R&S®WinIQSIM2™
Signal Generation Software
User Manual

1177553302
Version 10

ROHDE&SCHWARZ
Make ideas real

This document describes R&S®WinIQSIM2™ and its options.

- R&S®WinIQSIM2-K261
- R&S®WinIQSIM2-K262

This manual describes software version SW 5.30.239.xx and later of R&S®WinIQSIM2™.

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

Contents

1 Welcome to R&S WinIQSIM2

The R&S WinIQSIM2 simulation software is a Windows-PC based program that creates digitally modulated signal waveforms. Offering waveform signals in accordance with the definitions in the digital standards or with user-definable characteristics, R&S WinIQSIM2 is an indispensable application for anyone engaged in state-of-the-art digital modulation.

R&S WinIQSIM2 enables you to generate waveform files of various digitally modulated signals in accordance with the definitions in the digital standards or with user-definable characteristics.

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 an instrument, e.g. the vector signal generator R&S SMW. The signal calculation is performed in advance and the instrument plays the waveform file.

Features and functions

In addition to the wide range of digital standards, the functions of R&S WinIQSIM2 also comprise single carrier modulation, the generation of multicarrier signals, WCDMA and third-order signals.

The software calculates I and Q baseband signals on a Windows PC system comprising almost the same functionalities as Rohde & Schwarz vector signal generators. R&S WinIQSIM2 includes the characteristics of an R&S instrument, if defined. In addition, an internal AWGN noise generator allows you to superimpose noise on the generated signal.

The graphical signal display function visualizes a generated signal in various graphical views for quick evaluation and verification of the signal characteristics.

You can transmit a generated signal directly to a connected instrument in the network over LAN, or via USB or GPIB. Alternatively, you can store it locally in a file and retrieve it later on the instrument. The instrument plays back the loaded waveform file and thus generates the corresponding signal.

Required equipment at the instrument

To play waveform files on an instrument, this instrument requires the following equipment:

- Arbitrary waveform generator (ARB) or a waveform memory for playback of waveform files.
- Digital standard option that is the real-time option of the instrument firmware or the waveform option of the R&S WinIQSIM2 software.
  For example, the real-time option R&S SMW-K144 or the waveform option R&S SMW-K444 allows you to play 5G NR R&S WinIQSIM2 waveform files at the ARB of the R&S SMW.
- Optionally, multicarrier CW generation option
  To process multicarrier waveforms, install the corresponding option on the instrument.

- Optionally, AWGN option
  To process waveforms with additive white Gaussian noise (AWGN), install the corresponding option on the instrument.

See Chapter 1.3, "Supported Rohde & Schwarz instruments", on page 12 for the list of instruments from Rohde & Schwarz that can process waveform files.

For more information, refer to the specifications document.

GUI appearance and operation

The graphical user interface of R&S WinIQSIM2 is based on the GUI design of the R&S SMW vector signal generator.

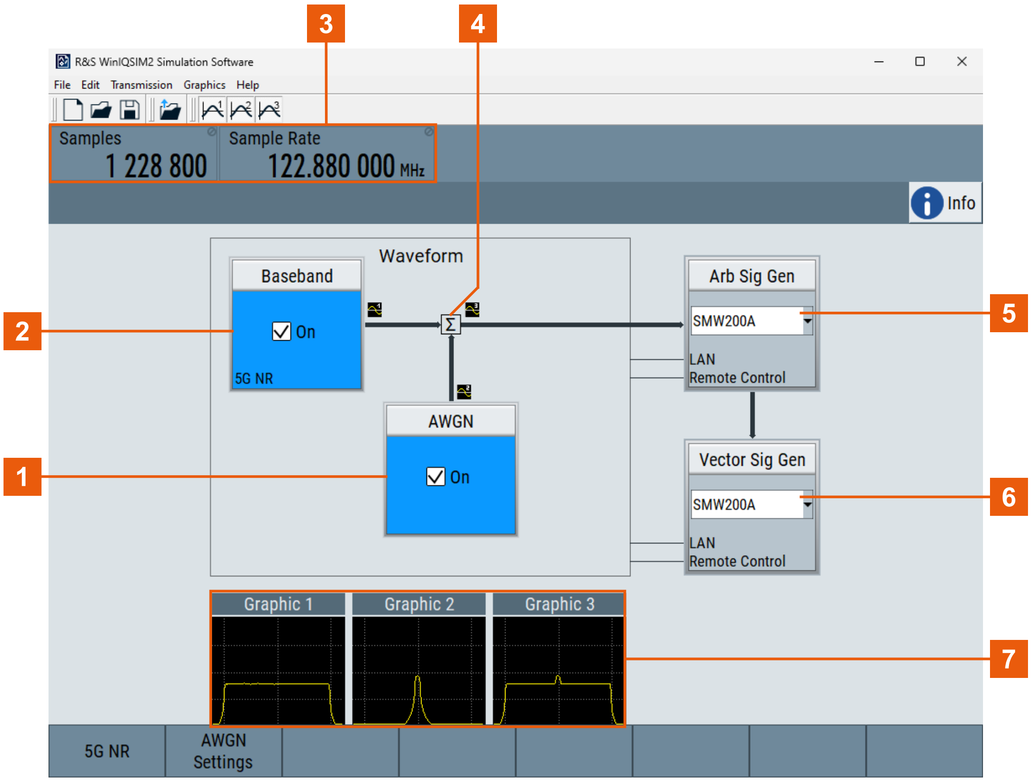


Figure 1-1: R&S WinIQSIM2 application window with signal flow

1 = Noise signal
2 = Digital waveform signal
3 = main parameters of the waveform signal
4 = Superimposed signal
5 = Connected arbitrary waveform signal generator
6 = Connected vector signal generator
7 = Graphical display of the digital waveform, noise and superimposed signals

The application window displays the signal generation in a block diagram. It indicates the current state of the functional blocks and allows you to display the current signal configuration graphically. The signal flow follows the logical left-to-right direction. The status bar above the block diagram shows the main characteristics of the signal. Thus you can see the status of signal configuration and active interfering components at a glance.

Comprehensive graphic display modes in time and frequency domain allow simulation and analysis of characteristics of digital communication systems. You can display for example i(t) and q(t), vector diagrams or spectrums.

You can configure the signal directly in the block diagram. R&S WinIQSIM2 offers intuitive and straight forward operation with a high degree of self-explanation due to the logically structured signal flow, dialogs and menus.

Related descriptions

The embedded context-sensitive help systems provide the help content related to the element that you are currently interacting with. The table of contents, the index and the find functions supports you in finding the information if you are using the documentation in PDF format or printable form. In particular in printed documents, you can find it helpful to use this section and get familiar with the structure of this description.

The description follows the procedure as you likely configure a new signal generation task. It starts with configuring the baseband source, describes how you can assign a noise or interferer signal and validate the signal with the graphics display. Setting up an instrument and transmitting the waveform file to the destination instrument complete the process description.

Finally, the description deals with general functions of R&S WinIQSIM2, information about remote control, like network connection and remote control commands, as well as error messages and troubleshooting.

See also Chapter 2.6, "Getting information and help", on page 44.

1.1 Key features

Outstanding features of R&S WinIQSIM2 are:

- Generation of all important digital communication standard signals
- Generation of custom digital signals, like single, multi-carrier CW or multi-segment waveforms
- Generation of noise signals with selectable bandwidth
- Importing I/Q samples for additional filtering or superimposing
- Comprehensive graphic display modes
- Intuitive operation via the block diagram
- Signal transmission to instruments via GPIB, USB, LAN, or file transfer via USB stick
- Direct control of instruments via LAN (remote desktop)

For a detailed specification, refer to the data sheet.

1.2 What's new

This manual describes software version SW 5.30.239.xx and later of R&S®WinIQ-SIM2™.

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

- R&S SFI100A added to the instrument configuration, see Chapter 1.3, "Supported Rohde & Schwarz instruments", on page 12 and `:INSTruments:TYPE` on page 302.
- Information on required options for playing custom digital modulation waveforms, see "Required options" on page 63.

1.3 Supported Rohde & Schwarz instruments

Waveform signals computed by R&S WinIQSIM2 can be loaded onto and processed by Rohde & Schwarz instruments as listed below.

Instruments with ARB

The following instruments are equipped with an arbitrary waveform generator (ARB) or provide a waveform memory playback.

Instrument type	Instrument
Vector signal generator	R&S SFI100A, R&S SMW200A, R&S SMM100A, R&S SMBV100B, R&S SMCV100B, R&S SGT100A
Performance vector tester	R&S PVT360A
Radio communication tester	R&S CMW500, R&S CMW100, R&S CMP200, R&S CMP180, R&S CMA180
Digital interface module	R&S EX-IQ-Box *)
Discontinued products	R&S SMBV100A, R&S SMU200A, R&S SMJ100A, R&S AMU200A, R&S AFQ100A, R&S AFQ100B, R&S BTC, R&S SFU

*) The R&S WinIQSIM2 generates waveforms that you can play back at the R&S EX-IQ-Box. There is no data transfer between R&S WinIQSIM2 and the R&S EX-IQ-Box.

Control of vector signal generators

The following vector signal generators can be used for generation of radio frequency (RF) signals. Moreover, these vector signal generators can be controlled by R&S WinIQSIM2.

Instrument type	Instrument
Vector signal generator	R&S SFI100A, R&S SMW200A, R&S SMM100A, R&S SMBV100B, R&S SMCV100B, R&S SGT100A
Discontinued products	R&S SMBV100A, R&S SMU200A, R&S SMJ100A

For more information, refer to the specifications document.

1.4 Documentation overview

This section provides an overview of the R&S WinIQSIM2 user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/winiqsim2

1.4.1 User manual and help

There are separate user manuals for the base software and the software options:

- Base software user manual
  Contains the description of all software modes and functions including operating R&S WinIQSIM2. It also provides a complete description of the remote control commands with programming examples, interfaces and error messages.
  The contents of the base software are available for download and as help in R&S WinIQSIM2. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.
- Software option user manuals
  Contains the description of the specific functions of software options. Basic information on operating R&S WinIQSIM2 is not included.
  The contents of the software options are available as help in R&S WinIQSIM2. The contents of R&S WinIQSIM2 GNSS software options is also available for download. For download version of the other software options, see the corresponding R&S SMW options user manuals.

All user manuals are also available as an HTML help (online version) for immediate display on the Internet.

1.4.2 Data sheets and brochures

The data sheet contains the technical specifications of the R&S WinIQSIM2. It also lists the options and their order numbers and optional accessories.

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

See www.rohde-schwarz.com/brochure-datasheet/winiqsim2

1.4.3 Release notes and open source acknowledgment (OSA)

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

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

See www.rohde-schwarz.com/software/winiqsim2

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

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

See www.rohde-schwarz.com/application/winiqsim2.

1.5 Typographical conventions

The following text markers are used throughout this documentation:

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

1.6 Notes on screenshots

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

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

2 Getting started

This section describes the basic steps to start and operate R&S WinIQSIM2 the first time.

