENT_COUNT: NumOfSeg} 185
{MWV_SEGMENT_DURATION: SegDur0, SegDur1, …, SegDurN-1} 185
{MWV_SEGMENT_FILES: “FileNameSeg0.wv”, “FileNameSeg1.wv”, …, “FileNameSegN-1.wv”} 188
{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1} 185
{MWV_SEGMENT_LEVEL_MODE: Mode} 187

{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}... 187
{MWV_SEGMENT_SETTINGS_FILE: SegSettingFilePath}...188
{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}...186
{MWV_SEGMENTx_COMMENT: text}... 188
{SAMPLES: Samples}...182
{TYPE: magic, xxxxxxxx}... 176
{WAVEFORM-Length: #l0Q0I1Q1...IxQx...IN-1QN-1…}...184
*CLS...584
*ESE... 584
*ESR?... 584
*IDN?... 585
*IST?...585
*OPC...585
*OPT?... 585
*PRE... 586
*PSC... 586
*RCL... 586
*RST... 586
*SAV...587
*SRE... 587
*STB?...587
*TRG...587
*TST?...588
*WAI...588
DIAGnostic:HUMS:DELete:ALL...610
DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL... 611
DIAGnostic:HUMS:DEVice:HISTory?... 610
DIAGnostic:HUMS:FORMat...611
DIAGnostic:HUMS:SAVE... 611
DIAGnostic:HUMS:STATe...612
DIAGnostic:HUMS:TAGS:ALL?... 612
DIAGnostic:HUMS:TAGS:DELete...612
DIAGnostic:HUMS:TAGS:DELete:ALL... 613
DIAGnostic:HUMS:TAGS[:VALue]... 613
SYSTem:COMMunicate:REST:ENABle... 613
SYSTem:COMMunicate:SNMP:COMMunity:RO... 613
SYSTem:COMMunicate:SNMP:COMMunity:RW...614
SYSTem:COMMunicate:SNMP:CONTact... 614
SYSTem:COMMunicate:SNMP:LOCation... 614
SYSTem:COMMunicate:SNMP:USM:USER...615
SYSTem:COMMunicate:SNMP:USM:USER:ALL?... 615
SYSTem:COMMunicate:SNMP:USM:USER:DELete...616
SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL... 616
SYSTem:COMMunicate:SNMP:VERSion... 616

Index

Symbols

/var/user directory ... 590
/var/volatile directory ... 590
&GTL ... 561
&LLO ... 561
&NREN ... 561
50 - Extern reference out of range or disconnected ... 865
140 - This modulation forces other modulations off ... 865
180 - Adjustment failed ... 866
182 - Adjustment data missing ... 866
183 - Adjustment data invalid ... 866
200 - Cannot access hardware ... 866
201 - Hardware revision out of date ... 866
202 - Cannot access the EEPROM ... 866
203 - Invalid EEPROM data ... 866
204 - river initialization failed ... 866
241 - No current list ... 866
242 - Unknown list type specified ... 866
261 - Waveform Protected ... 866
300 - Over-temperature protection shut-down ... 866
300 - Overload (Reverse Power) detected ... 866
300 - Reference PLL unlocked ... 866
460 - Cannot open the file ... 867
461 - Cannot write file ... 867
462 - Cannot read file ... 867
463 - Filename missing ... 867
464 - Invalid filename extension ... 867
465 - File contains invalid data ... 867

A

About
  Attenuator ... 358
  Power-On/EMF ... 454
  Reference oscillator ... 317
  UCOR ... 360
Accept
  Security settings ... 500
Access configuration menu
  Graphics ... 403
Access modes
  Overview ... 510
Accidental trigger
  Avoiding ... 89
Accurate level measurement
  Measurement period ... 255
Active connections
  Remote access ... 528
Active elements ... 66
Add LAN sensor
  NRP sensor mapping ... 387
Add sensor
  NRP sensor mapping ... 387
Add USBTMC sensor
  NRP sensor mapping ... 387
Add, change, delete
  User key action ... 473
Additive noise ... 289
Adjust
  BB input signal ... 275
  Display and keyboard ... 452
  Display settings ... 451
  Keyboard settings ... 451
Adjustment frequency
  Reference oscillator ... 322
Adjustments
  All ... 888
  All delayed ... 890
  Continue ... 889
  Delay settings ... 889
  Information ... 889
  Last full adjustment ... 888
  Settings ... 888
  Shutdown ... 890
  Warm up time ... 890
Advanced configuration
  LXI ... 545
Alphanumeric values
  Entering ... 69
AM ... 77
AM settings ... 244
  AM depth ... 245
  Modulation frequency ... 245
  Modulation period ... 245
  Modulation shape ... 245
  State ... 245
Angle alpha
  AQPSK ... 112
Annotation
  Disable amplitude display ... 495
  Disable frequency display ... 494
  Disable level ... 495
Aperture time
  Power sensors ... 384
Append
  Blank segment ... 204
  Sequencing play list ... 210
  Waveform ... 203
Application
  External digital signal ... 253
Application cards ... 23
Application notes ... 23
Apply
  Assistant settings ... 237
  External digital signal ... 253
  Settings of external RF and I/Q instrument ... 267
Apply and connect
  Settings of external RF and I/Q instrument ... 267
APSK
  Code rate ... 113
  Gamma ... 113
ARB ... 60
  Play list ... 193
  Sequencer mode ... 193
  Subsystem ... 709
ARB multicarrier
  Conflict ... 235
  Mode ... 227
ARB sequencer mode ... 194, 207
ARBitrary waveform generator ... 138
Arm trigger
  DM ... 101

Armed_Auto
Common settings 100
DM 100
Armed_Retrigger
Common settings 100
DM 100
ASK depth 112
ATSC 3.0 75
ATSC-M/H 75
Attenuation 117
Attenuator
About 358
RF signal 358
Settings 358
Attenuator settings
Level range 359
Mode 359
RF OFF mode 359
Auto
Common settings 100
DM 100
Auto level set 275
Auto once
Power sensors 384
Power viewer 384
Automatic level control
Readjust internal switch position 315
Automation 509
Autonegotiation
Failed 869
Avahi
LAN services 498
Average level
Power viewer 382
Avoiding signal gaps 197
Avoiding wrap-around 197
AWGN
Additive white Gaussian noise 283
Subsystem 665
AWGN mode 289
AWGN test signal 141