2.1 Installing R&S WinIQSIM2

R&S WinIQSIM2 is a stand-alone, PC-based software application that creates waveform files of digitally modulated signals.

Software and hardware requirements

To install and run R&S WinIQSIM2, the following hardware and software requirements have to be met:

Table 2-1: Software requirements

	Options	Remarks
Operating system	Microsoft® Windows 10, version 1607 "Anniversary Edition" and later	Any other versions or operating systems are not supported. The installation process checks the operating system and aborts the installation if your PC is not compatible.
System type	• 64-bit operating system • x64-based or x86-based processor	You can only run the latest WinIQSIM2 software on a 64-bit operating system. The installation files have the extension `x64` in the file name: `WinIQSIM2_v.vv.vvv.vv.x64.exe`
VISA runtime library	• R&S VISA, IO libraries for instrument control • National Instruments VISA 4.0. or higher (optional) • Other VISA runtime library	VISA driver is bundled with a GPIB (IEC/IEEE)-bus card from National Instruments (NI) or Agilent. If none of these cards are used, there is the option to perform data transmission via TCP/IP connection over LAN. Drivers can be obtained from R&S or NI directly.

Table 2-2: Hardware requirements

	Minimum requirements	Recommended hardware
AMD / Intel CPU	1 GHz	2 GHz
RAM	1 GB **Note:** The installation process checks the RAM size and aborts the installation if the minimum memory size is not given.	2 GB

	Minimum requirements	Recommended hardware
Display resolution	1024 x 800 pixels	≥ 1024 x 800 pixels
GPIB (IEC/IEEE)-bus card	• National Instruments • Agilent	Optional
Free HD space	600 MB	2 GB

To download the software

1. Download the latest version of R&S WinIQSIM2 at:
   https://www.rohde-schwarz.com/software/winiqsim2/
   The page lists downloads for the installer file, the release notes and the open source acknowledgement document of the latest software version.
2. Select the installer file with file extension `*.exe`.
   A file download window opens displaying the filename of the installer file `WinIQSIM2_v.vv.vvv.vv.x64.exe`. `<v.vv.vvv.vv.x64>` stands for the latest version of the 64-bit software as in Table 2-1.
3. Save the file to the directory from that you want to execute the file.

To install the software

To install the software, perform the following:

- Execute the installer file with administrator rights.
- Uninstall any previous version of R&S WinIQSIM2 before installing the new version. See "To uninstall a previous software version" on page 17.

1. In the windows explorer, execute the file `WinIQSIM2_v.vv.vvv.vv.x64.exe` from the directory where you saved the installer file.
   See "To download the software" on page 16.
2. Follow the instructions of the installation wizard.

   The setup file installs all software components R&S WinIQSIM2 requires for operation.

Table 2-3: Default file location (software installation for all users)

File type	File location	File name
User settings and data (waveforms, save/recall, etc.)	`%APPDATA%\Rohde-Schwarz\winiqsim2`	`*.wv`, `*.savrcl`, etc.
Program data	`%PROGRAMFILES(X86)%\Rohde-Schwarz\WinIQSIM2\xx.x`	`WinIQSIM2_Start.cmd`

To uninstall a previous software version

To uninstall a previous version, perform the following:

1. In the taskbar, select the "Windows Start" button.
2. Select "Settings > Control Panel > Programs > Programs and Features".
3. In the list of programs, select "R&S WinIQSIM2_v.vv.vvv.vv.x64".
4. Remove the program with "Uninstall/Change > Uninstall".

   The script file identifies and removes any currently installed items of R&S WinIQ-SIM2.

2.2 Starting R&S WinIQSIM2

To access R&S WinIQSIM2 easily, create a shortcut to the `*.exe` file and place it on the desktop of your computer.

Access:

1. On your computer, execute one of the following:
   - Select "Start" > "R&S WinIQSIM2" > "R&S WinIQSIM2 v.vv.vvv.vv x64".
   - Double-click the shortcut icon on the desktop.

   After starting up, the main application window appears.

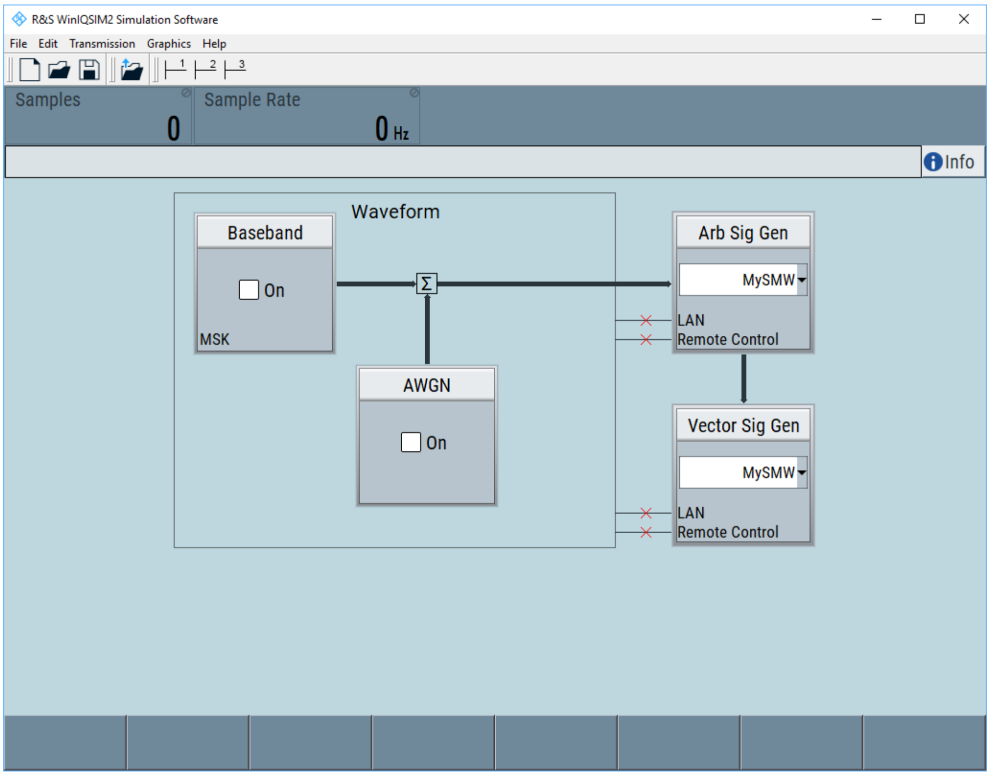


Figure 2-1: R&S WinIQSIM2 main application window in initial state

2. Select "File" > "New" (or the 🗋 icon alternatively), to start from an initial state.

2.3 Trying out R&S WinIQSIM2

General workflow

The general workflow for generating waveform signals requires a connected and configured instrument, for example, a signal generator. After connection and configuration of the instrument, configure the waveform signal in R&S WinIQSIM2.

Changing the instrument during or after waveform signal generation can lead to an invalid waveform signal or an invalid output signal at the signal generator.

The following step-by-step instructions provide an example of how to use R&S WinIQSIM2 to generate a single carrier waveform with AWGN and load it in the ARB of an R&S SMW.

The workflow includes the following steps:

2.3.1 Configuring the instrument

Before you generate a waveform or transmit a signal to a signal generator, you must configure the destination instrument and the connection between the PC with instrument and R&S WinIQSIM2.

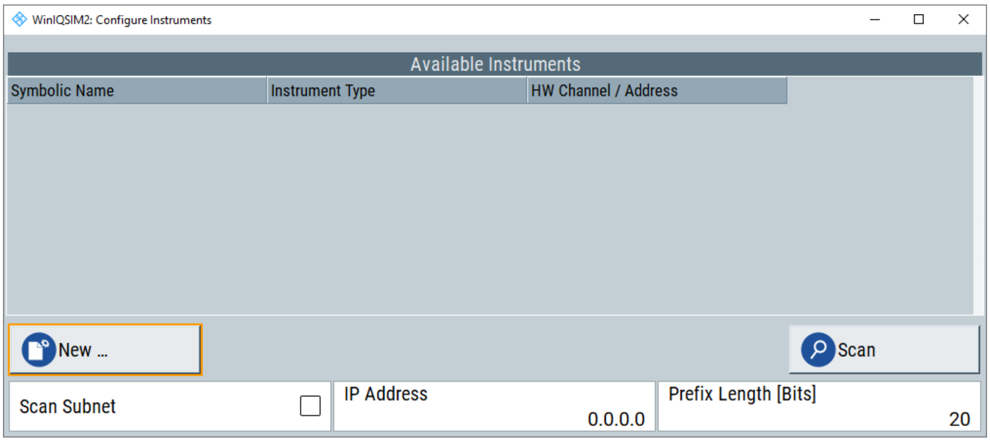
R&S WinIQSIM2 allows you to scan the LAN, GPIB, or USB interfaces for connected instruments ("Arb Sig Gen"/"Vector Sig Gen"). Detected instruments are automatically assigned to the list of "Available Instruments", including the associated information on the connection.

Alternatively, you can create and configure an instrument manually, as described in "To add an instrument manually" on page 187.

The general instrument settings affect various functions, e.g. the maximum size of the waveform file. Configure a detected instrument first before creating the waveform file.

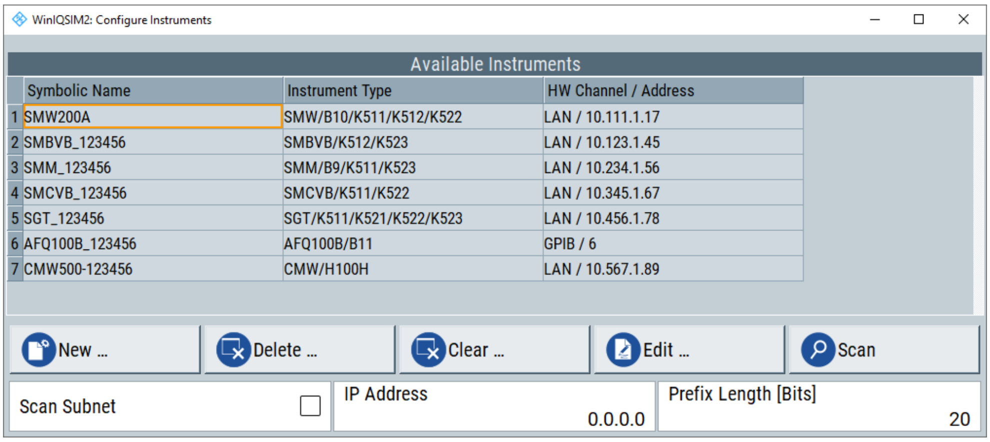
To scan for instruments

1. Connect the instrument to the LAN.
   For example, connect an R&S SMW equipped with option R&S SMW-B10.
2. Switch on the instrument.
3. In the menu bar of R&S WinIQSIM2, select "File > New" to start the software from an initial state.
4. In the block diagram, select "Arb Sig Gen"/"Vector Sig Gen" > "Instruments".
   The "Configure Instruments" dialog opens allowing you to perform the following:
   - Search for instruments in a network.
   - Search for instruments in a dedicated subnet of the network.
   - Search for instruments with USB/GPIB connection to a PC with R&S WinIQSIM2 installed.
   - Configure detected instruments.