B

B x T
DM 114
Bandwidth
Cosine filter 115
Bandwidth coupling 289
Baseband
Channel 274
Input 60
Output 60
Baseband generator 60
Baseband input
see BB input 270
Baseband only
Mandatory setting 117
Baseband signal
Shifting quickly in RF domain 251
Basic phase modulation
Modulation frequency 243
Modulation period 244
Modulation shape 244
State 243
Φ deviation 244
Basic workflow
Multi-segment waveform 214
Basics
Editor 354, 366
Export list files 370
Fill with sensor list files 368
Import list files 370
BB input 60
BB output 60
BBIN 270
Bench top, placing 25
Binary data
Edit, rules 168
Bit energy to noise power density 292
Bit rate 291
Block diagram
Display 64
Blue LED
State indication (active) 276
Broadcast standard
Supported 75
Brochures 22
Browser settings
LXI 542
Burst gate 81
Bytes order
Definition 622

C

C-List
See control list 120, 166
Calibrate RF output level with power sensor 388
Calibration certificate 22
CALibration subsystem 602
Carrier
Delay 234
Frequency 234
Gain 234
Index 234
State 234
State start/stop 236
Carrier + Interferer
PEP 294
Carrier + Noise
PEP 294
Carrier graph 238
Carrier leakage 298
Impairments 300
Carrier power 292
Carrier spacing 228
Carrier/Noise ratio 292
Carrying the instrument 24
Catch range
NRP power control 379
CCDF diagram 396
CCDF display 396
Center frequency
Changing without adjusting the RF 251
Central storage
Accessing 445
Change password
Setup (security) 503
Change user password
Setup (security) 502

Channel
Name ... 274, 278
State ... 279
Stream ... 278
Check display screen
Display screen test ... 886
Check front panel
Key panel test ... 884
Performing ... 884
Settings ... 884
Check touch panel
Touchscreen test ... 885
Checking the instrument ... 24
Clean
List of external instrument ... 264
Cleaning ... 879
Clear
NRP sensor mapping ... 387
RF output protection ... 359
User menu ... 469
Clear history
Undo/Redo ... 508
Clear status
Remote ... 584
Clipping ... 228
CList
See control list ... 124, 166
Clock
Frequency ... 147
Rate ... 147
Clock rate
Blank segment ... 204
Clock rate mode
Multi-segment waveform ... 205
Clock signal
Internal ... 80
Clock source ... 105
Internal ... 80
Close
Show SCPI command ... 564
Coding
DM ... 109
Command sequence
Remote ... 588
Commands of all settings
SCPI list ... 429
Comment ... 201
Complementary cumulative distribution function ... 396
Computer name
see hostname ... 550
Configuration
Restoring ... 431
Restoring instrument settings ... 427
Configuration list
Multi-segment waveform ... 194
Configure
Control signal ... 122
Configuring LAN services ... 496
Confirm user password
Setup (security) ... 502
Conflict ... 235
Connect
External RF and I/Q instrument ... 267
Connect all remote ... 260
Connect remote instruments
Keep connection on preset ... 260
On start-up ... 259
Connected device ... 273, 277
Connecting
Keyboard ... 28
LAN ... 27
Memory stick ... 28
Monitor ... 28
Mouse ... 28
Power ... 27
To Dig. IQ HS x ... 31
To IP Data ... 32
To Ref In/Ref Out ... 31
To RF ... 31
To RF coaxial connectors ... 29
USB devices ... 28
Connecting to RF coaxial connectors
To connect to pluggable connectors ... 30
To connect to screwable connectors ... 30
To prepare for connecting ... 29
Connection fault
169.254.*.* ... 869
Connector
AC power supply ... 39
Direction ... 463
Display Port ... 40
Find ... 269
Global ... 457, 463
High-speed digital IQ ... 40
Identify ... 269
IP data ... 40
LAN ... 40
Mapping ... 457
Ref In ... 41
Ref Out ... 41
RF 50 Ω ... 39
Shared ... 457
Show ... 269
Signal ... 463
USB ... 38, 40
User ... 457, 463
USER ... 40
Connector direction
Settings ... 260
Connector global
Signal, how to define ... 465
Constant I/Q test signal ... 141
Settings ... 152
Constellation diagram ... 394
Context-sensitive menu ... 66
Continue
Internal adjustments ... 889
Continue on error
Failed internal adjustments ... 870
Control list
ASCII format ... 124, 166
Binary format ... 167
Edit, rules ... 168
How to assign ... 125, 167
Manually (Control data editor) ... 124
Select ... 111
Tags ... 166
Control signal ... 80
Copy
Instrument settings ... 436
Several files ... 434, 442, 443
Show SCPI command ... 564
Counter ... 872

Create 201, 231
Multicarrier waveforms 223
New directory 436
Create and load 201, 231
Crest factor
Channel 274
Match 254
Where to find the value 255
Crest factor mode 228
Current frequency
Sweep 338
Current index
List mode 347
Current level
Sweep 339
Current segment 212
Custom digital modulation 60
Customer support 876
Cut
Instrument settings 436
Cut off frequency factor 115
CW
Frequency 311
CW (continuous wave) 80
CW frequency 290, 295
CW interferer 289
CW mode
Output level 314
CW signal
Generate in baseband 108
Settings 309
CW/Mod 80

D

D-List
See data list 167
DAB 76
DARC 77
Data
Accessing 418
Handling 418
Retrieving 418
Data entry 69
Data format
Definition 622
Data list 110
Access 432
Binary format 168
Edit, rules 168
Editor 118
How to assign 127, 168
How to create 126
How to open 591
Manually (data list editor) 126
Select 110
Select, edit, new 433
Standard modulation data source 79
Tags 167
Data sheets 22
Data source
Data list 79
DM 110
Extern serial data 110
Pattern 79
PRBS generator 79
Date 882
DC carrier leakage
Eliminating 251
How to shift baseband signal 251
Deactivate RF output 319
Deactivated licenses 477
Declassification 494
Default directory
Mass memory 590
User data 420, 590
Default settings 227
ARB 146
DM 108
Default values
Remote 586
Define
User key action 473
Delay
Falling edge of ramp envelope 117
Marker 104
Rising edge of ramp envelope 117
Trigger 102
Delay start 237
Delay step 237
Delay time
NRP power control 380
Delete
Instrument settings 436
List mode file 349
Sequencing list 211
Waveform 203
Delete instrument settings 599
Delta frequency
External RF and I/Q instrument 262
Delta phase
RF frequency 316
Detect
External instrument 264
Deviation
FSK modulation 112
Variable FSK 113
Device ID 476
NRP sensor mapping 387
Device reset 589
Device-specific notifications 865
DHCP 549
Dialog boxes 68
Differential coding
DM 109
DIG IQ auto setting 275
Digital I/Q
Input 270
Digital inputs
Connector type 272
Digital modulation
See DM 106
Digital output
State 276
Digital standard 60
Direction
Connector 260
Directory
Temporary data 590
User data 590
Disable
Frequency display 494
Level display 495
Disconnect all remote 260

Display
Active elements ... 66
Block diagram ... 64
Brightness ... 453
Context-sensitive menu ... 66
Info line ... 66
Information ... 63
Lock ... 495
Mapped connectors ... 259
On-screen keypad ... 66
Power sensors ... 382
SCPI list ... 564
Screen saver ... 453
Settings ... 452
Setup ... 452
Status bar ... 64
Tab labels ... 66
Taskbar ... 65
USB keyboard ... 453
Wait time (screen saver) ... 453
Display correction file data
UCOR ... 364
Display correction value
UCOR ... 363
Display permanent
Power sensors ... 382
Display port
Connector ... 40
Display screen
Checking ... 886
Display screen test
Perform ... 886
DISPlay subsystem ... 617
Display unit ... 403
Disposal ... 879
Distortion-free range
Max bandwidth ... 143
Resampling ... 143
DList
See data list ... 167
DNS server ... 525
DNS suffix ... 525
Documentation overview ... 21
Downgrade information ... 874
Factory version ... 874
Min. version ... 874
DRM ... 77
DTMB ... 75
Duration
Measurement period external digital signal ... 255
DVB-C ... 77
DVB-S ... 76
DVB-S2 ... 76
DVB-S2X ... 76
DVB-T ... 76
DVB-T2 ... 76
Dwell time
Sweep ... 341
Dwell time mode
List mode ... 347

E

Edge form of ramp envelope ... 117
Edge slope of ramp envelope ... 117
Edit
Binary data ... 168
Data list ... 118
Editor ... 354, 367
List mode data ... 349
Ramp in control list ... 122
UCOR data ... 364
Editor
Basics ... 354, 366
Edit ... 354, 367
Fill with sensor ... 354, 367
Goto ... 354, 366
Save ... 354, 367
Save as ... 354, 367
EMF display
RF level ... 455
Emulation
IDN string ... 528
Language ... 527
Mode ... 527
Set IDN and OPT to default ... 527
Enable
LAN interface ... 498
Enable registers
Remote ... 586
Enter license key ... 476
Enter password
Setup (security) ... 500
Error log ... 874
Error message
Missing burst gate marker in waveform file, please disable RF power ramping. ... 146
No or empty waveform file ... 146
Error messages ... 867
Adjustment data invalid (183) ... 866
Adjustment data missing (182) ... 866
Adjustment failed (180) ... 866
Cannot access hardware (200) ... 866
Cannot access the EEPROM (202) ... 866
Cannot open file (460) ... 867
Cannot read file (462) ... 867
Cannot write file (461) ... 867
Driver initialization failed (204) ... 866
Extern reference out of range or disconnected (50) ... 865
File contains invalid data (465) ... 867
Filename missing (463) ... 867
Hardware revision out of date (201) ... 866
Invalid EEPROM data (203) ... 866
Invalid filename extension (464) ... 867
No current list (241) ... 866
Over-temperature protection shut-down (300) ... 866
Overload (Reverse Power) detected (300) ... 866
Reference PLL unlocked (300) ... 866
SCPI ... 865
See notifications ... 864
This modulation forces other modulations off (140) ... 865
Unknown list type specified (242) ... 866
Waveform Protected (261) ... 866
Event status enable register (ESE)
Remote ... 584
Event status register (ESR)
Remote ... 584
Exclude frequency ... 430
Exclude level ... 430

Execute
Next segment ... 214
Single sweep ... 341
Trigger (list mode) ... 348
Execute single
NRP power control ... 379
Expiration date of option ... 874
Export
Execute ... 351, 371
SCPI ... 434
SCPI export ... 567
SCPI list ... 565
SCPI settings ... 565
Export deactivation response ... 477
Export license key ... 477
Export list files
Basics ... 370
Express level in
Volts ... 802
External digital signal
Application fields ... 253
Apply ... 253, 270
Baseband input ... 270
Feed to the instrument ... 253
Interface type ... 272
Possible applications ... 253
Required if ... 253
External frequency
Reference oscillator ... 319
External instrument
Detect ... 264
Remote instrument settings ... 263
Scan ... 264
Settings ... 261, 263
External RF and I/Q
Alias name ... 265
Settings ... 258
External trigger
Common source ... 281
Configuring ... 281
Providing the instrument with ... 281
External Trigger Delay
DM ... 102
Eye diagram ... 395

F

Factory
Preset ... 424
Factory version
Firmware ... 874
Fall delay ... 117
Feedback
Connector ... 463
Signal ... 463
Feeding
External digital signal ... 253, 270
File
Multicarrier table ... 235
SCPI export ... 566
Waveform ... 147
File catalog
List mode ... 349
File content
SCPI export ... 567
File contents
Multi-segment waveform ... 202
File handling ... 421
File list ... 595
File manager ... 434
File name ... 447
File select
Dialog ... 432
File server
Data exchange ... 445
File sharing ... 440
File storage location ... 590
File system ... 419
Accessing ... 440
File transfer ... 421
From file server ... 445
FTP/SAMBA ... 509
How to ... 440
File type selection ... 436
Files
User data ... 418
Fill
User correction data ... 354, 367
Fill table
Automatically ... 354, 367
UCOR ... 364
Fill with sensor
Basics ... 368
Editor ... 354, 367
Filter
DM ... 114
Power sensors ... 383
Filter cut off frequency ... 229
Filter length
Auto ... 384
User-defiend ... 384
Filter parameter
B x T ... 114
Cut off frequency factor ... 115
Gauss cut off frequency ... 115
Impact ... 94
Lowpass cut off frequency ... 115
Roll off factor ... 114
Finding out the default directory ... 420, 590
Firmware
Factory version ... 874
Min. version ... 874
Version ... 873
Firmware options
see software options ... 60
Fixed
Frequency ... 311
Flexible dynamic switch over ... 215, 216
Without signal interruptions ... 216
Floating
License server ... 478
Floating licenses ... 874
FM ... 77
FM settings ... 241
FM deviation ... 243
Modulation frequency ... 242
Modulation period ... 242
Modulation shape ... 242
State ... 242
FM/PhiM/AM settings ... 241
Format
SCPI Export ... 566
FORMat subsystem ... 621

FPGA/µC
Check for updates ... 896
Check for updates of external ... 897
Update installation internal assembly ... 896
Update table ... 896
Frequency
Annotation disable ... 494
CW, fixed ... 311
Multiplier ... 312
Offset ... 312
Power sensors ... 383
RF signal ... 311
Test signal ARB ... 149
UCOR ... 364
Frequency offset
Between the I/Q streams ... 257
External signal ... 250
Internal signal ... 250
Front panel
Checking ... 884
Connectors ... 38
Overview ... 35
Front panel test
Performing ... 884
FSK deviation ... 112
FSK type
Variable FSK ... 113
FTP
How to access the instrument ... 440
LAN services ... 498
Function keys
Overview ... 38
Fuse
Changing ... 879