5. Select "Scan" to search for instruments.

   All instruments found in the network and instruments connected via the GPIB or USB interfaces are displayed in the list of "Available Instruments". R&S WinIQSIM2 retrieves all information on connection to the instrument automatically.



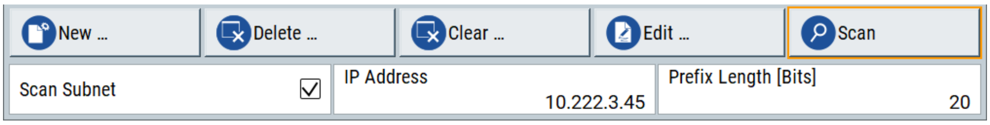
   Note: R&S WinIQSIM2 does not clear the list of "Available Instruments" before a scan. Any instruments found during a scan are added to the list.

6. If you found your R&S SMW in the list, close the dialog.

To scan a subnet of the network

To accelerate the scan of the network, you filter the scan for subnet parameters and an IP address.

1. Open the "Configure Instruments" dialog as described in "To scan for instruments" on page 19.
2. Select "Scan Subnet > On".
3. Set the IP address of an instrument within the subnet, e.g. "10.222.3.45".
4. Set the prefix length of the subnet, e.g. "20" bits.
5. Select "Scan".



The scan procedure searches for instruments within the subnet, to which the IP address "10.222.3.45" belongs.

To modify the configuration of detected instruments

You can configure search results of the list and modify the configuration of detected instruments, see Chapter 6.4, "Configure instruments settings", on page 194.

Troubleshooting non-detected instruments after scan

If the instrument you want to work with is not listed, check if the following prerequisites are fulfilled, and scan for the instrument again:

- Is the instrument switched on?
- Is the instrument accessible via LAN, GPIB, or USB?
- Is the firewall of the instruments' operating system deactivated?

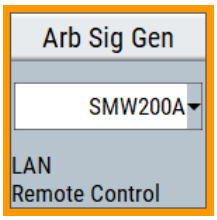
2.3.2 Selecting the instrument

Before you can select an instrument, configure external instruments first, see Chapter 2.3.1, "Configuring the instrument", on page 19).

For generating the waveform, you do not need a real instrument connected to R&S WinIQSIM2. You can also create a waveform based on a manual dummy configuration of the instrument (offline). See also "To understand the instrument configuration" on page 189.

To select the instrument

► In the instrument selection list of the "Arb SigGen"/"Vector Sig Gen" block, select e.g. "SMW200A".



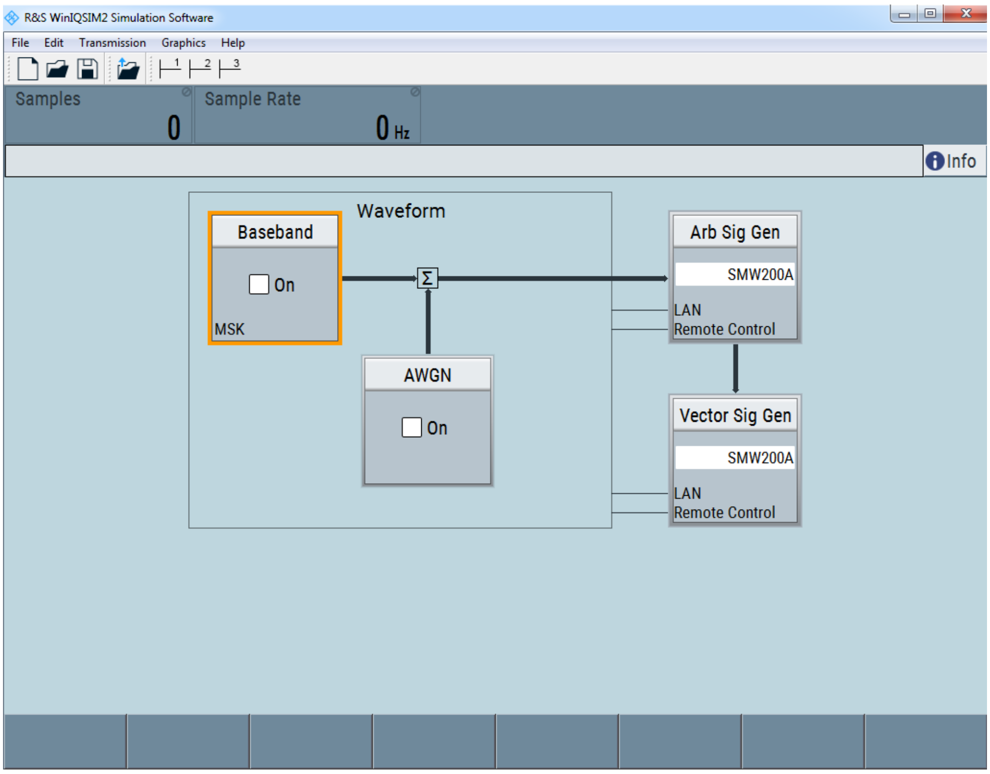
The R&S SMW is selected as the ARB signal generator used to create the waveform signal.

2.3.3 Generating a waveform signal

The example task is to configure a digital signal in accordance with the EUTRA/LTE standard. It introduces the way to access the settings and the configuration principles common for digital standards and the R&S WinIQSIM2 software.

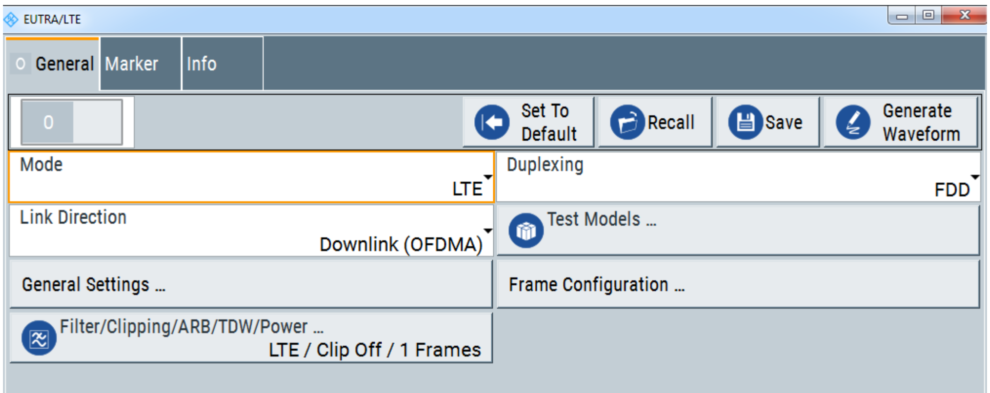
We use one of the provided EUTRA test models (E-TM), to show how to configure and generate a test signal.

1. In the menu bar, select "File" > "New" to start from an initial state.



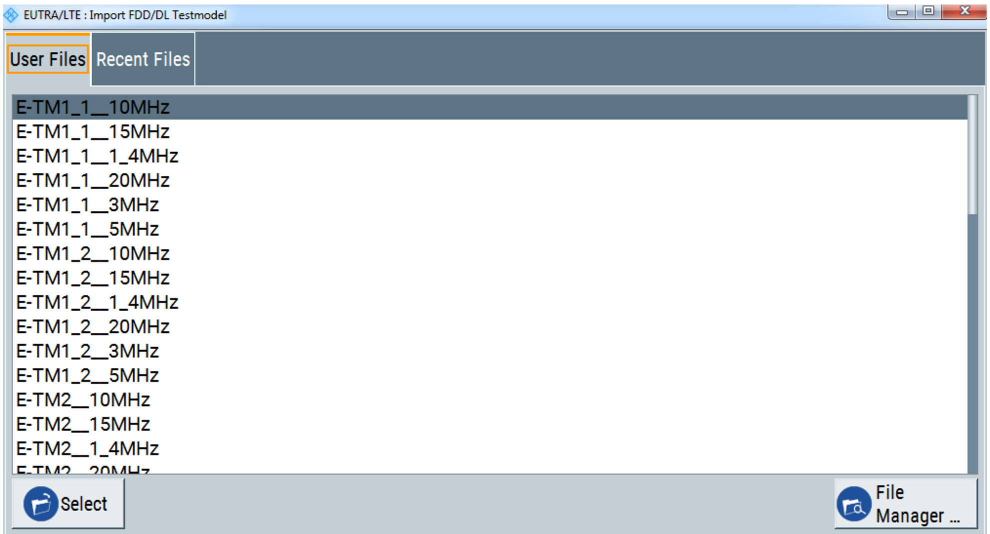
R&S WinIQSIM2 sets all settings to default, except selected instruments in the "ARB Sig Gen" and "Vector Sig Gen" blocks.

2. In the block diagram, select "Baseband" > "EUTRA/LTE".



The "EUTRA/LTE" settings dialog contains the parameters to configure the waveform signal.

3. In the "General" tab, select "Link Direction" > "Downlink (OFDMA)".
4. Select "Test Models" > "E-TM1_1__10MHz".
5. Confirm with "Select".
   The "Test Models" is a function for quick selection and settings adjustment according to one of the various EUTRA test models (E-TM). A standard "File Select" function enables you to select form files with predefined settings.



   The dialog closes automatically and the user interface confirms the name of the selected file.

6. Select "General DL Settings" to have a look at the channel bandwidth and the occupied bandwidth of the selected signal.