G

Gain
Impairment ... 297
Gain Imbalance ... 297
Gain start ... 236
Gain step ... 236
Gateway ... 525
Gauss cut off frequency ... 115
General configuration of instrument ... 451
General instrument functions
Checking parameters and dependencies ... 466
User key ... 467
User menu ... 467
General instrument settings ... 451
General workflow
Multi-segment waveform ... 214
Generate test signal
HD ... 150, 151, 152
RAM ... 150, 151, 152
Generating an unmodulated signal ... 309
Generating short sequences ... 89
Getting started ... 21
Global dwell time
List mode ... 347
Goto
Editor ... 354, 366
Graphics
Number of samples ... 401
Grey LED
State indication (inactive) ... 276
GUI
Setting ... 455
GUI update
Setup ... 451

H

Hard copy
Create, how to ... 449
File format ... 447
Print, how to ... 449
Hardcopy ... 446
Options ... 447
Hardware channel
External RF and I/Q ... 265, 266
Head panel
See Status bar ... 37
Header
See Status bar ... 37
Health and utilization
LXI ... 548
Help ... 21, 70
High-speed switch over
How to ... 217
HiSlip
Visa resource string ... 526
HiSLIP
Resource string ... 512
History
Undo/Redo ... 508
Host name
NRP sensor mapping ... 387
see hostname ... 550
Hostname ... 524
Changing ... 550
External RF and I/Q ... 266
LXI ... 542
Syntax ... 550
Use instead of IP address ... 550
Hotspot ... 65
How to
Access RF settings ... 308
Activate RF signal output ... 308
Calibrate RF output level with power sensor ... 388
Change the default directory ... 591
Checking hardware options ... 871
Checking RF assembly ... 871
Internal adjustments ... 890
Resolve adjustments errors ... 869
Run a hardware module selftest ... 894
Run delayed adjustments ... 891
Set RF frequency and level ... 309
Use an complete file path ... 591
Use the hostname instead of IP address ... 550
User key ... 474
User menu ... 470
How to:
Enable VNC ... 573
Remote control with LXI browser ... 553
HTTP
LAN services ... 498
HUMS ... 530
About ... 521
Add device tags ... 540
Delete device tag entry ... 540
Delete device tags ... 540
Delete history ... 531

Device ID ... 539
Device tag key ... 539
Device tag value ... 539
Device tags ... 538
Enhanced settings ... 531
Export history ... 531
LXI ... 548
Protocol settings ... 532
REST ... 533
SNMP protocol ... 533
SNMPv2 access ... 533
SNMPv2 community ... 534
SNMPv2 configuration ... 533
SNMPv3 user ... 534
State ... 531

I

I offset ... 298
I/Q connection
Status ... 261
I/Q diagram ... 392
I/Q Impairments
Linear ... 297
I/Q modulation ... 302
Performance optimization ... 304
I/Q output digital
Settings ... 275
I/Q stream mapper
Settings ... 257
I/Q swap ... 303
Identification
Emulation mode ... 527
Remote ... 585
Identify
Connector ... 269
Identify connector
Setting ... 269
IDN string
Emulation mode ... 528
Imbalance
Impairments ... 300
Impairment
Digital ... 297
Linear ... 297
Impairments
Digital ... 299
Import
Execute ... 351, 371
SCPI ... 434
Import license key ... 477
Import list files
Basics ... 370
Import/Export
Lists ... 350
Select file ... 351, 371
Inactive licenses ... 477
Index
List mode ... 347
Info line ... 66, 867
Information
Internal adjustments ... 889
Inhibit trigger ... 90
Input
Clock slope ... 464
Impedance Clock/Trigger ... 464
Threshold Clock/Trigger ... 464
Trigger slope ... 465
Input connector ... 40
Input waveform file ... 237
Input/output signals and interfaces
Overview ... 252
Installed assembly ... 872
Instrument
Carrying ... 24
Checking ... 24
Lifting ... 24
Operating site ... 24, 25
Unpacking ... 24
Instrument emulations ... 520, 527
Instrument help ... 21
Instrument name
External RF and I/Q instrument ... 262
Instrument security procedures ... 22
Instrument settings
Recall ... 586, 599
Save ... 587, 601
Interferer
CW, generation ... 283
Interfering signal
Use an external digital signal ... 253
Internal
Clock reference ... 80
Internal adjustements
How to ... 890
Internal adjustment
Continue on error ... 870
Internal adjustments
Abort on error ... 870
Troubleshooting ... 869
IP address ... 512
Changing ... 549
Dynamic ... 524
External RF and I/Q ... 266
LXI ... 542
Not recognized ... 869
NRP sensor mapping ... 387
Zeroconf ... 524
IP address mode ... 524
IP configuration
LXI ... 544
IQ subsystem ... 782
ISDB-T ... 76
IST flag
Remote ... 585

J

J.83/B ... 77

K

key ... 451
Key
★ (User) ... 38
Esc ... 38
Freq/Level ... 38
Help ... 38
Home ... 38
On/Standby ... 37
Preset ... 38
RF On/Off ... 38
Save/Recall ... 38

Key panel test
Check front panel ... 884
Keyboard
On-screen ... 69
Setting ... 455
Settings ... 452
Setup ... 452
Subsystem ... 628
Usage ... 62
Keypad
On-screen ... 69

L

LAN
Connecting ... 27
Environment ... 27
Interface ... 512
IP address ... 512
Main services ... 498
Reset ... 542
Samba services ... 499
Services ... 496
LAN configuration ... 548
LXI ... 544
LAN interface
Avahi ... 498
Enable ... 498
FTP ... 498
HTTP ... 498
LAN over SCPI ... 498
SMB (Samba) ... 498
SSH ... 498
VNC ... 498
LAN status
LXI ... 541
Language
Emulation ... 527
Last factory calibration ... 873
Last full adjustment
Internal adjustments ... 888
Last full test
Hardware modules selftest ... 893
Layout
USB keyboard ... 453
Learn
List mode ... 348
Learn list mode data
List mode ... 348
Length
Control list ... 122
Lev Att
see Level attenuation ... 81
LEV_ATT ... 117
Level
Annotation disable ... 495
Behavior (RF) ... 315, 345, 380
Level attenuation ... 81
DM ... 117
Level default unit
Change ... 802
Level in SCPI in V ... 802
Level limit ... 314, 380
Level mode
Multi-segment waveform ... 205
Level offset
Power sensors ... 383
RF level ... 314
State (power sensors) ... 383
Level range
Attenuator settings ... 359
Level settings
On start-up ... 454
LF output
Sweep reset ... 341
Libraries
Access ... 169
Download file ... 171
Load file ... 173
Play file ... 173
Required options ... 169
Save file ... 172
License
Keys ... 474
License for software option ... 874
Infos ... 874
License server
Add remote connection ... 488
Enable connection restrictions ... 487
Restrict remote connection ... 485
Licenses ... 474
Server ... 478
Settings ... 475
Lifting the instrument ... 24
Limit
RF level ... 314, 380
List
Define ... 349
Range ... 349
State ... 346
Values, defining ... 353, 366
List file
Catalog ... 349
List mode
Create list automatically ... 354, 367
Current index ... 347
Dwell time mode ... 347
Edit ... 349
Execute trigger ... 348
Export user data ... 351, 371
File settings, import/export ... 350, 371
Global dwell time ... 347
Import/export ... 350, 370
Learn list mode data ... 348
Load from file ... 351, 371
Load user data ... 350
Reset ... 348
Select file ... 349
Settings ... 345
State ... 346
Trigger execute ... 348
Trigger source ... 347
Load
See recall ... 428
User filter ... 115
Waveform ... 147
Load instrument settings ... 586, 599
Load list ... 200
Load user mapping ... 112
Loading
Trying out ... 55
Local to remote switch over ... 561