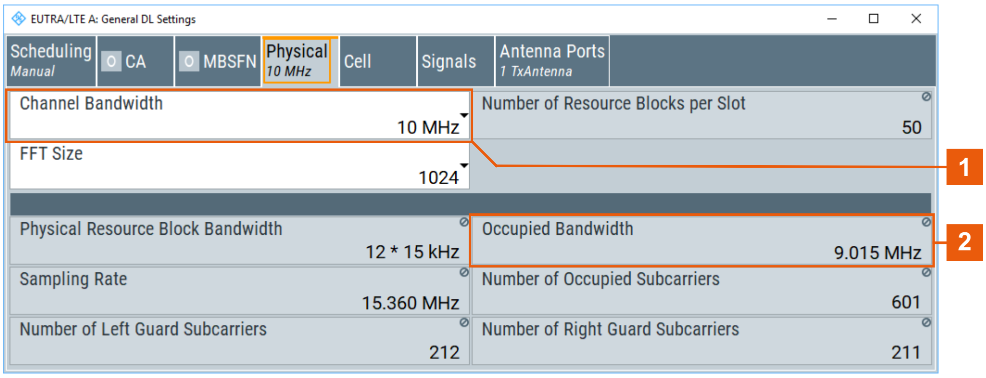
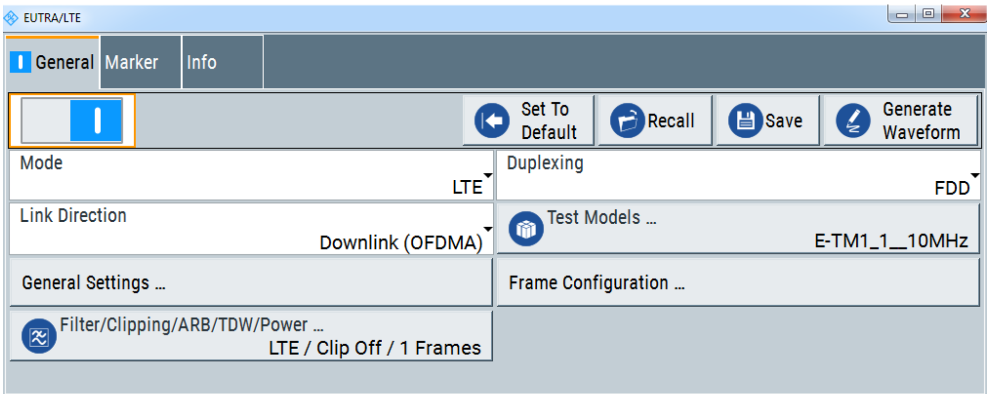


Figure 2-2: Test model E-TM1_1_10MHz bandwidth parameters

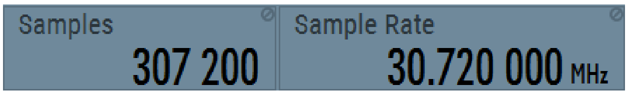
1 = "Channel Bandwidth" > "10 MHz"
2 = "Occupied Bandwidth" > "9.015 MHz"

The selected test model operates with a channel bandwidth of 10 MHz. The signal occupies 9.015 MHz.

7. Close the "General DL Settings" dialog.
8. In the "General" tab, select "State" > "On".



R&S WinIQSIM2 calculates the EUTRA/LTE test signal with the selected channel bandwidth. It displays the characteristic signal parameters, i.e. the number of "Samples" and the used "Sample Rate" in the status bar of the main window.

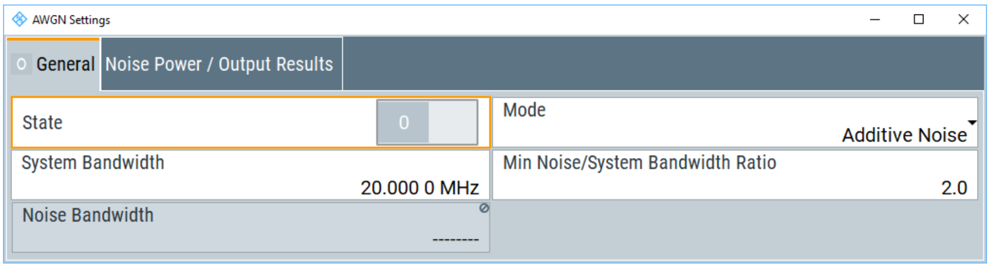


2.3.4 Adding noise to the waveform signal

In R&S WinIQSIM2, you can also superimpose the waveform with noise.

In the example, we generate an average white Gaussian noise (AWGN) signal that is to be superimposed with the interference-free LTE signal. The minimum noise to system bandwidth ratio is two.

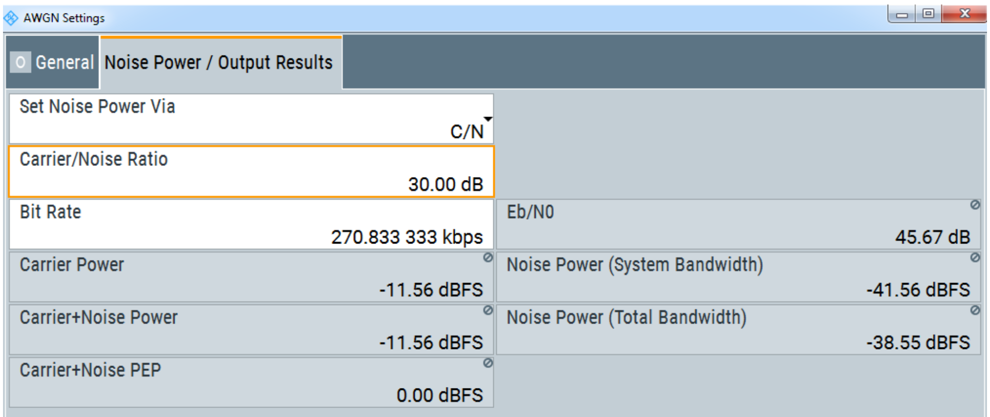
1. In the block diagram, select "AWGN".



The "AWGN Settings" dialog contains the parameters for configuring additive white Gaussian noise, noise level or CW interfering.

2. In the "General" tab, select "Mode" > "Additive Noise".
3. Set "System Bandwidth" > "10 MHz".

4. Enter "Min. Noise/System Bandwidth Ratio" > "2".
5. In the tab "Noise Power / Output Results", enter "Bit Rate" > "270.833333 kbps".



6. Enter "Carrier/Noise Ratio" > "30 dB".
7. In the "General" tab, select state "On".

   R&S WinIQSIM2 generates the noise signal.

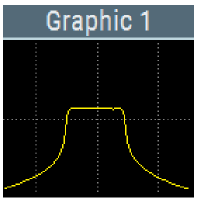
2.3.5 Visualizing the waveform signal

It is often useful to verify a generated waveform before storing or transmission. This example shows you how to configure the display function of the R&S WinIQSIM2, and how to view the signals in particular, both the baseband and the AWGN, and the superimposed signal. The example uses the waveform generated as described in Chapter 2.3.3, "Generating a waveform signal", on page 22, and the AWGN signal of Chapter 2.3.4, "Adding noise to the waveform signal", on page 24.

The graphics panel is an important tool for checking the signal configuration. In this panel, you can display the generated I/Q signal as an I/Q diagram, and derived representations thereof like the vector diagram or the signal spectrum. For more information, see Chapter 5, "Displaying simulated waveforms graphically", on page 161.

To display the baseband waveform signal

1. In the menu bar of the main window, select "Graphics > Graphic 1 > Graphic 1 (Preview Only)".
   R&S WinIQSIM2 indicates the graphics preview in the block diagram.

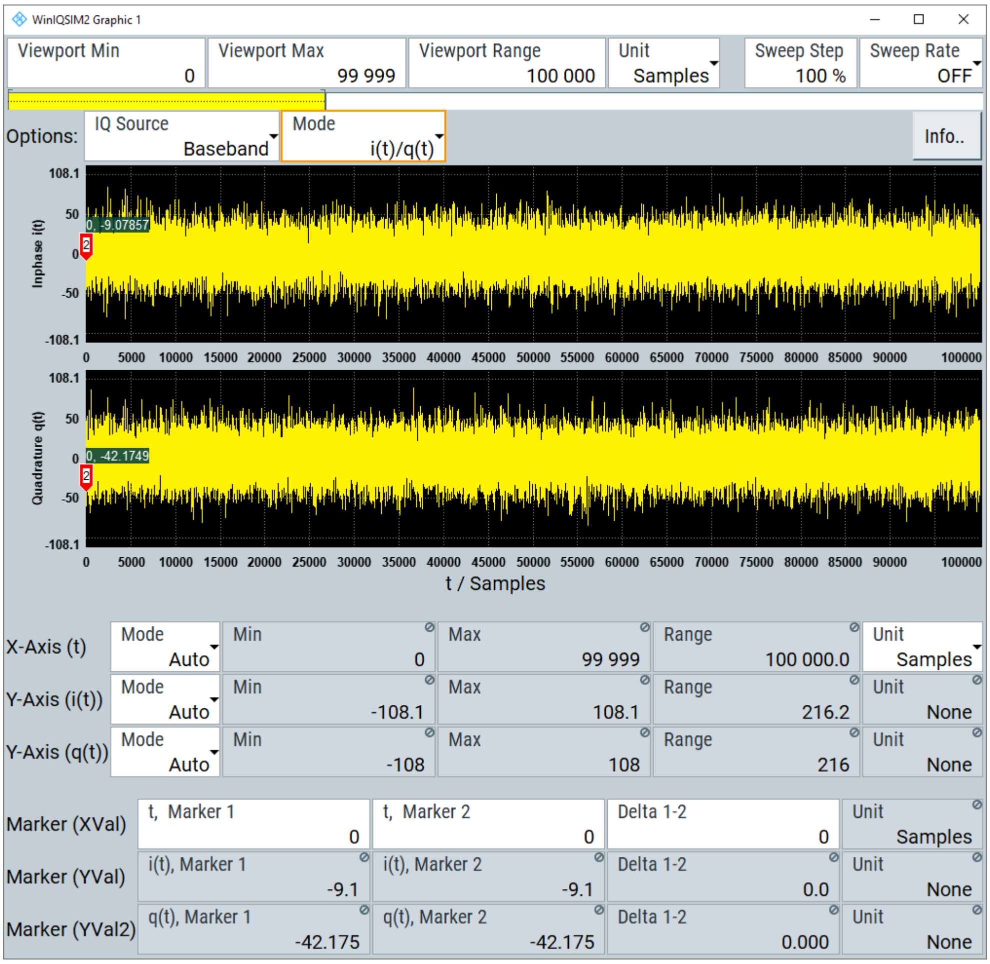


A small icon assigned directly to the signal line indicates the shown waveform.

To access the graphic settings, perform one of the following:

a) Double-click the small graphics display.

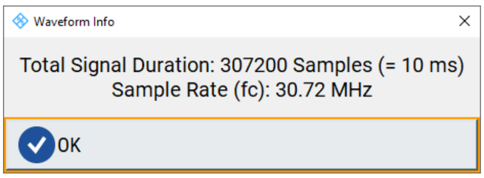
b) In the menu bar, select "Graphics > Graphic 1 > Graphic 1 (Complete)".



The "Graphic 1" settings dialog opens displaying "Viewport" and "Options:" settings to configure the operating range of the waveform and specify the signal that you want to monitor.