Lock
Display ... 495
Lowpass cut off frequency ... 115
LSB/MSB order
Definition ... 622
LucasFonts
RSCorpid EULA ... 874
LXI
Advanced configuration ... 545
Browser settings ... 542
Configuration ... 579
Health and utilization ... 548
Hostname ... 542
IP address ... 542
IP configuration ... 544
LAN configuration ... 544
LAN status ... 541
MAC address ... 542
Ping ... 546
Remote trace (SCPI) ... 546
Reset (LXI) ... 542
Status settings ... 541
Tracing ... 560
LXI broswer
Starting remote control ... 553
LXI settings ... 541

M

Mac address ... 525
MAC address
LXI ... 542
Maintenance ... 879
Changing fuses ... 879
Managing license keys ... 474
Managing licenses ... 474
Manual interaction ... 62
Map network share
Settings ... 436
Map stream x to connector
Settings ... 258
Mapping network folders ... 438
Marker ... 83
Marker Delay ... 104
MARKER LIST ... 182, 191
Marker output signals ... 82
Marker positions ... 123
Marker trace
Periodical ... 179, 190
Mass storage location ... 590
Matching
Crest factor ... 254
Measured level
NRP level control ... 379
Measurement period ... 275
How long ... 255
Min. version
Firmware ... 874
Minimum locking range ... 320
Mode
Attenuator settings ... 359
Emulation ... 527
Graphics ... 401
IP address ... 524
List ... 347
NRP power control ... 379
Sweep ... 339
User variation ... 312, 316
Modulation data
Source internal ... 79
Modulation type ... 112
Monitoring
Signal parameter ... 392
Mounting, in a rack ... 26
Mouse
Usage ... 62
Multi carrier signal
General principle ... 224
Multi instrument mode
Assign signal ... 417
Mode ... 417
State ... 416
Multi-segment
Crest factor ... 213
Multi-segment table ... 203
Multi-segment waveform
File contents ... 202
Multi-segment waveform sequencing ... 194
Multicarrier waveforms ... 223
Multiple files
Copy ... 434, 442, 443
Multiplier
Frequency ... 312

N

Naming conventions
Allowed file names ... 419
Navigation controls
Rotary knob ... 38
Network
Connection fails ... 869
Environment ... 27
Settings ... 522
Network share
Mapping ... 436, 438
Network status ... 523
New list ... 200
New password
Setup (security) ... 502
New user password
Setup (security) ... 502
Next segment ... 212
Mode ... 212
Source ... 213
Noise
Additive, generation ... 283
Pure, generation ... 283
Noise bandwidth
AWGN ... 295
Noise only ... 289
Noise power
System bandwidth ... 293
Total bandwidth ... 294
Noise ratio
Power sensors ... 384
Non-dedicated connectors ... 457
Non-operational data ... 418
Notifications ... 864, 867
Device-specific ... 865
NRP level control
Measured level ... 379

NRP power control 376
Catch range 379
Delay time 380
Execute single 379
Mode 379
Reference level 379
Remote command sequence 802
Select sensor 378
Settings 377
State 378
Take measured level as reference 379
Target level 379
NRP power viewer 374
Settings 376
Use S-Parameter 385
NRP sensor configuration 381
NRP sensor mapping 385
Add LAN sensor 387
Add sensor 387
Add USBTMC sensor 387
Clear 387
Connector 386
Device ID 387
Host name 387
IP address 387
Protocol 386
Scan 387
Sensor name 386, 387
Serial number 387
Settings 386
NTP
Address 883
Number of carriers 228
Number of licenses 874
Numeric data entry 69
Numeric values
Entering 69

O

Offset
Frequency 312
Offset I/Q
Impairments 300
Old password
Setup (security) 502
Old user password
Setup 501
On-screen keypad 66
On/Off Ratio marker mode 84
Open source acknowledgment (OSA) 23
Open-source acknowledgments 874
Operating site
Choosing 24
Setting up the instrument 25
Operation
Concepts 62
Manual 62
Operation complete
Remote 585
Operation hours 873
Operation mode 428
Operation status register 519
Operational data 418
Optimization mode 304
I/Q 304
Optimize crest factor
Multicarrier 228
Option
Expiration date 874
R&S SMCVB-K19 40
Option: expiration date 874
Options
Identification (remote) 585
see user manual 60
Oscillator
Reference 317
Output
SCPI list (select file) 566
OUTPut
Subsystem 629
Output connector 40
Output connectors
RF 50 Ω 39
Output file 201, 232
Multi-segment waveform 194
Overflow
Avoid 255
External signal 255
Oversampling factor 143
Overview
External RF and I/Q 269

P

Parallel poll register enable
Remote 586
Password
Change (security password) 503
Change (user password (security)) 502
Confirm (security password) 502
Confirm (user password (security)) 502
Enter (security password) 500
New (security password) 502
New (user password (security) 502
Old (security password) 502
Old user password 501
Protection level 492
Password management
Security 500
Paste
Instrument settings 436
Pattern
Data source 110
Standard modulation data source 79
PCI bus 872
Peak power
Channel 274
Digital output 278, 280
PEP
Carrier + Noise 294
Percentage of signal bandwidth
Graphics 402
Performance
I/Q modulation 304
Period
Blank segment 204
Periodical
Marker trace 179, 190
Periodical markers 164
Phase
Subsystem 801
Phase modulation settings 243