2. To configure the waveform operating range, specify the "Viewport" parameters.

3. To check signal duration and sample rate, click the "Info.." button.

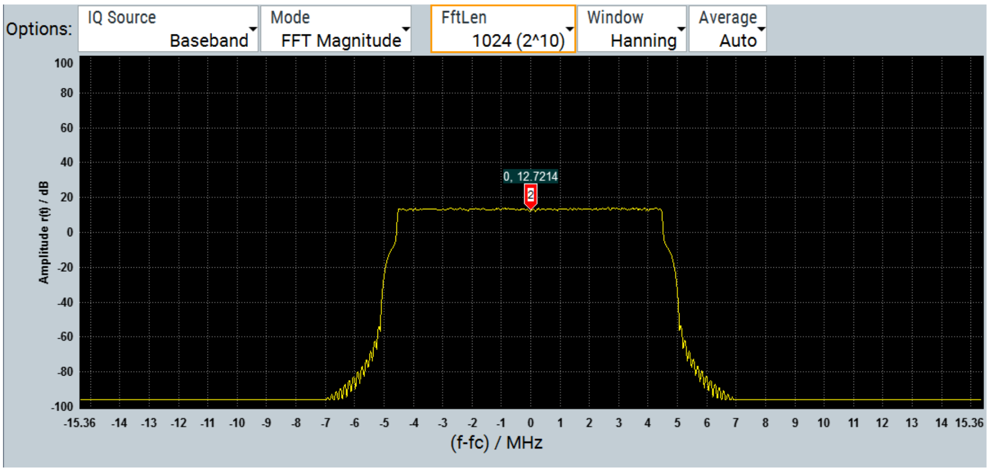


4. To configure the I/Q parameters, try out the following:

a) Select "IQ Source" > "Baseband".

b) Select "Mode" > "FFT Magnitude".

c) Select "Len" > "2048 (2^11)".



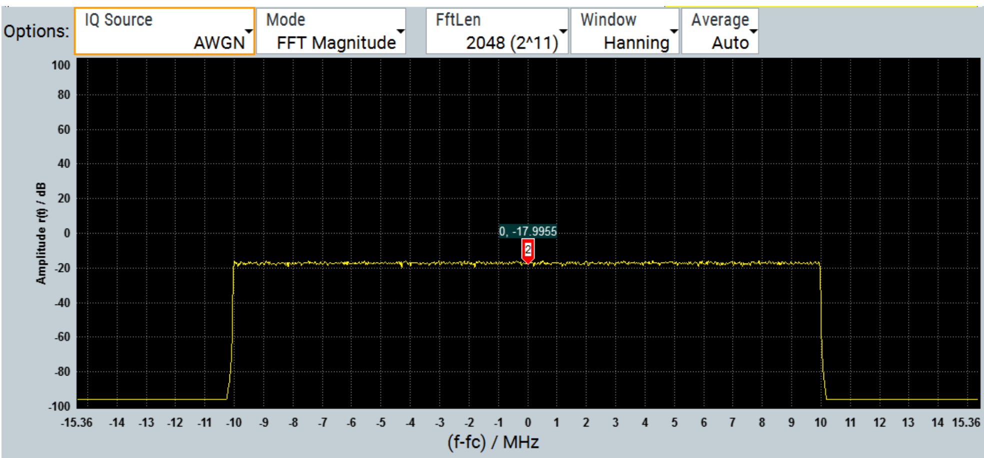
The power spectrum displays the frequency versus the amplitude of the baseband signal of the waveform.

For related settings, see Chapter 5, "Displaying simulated waveforms graphically", on page 161.

To display the AWGN signal

In this example, we use the second graphic function to display the AWGN signal. Perform the following steps:

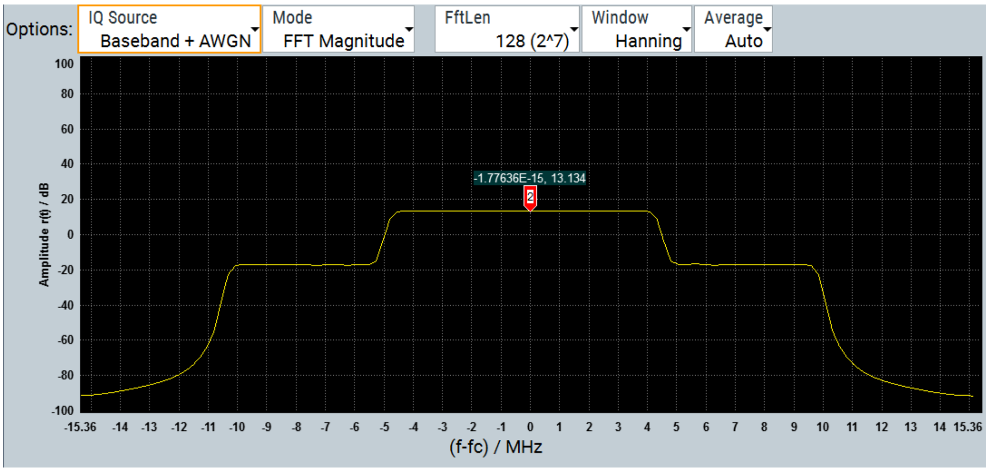
1. In the menu bar of the main window, select "Graphics" > "Graphic 2" > "Graphic 2 (Complete)".
2. In the "Graphic" dialog, select "IQ Source" > "AWGN".
3. Select "Mode" > "FFT Magnitude".
4. Select "Len" > "2048 (2^11)".



The power spectrum displays the generated additive white Gaussian noise signal.

To display the baseband signal superimposed with AWGN

1. In the menu bar of the main window, select "Graphics" > "Graphic 3" > "Graphic 3 (Complete)".
2. Select "IQ Source" > "Baseband + AWGN".
3. Select "Mode" > "FFT Magnitude".
4. Select "Len" > "2048 (2^11)".



The power spectrum displays the waveform derived from the baseband signal superimposed with the AWGN signal.

To retrieve more information, zoom in the spectrum and place the markers to the positions to measure the corresponding values. See To zoom a particular area of the waveform.

To use markers to analyze the signal

Using the markers you can determine particular readings of the signals, e.g. to verify the settings directly in the graph. You can position the markers in the diagram to find out the appropriate values.

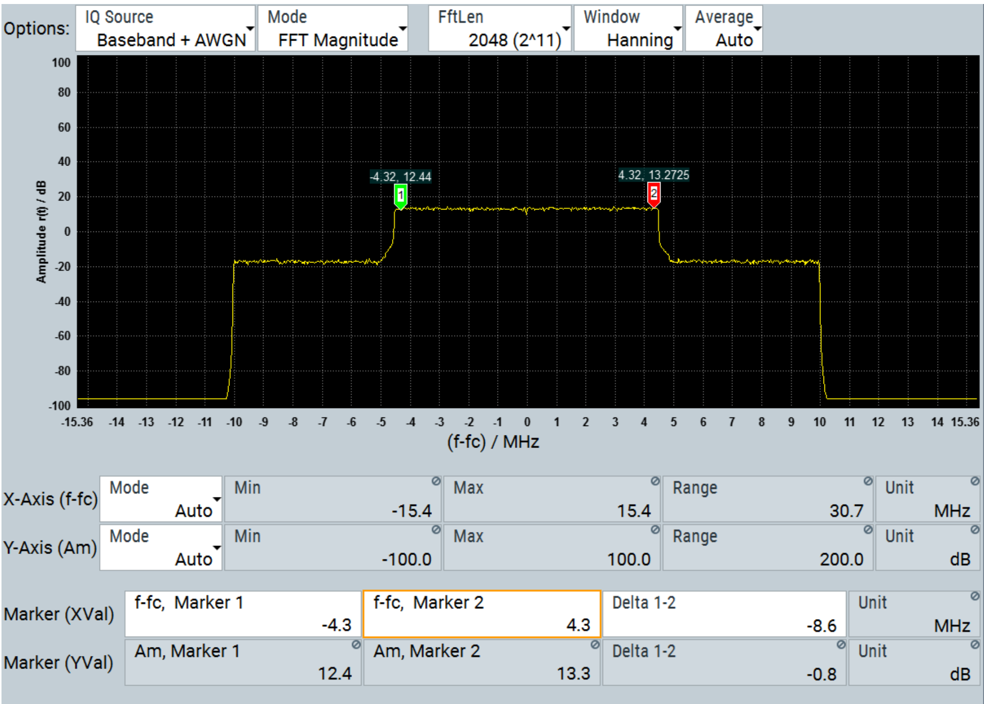
In the following examples, we set the markers to determine the occupied bandwidth of the baseband waveform, and the carrier/noise ratio.

To determine the occupied bandwidth of the baseband signal

1. Open the "Graphics 3" dialog.
2. In the diagram, drag the first marker to the left:
   a) Left-click the first marker.
   b) Keep the mouse key pressed.

   R&S WinIQSIM2 denotes the current X-axis position by a colored line.
3. Drag and drop the marker to the start position of the baseband signal (on-time).

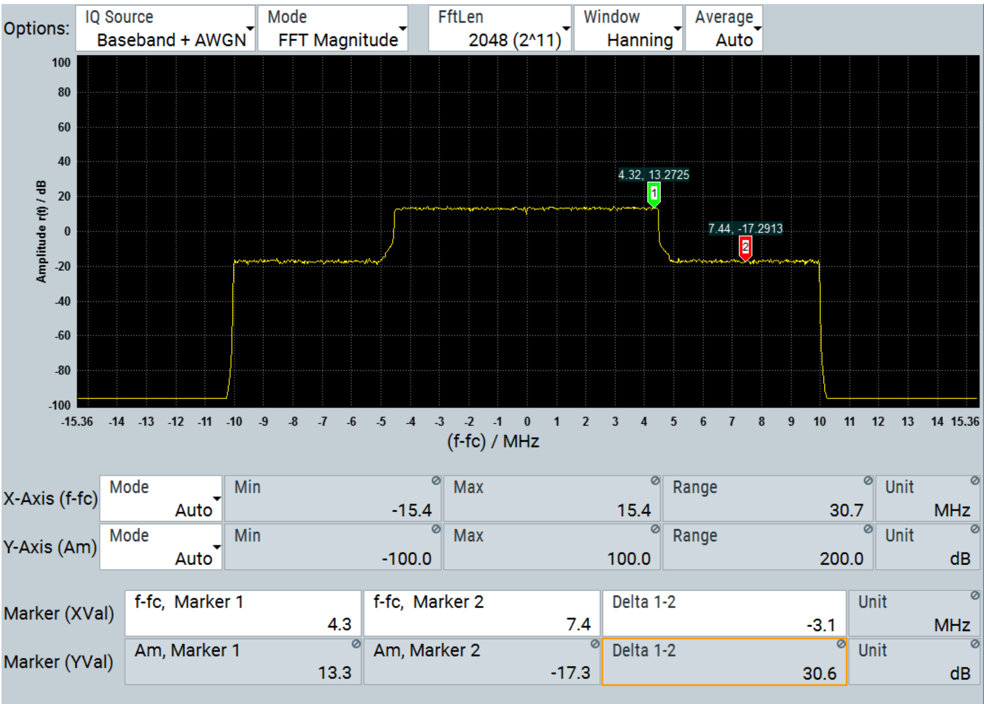
4. Accordingly, move the second marker to the end position.



You can see the current X and Y-axis positions of the markers in the diagram, or in the "Marker" fields in the lower section of the dialog. The calculated "Delta 1-2" frequency value reflects the occupied bandwidth of the EUTRA/LTE signal approximately, see Generating a waveform signal, step 6.

To determine the carrier-to-noise ratio

1. Open the "Graphics 3" dialog.
2. In the diagram, left-click and hold the first marker.
3. Drag and drop "Marker 1" to the top level of the noise signal.
4. Accordingly, move the second marker to the top level of the baseband waveform signal.

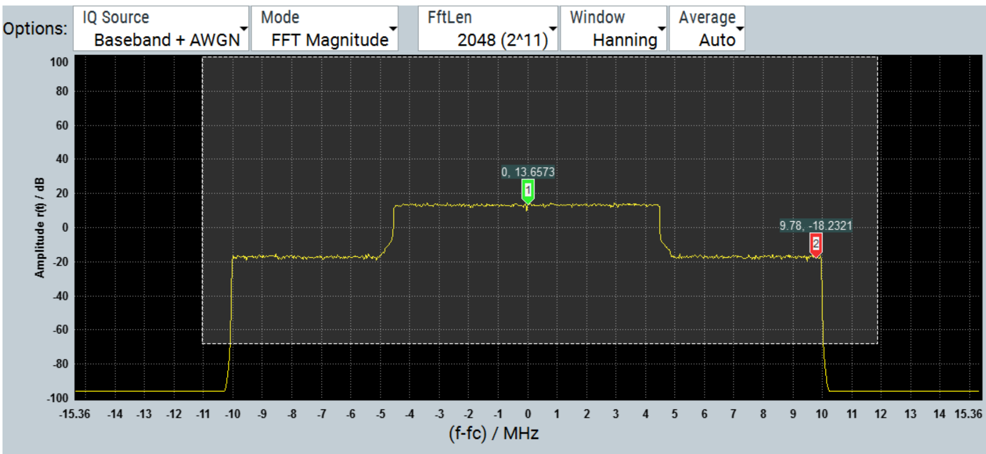


R&S WinIQSIM2 determines the carrier/noise ratio of approximately 30 dB based on the markers amplitude values.

To zoom a particular area of the waveform

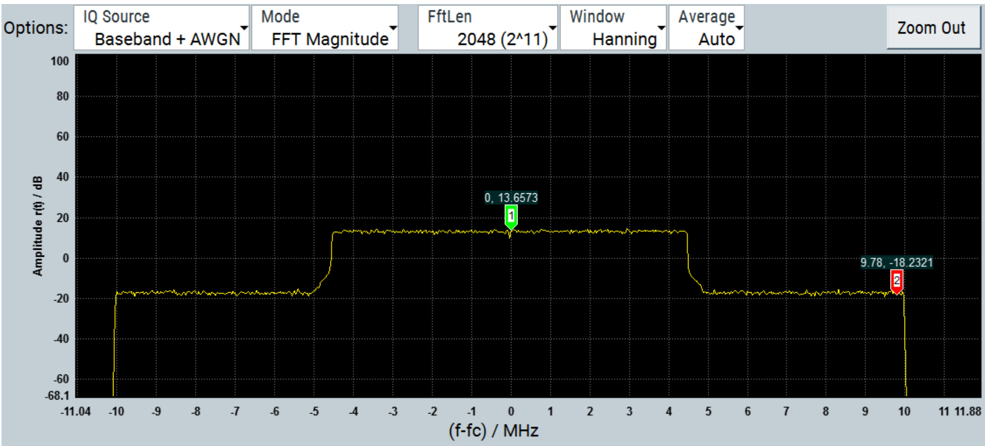
To retrieve more information, you can enlarge any section of the graph and thus visualize particular values of the signal in detail.

1. Left-click and hold the upper left corner of the section you want to zoom.
2. Draw the zoom rectangle.



A dotted rectangular frame denotes the marked area.

3. Release the mouse button.

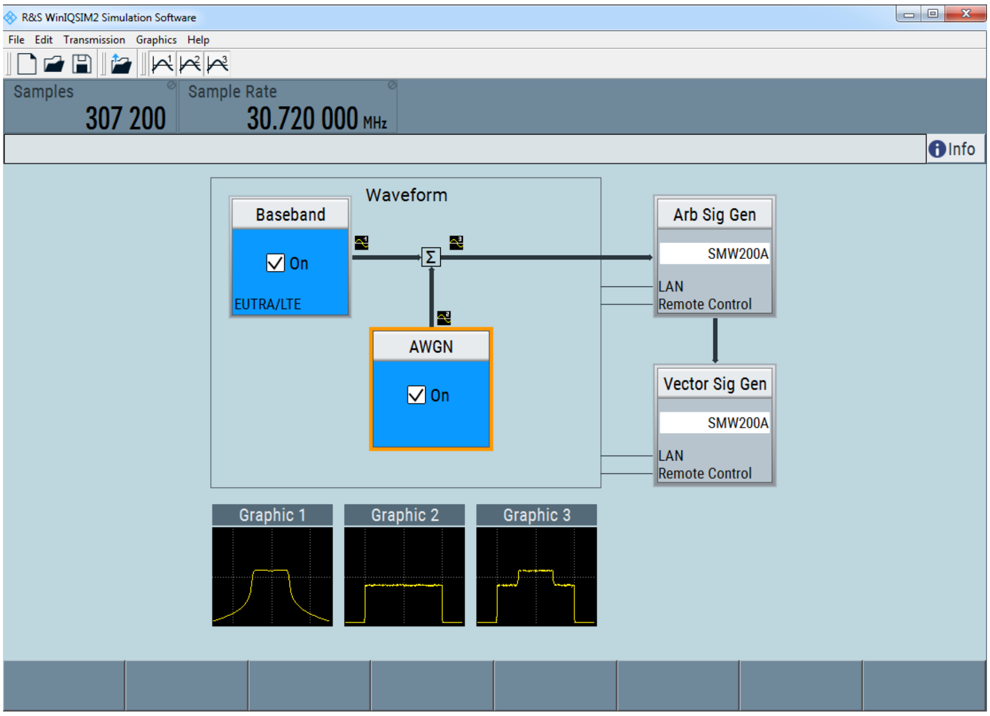


R&S WinIQSIM2 enlarges the selected section. Now you can analyze the signal trace in more detail visually.

4. To return to the initial size, select "Zoom Out".

To display the graphics in the main window

► Close all graphics dialogs.



R&S WinIQSIM2 shows the small graphics preview of all active diagrams. "Graphic 1" displays the baseband signal, in "Graphic 2" you can see the AWGN signal, and in "Graphic 3" the baseband signal interfered with noise.

2.3.6 Transmitting the waveform to the R&S SMW

Transferring the waveform file to the signal generator, requires that the connection between R&S WinIQSIM2 and the R&S SMW is on.

You can see the connection at a glance in the block diagram denoted by the two thin control lines, see Chapter 2.5.1.4, "Block diagram", on page 39.

If the lines are crossed, establish the connection as described in Chapter 2.3.1, "Configuring the instrument", on page 19 and Chapter 2.3.2, "Selecting the instrument", on page 21.

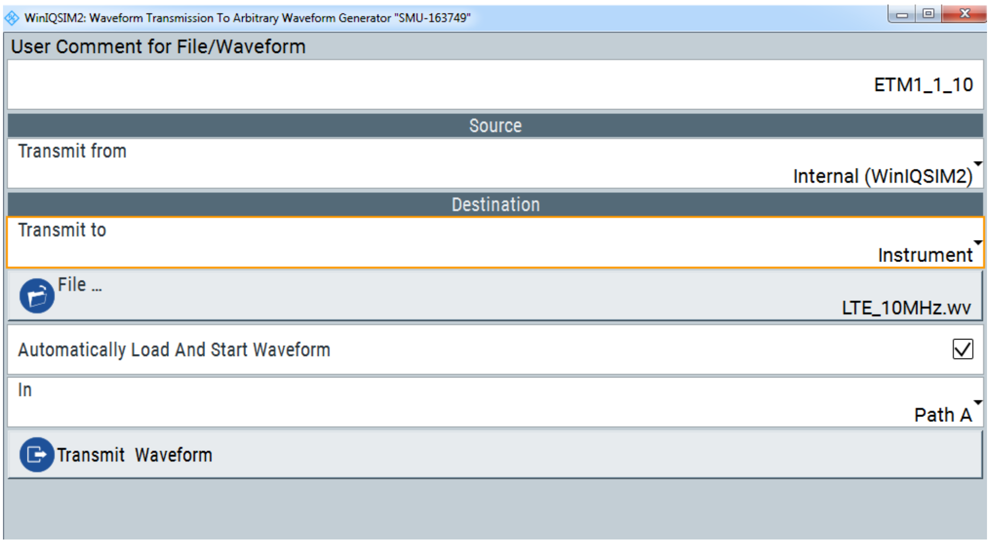
In addition, the following requirements must be met:

- Enabled file transfer via LAN and the used interface protocol
- Enabled write permission on the instrument's file system

For more information on security settings, see the user manual of the instrument.

To transmit the generated waveform to the R&S SMW

1. To configure the transmission, perform one of the following:
   a) In the menu bar, select "Transmission > Transmit".
   b) In the toolbar, select .



   The "Waveform Transmission To Arbitrary Signal Generator" dialog opens.

2. Select "Source" > "Internal (WinIQSIM2)".
   R&S WinIQSIM2 selects the last generated waveform data automatically.
3. Select "Destination" > "Transmit to" > "Instrument".
4. Select "File" to determine the filename and directory for storing on the instrument.
   a) Select/create the destination directory on the instrument.
   b) Enter the "File Name".

c) Confirm with "Ok".

To activate ARB signal generation at the R&S SMW

The waveform is ready for transmission to the instrument as described in "To transmit the generated waveform to the R&S SMW" on page 32.

1. Open the dialog "Waveform Transmission To Arbitrary Signal Generator".
2. Select the required baseband path, for example "Path A".
3. Add a comment to the waveform.
4. Select "Transmit" to start the transmission.

   R&S WinIQSIM2 transmits the waveform file to selected folder of the R&S SMW. After successful transmission, the R&S SMW loads the file, enables the ARB and plays the transmitted waveform, and automatically provides the waveform signal at the I/Q modulator outputs.

2.3.7 Transmitting the waveform to a file

When transmitting the waveform signal to a file, R&S WinIQSIM2 basically saves the signal information in a file.

To save the generated waveform file

1. In the toolbar, select .

   The "Waveform Transmission To Arbitrary Signal Generator" dialog opens.

2. Add a comment to the waveform.
3. To confirm the comment, select "Enter".
4. Select "Source" > "Internal (WinIQSIM2)"

   R&S WinIQSIM2 selects the last generated waveform data automatically.

5. Select "Destination" > "File".
6. Select "File" to determine the filename and directory for storing the waveform.

a) Select/create the destination directory.
b) Enter the "File Name".
c) Confirm with "Save".

7. Select "Transmit Waveform".

   R&S WinIQSIM2 saves the waveform file with file extension `*.wv` in the specified directory on your computer.

2.4 Overview of R&S WinIQSIM2

This section helps you to get familiar with R&S WinIQSIM2. It provides an introduction to the general concept of the software, including the description of the main blocks in the signal generation flow.

2.4.1 Brief introduction to the concept of R&S WinIQSIM2

The signal generation software comprises all the functionalities required for creating waveform files of digitally modulated baseband signals. It provides almost all standard-compliant digital signals, user-definable signals with selectable modulation parameters and multicarrier signals.