Phase offset 250
Between the I/Q streams 258
Phase reference 317
Phase start 237
Phase step 237
Ping
LXI 546
Placing, on a bench top 25
Play list 194, 201, 209, 214
Play list file
Sequencing list file 194
Playlist
See play list 194
PN sequence
See PRBS 79
Position
Cursor in graphical display 123
Power
Carrier + Interferer 294
Carrier + Noise 294
Connecting the instrument 27
Signal + Interferer 294
Signal + Noise 294
UCOR 364
Power of starting carrier 236
Power on
Key 37
Power ramp
Restrict to baseband 117
Power ramping 81, 116
Power reference 230
Power sensors
Activation 382
Aperture time 384
Auto once 384
Filter 383
Filter length 384
Frequency 383
Level (average) 382
Level (peak) 382
Level offset 383
Noise ratio 384
NRP power control 376
Serial number 382
Source 383
State 382
State (level offset) 383
Timeout 384
Unit 382
Update 375
Use default aperture time 384
Zero 382
Power Sensors
Display 382
Display permanent 382
Power spectrum 397
Power supply
Connector 39
Power viewer
Auto once 384
Power-On
Settings 454
Power-On count 873
Power-On state
I/Q digital output 280
RF level 455
Power-On/EMF
About 454
RF signal 454
PRBS generator
Standard modulation data source 79
PRBS type 110
Prefix, year, month, Day 449
Preparing for use 24
Preset
Factory preset 424
Ramp 122
Print
Hard copy 449
Processing time 89
ARB 153
Protection
Settings 491
Setup 490
Protection level
1 490
2 490
3, 4, 5 490
Adjustments 490
Calibration 490
Factory only 490
Protection level 492
Service department 490
Pulse divider marker 83
Pulse frequency marker 83
Pulse modulation settings 245
Double pulse delay 247
Double pulse width 247
Pulse mode 246
Pulse period 246
Pulse width 247
State 246
Transition type 247
Video polarity 247
Purge
List of external instrument 264

Q

Q offset 298
QR code 540
Quadrature offset
Impairments 301
Quadrature Offset 299
Quantified Licenses 478
Questionable status register 519
Quick recall 430
Quick save 430
Quick shift of the baseband signal
How to 251

R

R&S SMCVB-K200 478
Rack, mounting 26
Ramp
All up or all down 122
Low to high and vice versa 122
Ramp function 117
Ramp time 117
Ratio noise/system bandwidth
Minimum 289
RDS 77

Readjust
Automatic level control ... 315
Rear panel
Overview ... 39
Reboot ... 508
Recall
Instrument settings ... 430
User menu ... 469
Recall instrument settings ... 586, 599
Recall intermediate ... 586
Recorded SCPI commands
SCPI list ... 565
Rectangular test signal ... 141
Rectangular test signals
Settings ... 150
Redo ... 507
Clear history ... 508
History ... 508
Settings ... 507
State ... 508
Reference curve
Show, hide, assign ... 404
Reference frequency output
Loop through ... 321
Reference oscillator ... 317
Adjustment ... 321
Adjustment frequency ... 322
External frequency ... 319
Output frequency ... 321
Preset ... 318
RF off state ... 319
Source ... 318
Synchronization bandwidth ... 319
Release notes ... 23
Reload
SCPI list ... 567
Remote access ... 509
Active connections ... 528
DNS server ... 525
DNS suffix ... 525
HISLIP resource (VISA resource string) ... 526
HUMS ... 530
Identification ... 527
IDN string ... 528
Instrument emulations ... 527
IP address mode ... 524
Language ... 527
Network gateway ... 525
Network hostname ... 524
Network IP address ... 524
Network Mac address ... 525
Network resource (Ethernet resource string) ... 526
Network settings ... 522
Network status ... 523
OPT string ... 528
QR code ... 540
Set IDN and OPT to default ... 527
Settings ... 520
Socket resource (VISA resource string) ... 526
Subnet mask ... 524
Visa resource strings ... 526
VXI11 resource (VISA resource string) ... 526
Workgroup name ... 524
Remote connection
Add floating license server ... 488
Configure license server restrictions ... 485, 487
Status ... 261
Remote control ... 62
Access modes ... 510
Command ... 268
Command sequence ... 268
History ... 268
Interfaces and protocols ... 511
IQ digital ... 783
Mode ... 268
Programming examples ... 583
Programs and libraries ... 514
RF envelope ... 783
SCPI ... 509
Source subsystem ... 660
Trace ... 268
Remote Desktop ... 62
Remote interfaces and protocols ... 511
Remote operation ... 62
VNC ... 509
Remote trace
LXI ... 546
Removing sensitive data ... 874
Rename
File ... 600
Instrument settings ... 436
Resampling
External baseband signal ... 255
Reset
List mode ... 348
RF frequency (delta phase) ... 317
Sweep ... 341
Reset device parameters ... 589
Reset values
Remote ... 586
Resolution
Graphics ... 402
Resolving internal adjustment failures ... 869
Resource string
VISA ... 512
Restart marker ... 206
Restoring configuration ... 423
Result
Hardware modules selftest ... 892
Resulting file name ... 449
Retrace
Sweep ... 339
Retrigger
Common settings ... 100
DM ... 100
RF
Signal ... 307
RF 50 Ω connector ... 39
RF couple
External RF and I/Q instrument ... 262
RF frequency
Configuring ... 309
External RF and I/Q instrument ... 262
RF frequency sweep
State ... 338
RF level
Configuring ... 309
EMF display ... 455
External RF and I/Q instrument ... 262
Offset ... 314
PEP ... 309
Power-On state ... 455
Setting characteristics ... 315, 345, 380
Settings ... 313

RF level sweep
State ... 338
RF OFF mode
Attenuator settings ... 359
RF off state
Reference oscillator ... 319
RF ON, RF OFF, RF ON/OFF ... 308
RF output
Amplitude ... 314
Impedance ... 308
PEP ... 309
Protection ... 359
State ... 308
RF Output
Level range ... 315, 345
RF output signal
Phase ... 316
Phase reference ... 317
RF path
External RF and I/Q ... 266
RF phase
Configuring ... 309
RF signal
Attenuator ... 358
Frequency ... 311
Power-On/EMF ... 454
User correction ... 360
RF state
External RF and I/Q instrument ... 262
Rise delay ... 117
RMS
Digital output ... 278, 280
RMS power
Channel ... 274
Roll off factor
DM ... 114
Rotary knob ... 38
User variation ... 312, 316
Run module test
Hardware modules selftest ... 892

S

S-Parameter
Activate corrections ... 385
Safety instructions ... 15, 22
Samba services
SMB client ... 499
SMB server ... 500
SAMBA/SMB
How to access the instrument ... 440
Sample rate
Aggregated ... 275, 279
Channel ... 274, 278
Link ... 275, 279
Source ... 272
Where to find the value ... 255
Samples
Blank segment ... 204
Samples per period ... 149
Sanitize ... 494
save
Save ... 428
Save
Control list ... 123
Editor ... 354, 367
Instrument settings ... 429
Sequencing list ... 209
User menu ... 469
Save and load ... 427
Save as
Editor ... 354, 367
Save hard copy as
bmp, jpg, png ... 447
Save instrument settings ... 587, 601
Save intermediate ... 587
Save list ... 201
Save/Recall ... 227, 427
Dialog ... 428
DM ... 108
How to ... 431
SCPI-Export ... 568
Saving
Trying out ... 54
Saving files ... 591
Scan
For external instrument ... 264
NRP sensor mapping ... 387
SCONfiguration subsystem ... 646
SCPI
Error messages ... 865
Export ... 434
Export settings ... 565
Import ... 434
LAN services ... 498
Output file ... 566
SCPI export ... 567
File content ... 567
Select file ... 566
SCPI Export
Format ... 566
SCPI list
Commands of all settings ... 429
Display ... 564
Export ... 565
Recorded SCPI commands ... 565
Show all commands ... 429
SCPI remote trace
LXI ... 546
SCPI script
Select ... 473
SCPI-Export
Save/Recall ... 568
Screen saver
Activate ... 456
State ... 453
Wait time ... 453
Security
Accept settings ... 500
Change password (setup) ... 503
Change user password (setup) ... 502
Confirm password (setup) ... 502
Confirm user password (setup) ... 502
Display lock ... 495
Enter password (setup) ... 500
New password (setup) ... 502
New user password (setup) ... 502
Old password (setup) ... 502
Old user password ... 501
Password management ... 500
Sanitize ... 494
Security password ... 502
Settings ... 492
Setup ... 490

USB storage (setup) ... 493
User name (setup) ... 501
User password ... 501
Volatile memory ... 493
Security password
Security ... 502
Setup ... 502
Security procedures ... 22
Security settings ... 490
Segment # ... 203
Segment down ... 203, 211
Segment marker ... 206
Segment up ... 203, 211
Select
List mode data file ... 349
Setup file ... 473
User correction data file ... 364
Select file ... 433
Select instrument
External RF and I/Q ... 265
Self-test
About ... 880
Remote ... 588
Selftest
How to run a hardware module selftest ... 894
Last full test ... 893
Result ... 892
Run module test ... 892
Test table ... 893
Sensitive information
Protecting ... 420, 426
Sensor
NRP power control ... 378
Sensor name
NRP sensor mapping ... 387
Sequencing graph ... 211
Sequencing list ... 201, 209, 214
Load ... 208
New ... 208
Serial bus ... 872
Serial number ... 39, 551
NRP sensor mapping ... 387
Power sensors ... 382
Service manual ... 22
Service request enable register (SRE)
Remote ... 587
Services
LAN ... 496
Set according to ... 108
Set IDN and OPT to default
Emulation mode ... 527
Set level via
Digital output ... 280
Set noise level via ... 291
Set to default ... 227
ARB ... 146
DM ... 108
Settings
Active connections ... 528
Attenuator ... 358
Check front panel ... 884
Delayed adjustment ... 889
Display ... 452
Instrument emulations ... 527
Internal adjustments ... 888
Keyboard ... 452
Licenses ... 475
List mode ... 345
Managing ... 418
NRP power control ... 377
NRP power viewer ... 376
NRP sensor mapping ... 386
On power-on ... 454
Protection ... 491
Remote access ... 520
RF level ... 313
SCPI export ... 565
Security ... 492
Show SCPI command ... 564
UCOR ... 362
Undo/Redo ... 507
User key ... 472
Setup
Accept security settings ... 500
Adjusting display ... 451
Adjusting keyboard ... 451
Annotation frequency ... 494
Annotation level ... 495
Change password ... 502
Change password (security) ... 503
Confirm password ... 502
Confirm password (security) ... 502
Display lock ... 495
Enter password (security) ... 500
GUI update ... 451
Keyboard settings ... 452
Layout (USB keyboard) ... 453
New password ... 502
New password (security) ... 502
Old password (security) ... 502
Password (protection) ... 492
Performing the front panel test ... 884
Protection level ... 492
Screen saver ... 453
Security password ... 502
USB storage (security) ... 493
User name (security) ... 501
User password ... 501
Wait time ... 453
Setup files
Data exchange ... 445
Shape
Sweep ... 339
Shared connectors
Global connectors ... 457
Shifting the baseband signal ... 248
Show
SCPI list ... 429
Show powers for output
AWGN ... 291
Show SCPI command
Close ... 564
Copy ... 564
Settings ... 564
Shut down ... 508
Signal + Interferer
PEP ... 294
Signal + Noise
PEP ... 294
Signal duration ... 229
Signal generation status ... 100
Signal monitoring
Graphical display ... 392
Signal period mode ... 229

Signal power ... 292
Signal to connector mapping
How to ... 465
Signal/Noise ratio ... 292
Sine test signal ... 141
Sine test signals
Settings ... 148
Single
Common settings ... 100
DM ... 100
Execute (list mode) ... 348
SMB (Samba)
LAN services ... 498
Socket
Visa resource string ... 526
Softkey bar
See Taskbar ... 65
Software options ... 60
Source
Graphics ... 401
Power ramp control ... 116
Power sensors ... 383
Reference oscillator ... 318
Sweep trigger ... 339
Source points for graphic display ... 397
Source subsystem
Remote control commands ... 660
Spacing
Frequency sweep ... 341, 343
RF level sweep ... 344
Span
Frequency sweep ... 343
Specifications ... 22
Specified trigger delay ... 102
Spectrum display ... 397
SSH
LAN services ... 498
Standard ... 108
Standard settings ... 227
DM ... 108
Standard-compliant signals ... 75
Standby
Key ... 37
Start
Frequency sweep ... 343
RF level sweep ... 344
Start carrier index ... 236
Start delay ... 237
Start phase ... 237
Starting gain ... 236
Starting the signal generation with the first sample ... 89
State
Adjustment (reference oscillator) ... 321
ARB ... 146
AWGN ... 288
BB Input ... 272
DM ... 107
I/Q digital output ... 277
I/Q modulation ... 303
Impairments ... 300
List mode ... 346
NRP power control ... 378
Power sensors ... 382
RF frequency sweep ... 338
RF level sweep ... 338
RF output ... 308
RF output protection ... 359
Screen saver ... 453
UCOR ... 363
Undo/Redo ... 508
Status
Remote connection to external RF and I/Q ... 261
Status bar
Display ... 64
Status byte
Remote ... 584, 587
Status information ... 477
Status register
Response format deinition ... 622
Status reporting system ... 517
Common commands ... 584
Overview of status registers ... 517
Status settings
LXI ... 541
Step
Frequency sweep ... 343
Linear (frequency sweep) ... 343
Logarithmic (frequency sweep) ... 343
RF level sweep ... 345
Step width
User variation ... 312, 316
Stop
Frequency sweep ... 343
RF level sweep ... 344
Stop carrier index ... 236
Storage ... 879, 880
Storage location
/usb/ ... 419
/var/user ... 419
/var/volatile ... 419
Mass memory ... 590
Stream distributing
Settings ... 258
Stream mapping
Settings ... 258
Subnet mask ... 524
Subsystem
Keyboard ... 628
OUTPut ... 661
Phase ... 801
Power ... 802
SOURce:INPut ... 661
Sum signal
How to shift basebands ... 251
Support ... 874
Suppressing
Carrier leakage ... 251
Sweep
Center frequency ... 343
Current frequency ... 338
Current level ... 339
Dwell time ... 341
Execute single ... 341
Frequency span ... 343
Mode ... 339
Reset ... 341
Retrace ... 339
Shape ... 339
Spacing ... 341, 343, 344
Start/stop frequency ... 343
Start/stop level ... 344
State (RF frequency) ... 338
State (RF level) ... 338