The graphical user interface provides intuitive operation via a block diagram, representing the core functionalities in blocks. You can control the entire process of the signal configuration via the block diagram. At a glance, you can see the status of signal configuration, active interference signals, the signal flow and connected instruments. In addition, R&S WinIQSIM2 shows the signals graphically.

2.4.2 Possible ways to operate R&S WinIQSIM2

This chapter provides an overview on how to work with R&S WinIQSIM2 and describes the manual operation of the software and also the alternative ways of operation.

There are two ways to operate R&S WinIQSIM2:

- Manual operation:
  Run the software on your PC and use the mouse and/or keyboard.
- Remote control:
  A remote control program either installed on the same or another computer, controls R&S WinIQSIM2, see Chapter 2.5.3, "Remote control", on page 44.

With remote control, you can create programs to automate repeating settings, tests and measurements.
This way of operation is described Chapter 10, "Automation of R&S WinIQSIM2", on page 231.
Tip: As a special function, R&S WinIQSIM2 provides SCPI recording. Using this function, you can record and save the settings of your configuration for later reuse. SCPI recording is accessed via the context-sensitive menu.

2.4.3 Signal flow at a glance

The framed area symbolizes R&S WinIQSIM2 as one unit. It shows the blocks for generation of the baseband and interference signals, and the signal flow to the peripheral signal generators.

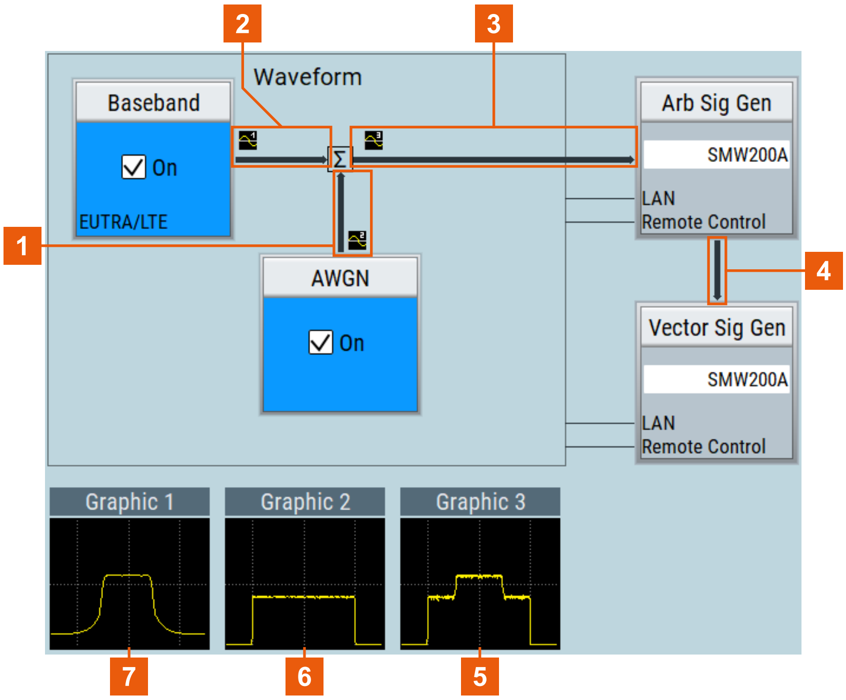


Figure 2-3: R&S WinIQSIM2 signal flow

1, 6 = Noise signal flow and signal shape
2, 7 = Digital waveform signal flow and signal shape
3, 5 = Signal flow of digital waveform and superimposed noise and signal shape
4 = Signal flow of ARB signal from waveform data

2.4.4 Baseband block

The "Baseband" block represents the source of the baseband signals.

This functional block is the access point to:

- *The internal baseband generator*

With the baseband generator, you can create a user-defined signal ("Custom Digital Modulation"), including MCCW signal generation and "Import IQ Data".

- *The available digital standards*
  Generation of digital signals in accordance with the supported standards require the corresponding R&S WinIQSIM2 digital standard options installed on the instrument.

2.4.5 AWGN block

The "AWGN" block controls the additional white Gaussian noise (AWGN) generator.

You can create a white noise signal ("Additive White Gaussian Noise"), or a sinusoidal signal ("CW Interferer") with adjustable frequency offset, and superimpose this noise signal with the baseband signal. Alternatively, you can generate a pure noise signal ("Noise only").

2.4.6 Arb Sig Gen and Vector Sig Gen blocks

These blocks represent instruments that can process the waveforms created by R&S WinIQSIM2. You can configure a remote connection to an instrument in the network, transfer the created waveform file directly and even activate the signal generation on the instrument. In addition, you can scan for connected instruments in the network.

R&S WinIQSIM2 distinguishes two types of generators:

- "Arb Sig Gen", the arbitrary waveform generators for generating the I/Q baseband signal.
- "Vector Sig Gen", the vector signal generators for modulating the I/Q signal to RF via a local oscillator (LO) and an I/Q modulator.

Both generator types can be integrated in a single instrument, as, e.g., in the R&S SMW.

But there are also instruments that provide only one component, such as the I/Q modulation generator R&S AFQ or the R&S SGT vector RF source.

R&S WinIQSIM2 assigns detected or manually configured instruments according to their functionality automatically to respective signal generator block. The instrument selection fields of the blocks provide all available instruments listed under their symbolic name.

2.5 Controlling R&S WinIQSIM2

This section provides an overview on how to work with R&S WinIQSIM2. It describes what kind of information is displayed in the diagram area, how to operate R&S WinIQSIM2 manually or in remote control mode, and how to use the online help.

2.5.1 Understanding the display information

The application window shows all main settings and control elements of R&S WinIQ-SIM2. All menus and dialogs use known elements, like, for example, selection lists, icons, checkboxes, and entry fields.

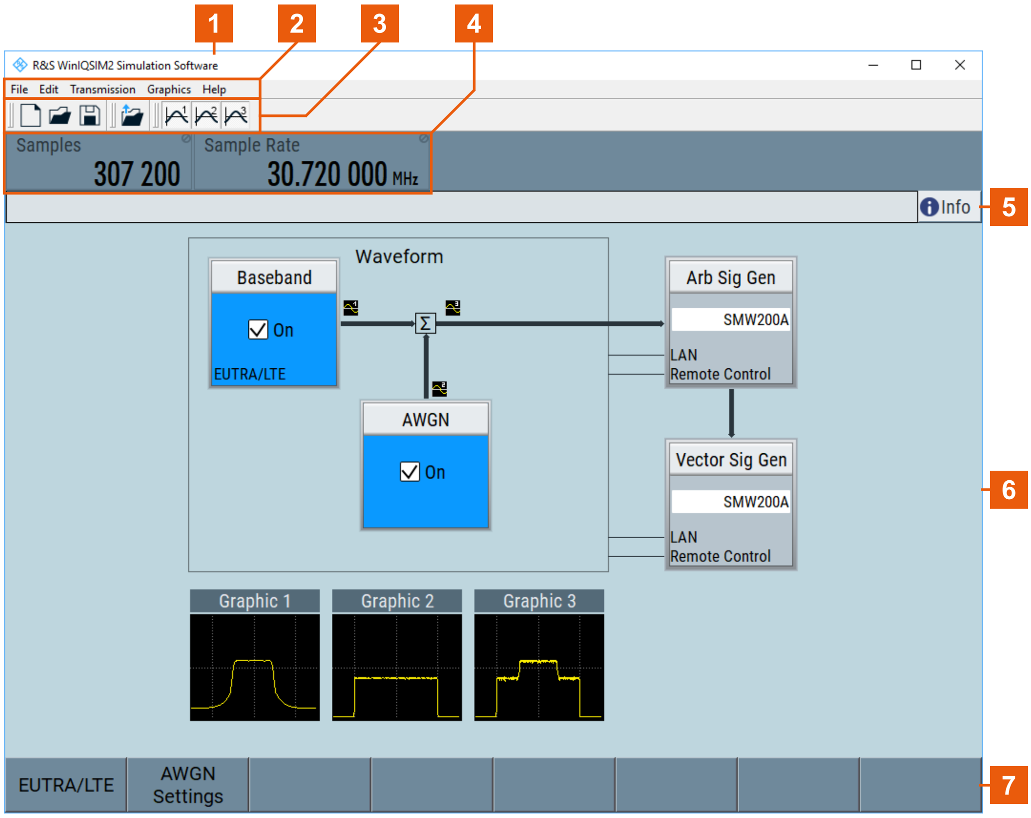


Figure 2-4: R&S WinIQSIM2 main application window

1 = Title bar
2 = Menu bar and toolbar, page 37
3 = Menu bar and toolbar, page 37
4 = Status bar, page 39
5 = Info line, page 39
6 = Block diagram, page 39
7 = Taskbar, page 41

The following sections explain the labeled operation areas in detail.

2.5.1.1 Menu bar and toolbar

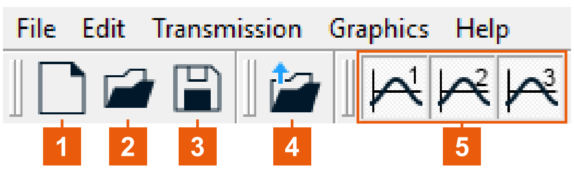
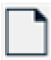


Figure 2-5: R&S WinIQSIM2 menu bar and toolbar

1 = New
2 = Open
3 = Save
4 = Transmit
5 = Graphics

The toolbar contains the most commonly used general functions of the application. The toolbar icons provide quick and easy access with the mouse pointer. Alternatively, you can also find these functions in the menus or you can use keyboard shortcuts to execute a function. For an overview, see Table 2-4.

Table 2-4: Menu bar, icons and shortcuts

Legend	Toolbar	Menu bar	Shortcut	Description
1		"File" > "New"	Ctrl+N ALT+F > N	Resets R&S WinIQSIM2 to default.
2		"File" > "Open"	Ctrl+O ALT+F > O	Loads an existing configuration file, containing specific settings of a configured application. The file extension is predefined (`*.savrcl`).
3		"File" > "Save"	Ctrl+S ALT+F > S	Saves all settings to the current configuration to an existing file.
-	-	"File" > "Save as"	Ctrl+Shift+S ALT+F > N	Saves the complete settings to the current configuration to a new file (`*.savrcl`).
-	-	"File" > "Setup"	ALT+F > P	Displays the current software version and options. Opens a dialog to configure the location for temporary files. Opens a dialog to configure the SCPI port for remote control.
-	-	"File" > "Exit"	ALT+F > X	Terminates R&S WinIQSIM2. The current configuration settings are saved and restored when you restart the program.
-	-	"Edit" > "Undo/Redo"	ALT+E > U	Reverts to the last configuration (undo), or reverses the undo (redo).
-	-	"Edit" > "Show SCPI Recording List"	ALT+E > S	Opens a dialog to record SCPI commands in a list.
-	-	"Edit" > "User Menu"	ALT+E > M	Opens a dialog to configure a user-defined subset of R&S WinIQSIM2 settings.
4		"Transmission" > "Instruments"	ALT+T > I	Opens a list of available instruments.
-	-	"Transmission" > "Transmit"	ALT+T > T	Opens a dialog for configuring file transmission to an ARB instrument.
5	 	"Graphics x" > "Graphics x (Preview only)"	ALT+G > 1... > 1... (toggle)	Displays a small graphics preview in the block diagram.