Step 343, 345
Trigger manually 341
Switch over
Flexible 216
High speed 217
Switching
Modulation to CW 113
On or off 33
Symbol rate
DM 109
Symbolic name
External RF and I/Q 265
Sync. Output to external trigger 101
Sync. Output to trigger 101
Synchronization
Assign signal 417
Mode 417
State 416
Synchronization bandwidth
Reference oscillator 319
Synchronize
External RF and I/Q instrument 262
Synchronizing
Several instruments 281
Signal generation 281
Synchronous generation start 85
System
Factory preset 424
System bandwidth
AWGN 289

T

T-DMB 76
Tab labels 66
Tag type 186
Clock 179
Comment 177
Control length 179, 190
Control list width4 188
Copyright 178
Data bit length 189
Data list 190
Date 178
Emptytag length 180
Level offset 181
Magic 176
Marker mode 181
Samples 182
Segment clock mode 186
Segment comment 188
Segment count 185
Segment duration 185
Segment files 188
Segment length 185
Segment level mode 187
Segment level offset 187
Segment start 186
Settings file 188
Trace list 182, 191
Waveform length 184
Take measured level as reference
NRP power control 379
Tapping points 397
Target crest factor 228
Target level
NRP power control 379
Temperature offset
Internal adjustments 889
Temporary files 420, 426
Test
Check front panel 884
Test signal
Amplitude of test signal 151
ARB generator 141
Frequency 149, 151
Offset DC 151
Phase offset Q 149
Samples per period 149, 151
Value I, Q 152
Test table
Hardware modules selftest 893
Testing
High-power amplifiers 238
Text entry 69
Time
UTC 882
Time protocol
Settings 883
Timeout
Filter (power sensors) 384
Tooltips
Show 70
Touchscreen
Compared with mouse 62
Overview 36
Usage 62
Touchscreen test
Perform 885
Trace
Enable in graphic 404
Tracing
Messages 560
SCPI commands 560
Transmitter test
Generating a multi carrier signal 238
Transporting 878
Trigger
Event (remote) 587
Execute (list mode) 348
Generate signal manually 463
Manually 463
Sweep, manually 341
Trigger delay
Actual 102
Expressed in seconds 102
Expressed in time 102
Resulting 102
Unit 102
Trigger Delay
DM 102
Trigger event 85
Delay 90
Suppress 90
Trigger example 214
Trigger Mode
Common settings 100
DM 100
Trigger signal duration 102
Trigger signals
Baseband 84
Trigger source
DM 101
Graphics 401

List mode ... 347
Sweep ... 339
Trigger, accidental
Avoiding ... 89
Triggering
Multi-segment waveform ... 196
Segment ... 196
Tripped
RF output protection ... 359

U

UCOR
About ... 360
Calibrate RF output level with power sensor ... 388
Data ... 364
Display correction file data ... 364
Display correction value ... 363
Edit data ... 364
Export user data ... 351, 371
File catalog ... 364
File settings, import/export ... 350, 371
Fill with sensor ... 369
Import/export ... 350, 370
Load from file ... 351, 371
RF signal ... 360
Select file ... 364
Settings ... 362
State ... 363
Values, defining ... 353, 366
Undo ... 507
Clear history ... 508
History ... 508
Settings ... 507
State ... 508
Units X-axis
Change ... 403
Unmodulated signal ... 80
Unpacking the instrument ... 24
Up-conversion
Important parameters ... 254
USB
Storage (security) ... 493
Use default aperture time
Power sensors ... 384
User clock ... 206
User correction
see UCOR ... 360
User data
Access ... 432
Load from a specific directory ... 592
User files ... 419
User filter
Catalog ... 115
Delete ... 115
User interface
Lock ... 495
User key ... 467
Action name ... 472
Add, change, delete action ... 473
Assign actions ... 474
Define action ... 472, 473
SCPI command ... 473
Select dialog ID ... 473
Settings ... 472
Toggle between define and execute mode ... 473
User manual ... 21
User mapping
Catalog ... 112
Delete ... 112
User menu ... 467
Access ... 470
Clear ... 469
Create ... 470
Recall ... 469
Save ... 469
Settings ... 469
User name
Setup (security) ... 501
User password
Security ... 501
Setup ... 501
User preset ... 423
User variation
Activating ... 312, 316
Level ... 312, 316
RF ... 312, 316
User-definable preset
Recall ... 468
Utility keys
Overview ... 38

V

Value
Sample rate ... 277
Variable FSK
Deviation ... 113
Selecting ... 113
Varying
RF frequency and level ... 312, 316
Vector diagram ... 393
Vector modulation ... 302
Version
Firmware ... 873
Videos ... 23
VISA ... 511
Resource string ... 512
Visa resource string
Ethernet ... 526
HISLIP ... 526
Socket ... 526
VXI11 ... 526
Visa resource strings ... 526
VNC ... 62
How to enable ... 573
LAN services ... 498
Volatile memory ... 420, 426
Volatile mode
Activate ... 493
VXI11
Visa resource string ... 526

W

Wait
Remote ... 588
Wait time
Screen saver ... 453
Wanted signal
Use an external digital signal ... 253
Warnings ... 864, 867

Waveform
Edit, rules 168
Info 147, 203
Load file 147
Maximum length 144
Optimizing 143
Waveform file
Corrupted, reasons 168
Web interface 62
What's new 21
White papers 23
Wi-Fi
WLAN 576
Workflow
Multi-segment waveform 214
Workgroup name 524
Wrap-around
Avoiding problems 224
Overcome the problem 216

Z

Zero
Power Sensors 382
Zeroconf
IP address 869
Zeroconf (Avahi) protocol 549
Zoom
Control list display 123