Legend	Toolbar	Menu bar	Shortcut	Description
-	-	"Graphics x" > "Graphics x (Complete)"	ALT+G > 1 > 1 (toggle)	Opens the dialog for graphical display.
-	-	"Help" > "Contents"	F1 ALT+H > C	Opens the R&S WinIQSIM2 online help.
-	-	"Help" > "Index"	ALT+H > C	Shows the index of the online help.
-	-	"Help" > "About"	ALT+H > A	Displays information on the software version.

2.5.1.2 Status bar

The status bar displays the main characteristics of the active signal, like samples or symbols and data rates.

Samples
Displays the number of samples, respectively the number of symbols over sampling factor, depending on the signal.

Remote command:
`:GENerate:WAVeform:SAMPles?` on page 298

Sample Rate
Displays the rate at which the samples are sent, depending on the signal in samples/s or symbols over sampling factor.

Remote command:
`:GENerate:WAVeform:SRATe?` on page 298

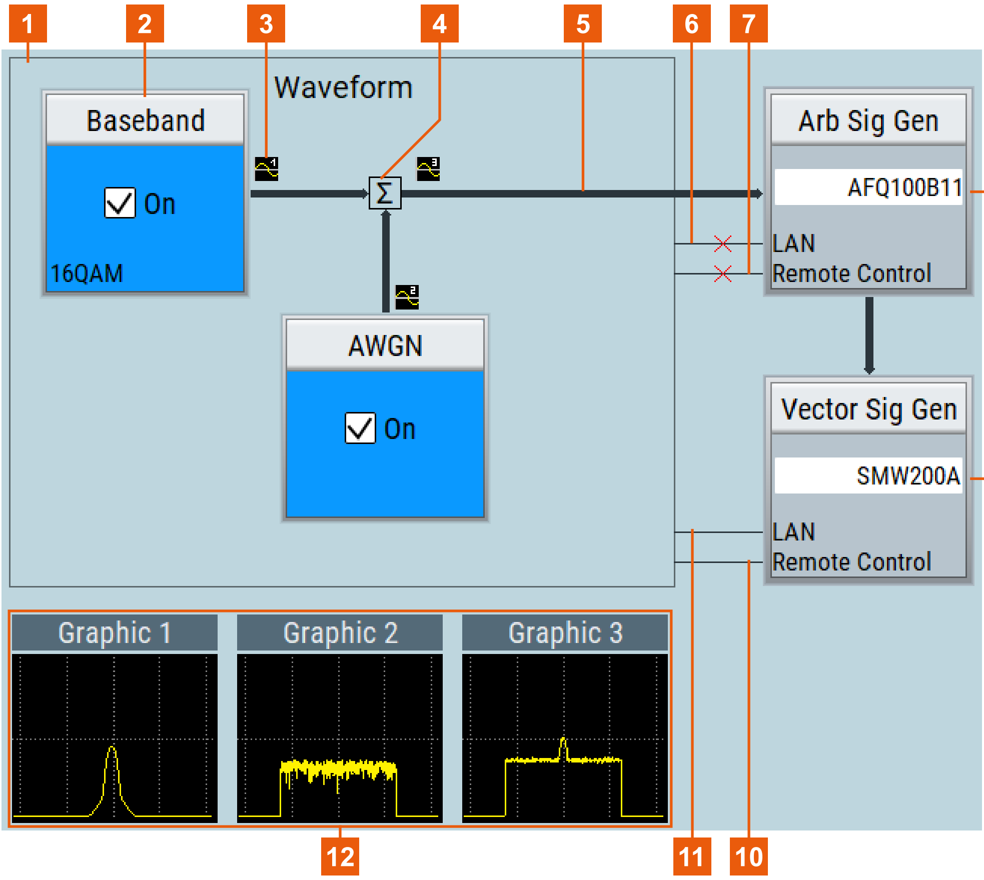
2.5.1.3 Info line

The info line shows brief status information and error messages. It appears above the block diagram, when an event generates a message. For information on the error messages and warnings, refer to Chapter 12, "Troubleshooting and notifications", on page 402.

You can also access an info window with detailed information on all messages in a history list. For details, see Chapter 9.3, "Querying notifications", on page 227.

2.5.1.4 Block diagram

The block diagram shows the current configuration and the signal flow in R&S WinIQSIM2 and to the external instruments with the aid of function blocks, connected by signal lines. The following figure displays elements that can appear in the block diagram.



1 = Waveform generation section
2 = Baseband block
3 = Graphics indicator
4 = Summation sign
5 = Signal flow arrow
6, 11 = Network control lines (not connected / connected)
7, 10 = Remote control lines (not connected / connected)
8 = ARB signal generator block
9 = Vector signal generator block
12 = Small graphics preview

Legend	Item	Description
1	Waveform generation section	Covers the functional blocks for generating the waveform and additive white Gaussian noise.
2, 8, 9	Functional blocks	Represents a basic task in signal generation. The button provides access to any number of associated actions to accomplish the task. The checkbox ("On"/"Off" and the block label quickly activates the basic task.
3	Graphics indicator	Denotes that the signal is displayed graphically (8).
4	Summation sign	Denotes superposition of baseband signal and noise signal.

Legend	Item	Description
5	Signal flow arrow	Displays the signal flow.
6, 7 10, 11	Network control lines Remote control lines	Indicate the connection to external instruments: ● Solid line: The connection to the instrument exists (6, 7). ● Crossed line: The connection is interrupted (10, 11). **Note:** Two parallel solid lines indicate that the interface is set up and ready for remote control. If one of two parallel lines is crossed, the interface configuration and the selected connection do not match. E.g., the instrument is visible via LAN, but the GPIB interface is configured for remote control.
12	Small graphics preview	Shows small graphics in the block diagram.

2.5.1.5 Taskbar

The "Taskbar" contains labeled softkeys of active dialogs.

Whenever you open a settings or a graphics dialog, it is automatically assigned to a softkey in the "Taskbar".

If you minimize a dialog, R&S WinIQSIM2 keeps it active in the background and in the taskbar. Click the corresponding softkey to maximize it again.

Figure 2-6: Softkeys representing active settings and graphics dialogs

1 = Waveform settings dialog
2 = AWGN settings dialog
2 = Graphics dialog for "Graphic 1"
3 = Remote control settings dialog

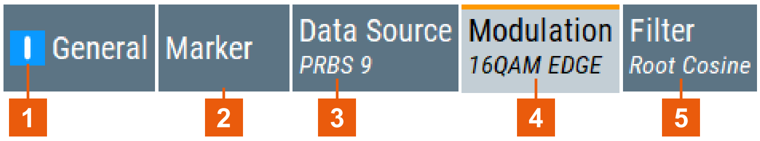
R&S WinIQSIM2 maintains up to eight active dialogs in the background. Each opened dialog turns off the function that has been opened first, according to FIFO (first in first out).

2.5.1.6 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.

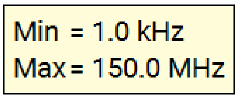
- Appearance of active elements
  - *Active* elements like On/Off switches, state buttons, blocks and symbols have a blue background.
  - *Selected* elements such as blocks, tab labels, entry fields or checkboxes are highlighted orange.
  - *Inactive* elements are gray.

- Dialogs
  The dialogs of R&S WinIQSIM2 contain the setting parameters of the functions.
  – The header of a dialog follows the general naming convention *<DialogName>* *<SourceDialog>*.
  – Key parameters indicated in tab labels.
    A dialog is divided into tabs with logically grouped parameters. The tab label expresses the content and can also contain status indicators or the set value of a key parameter.



1 = Status elements
2 = Inactive elements
3, 4, 5 = Active, selected elements

- Tooltips
  In edit mode, a tooltip indicates the value range of a parameter or shows information on current settings.



- Context-sensitive menus
  Within the entire screen display, including single parameters, you can access context-sensitive menus providing additional functions. The list varies, depending on where you access the menu.

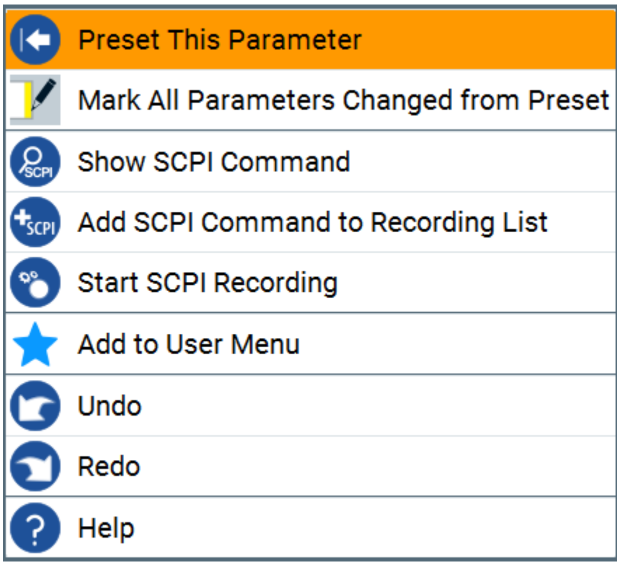
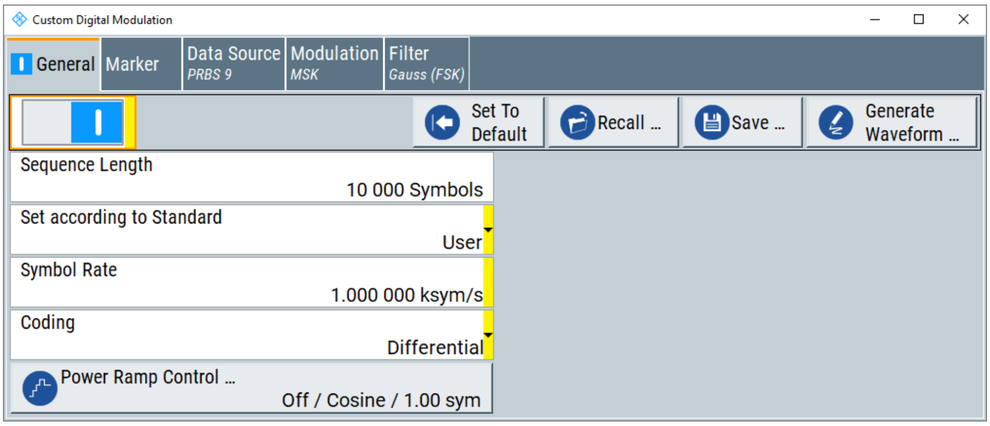


Figure 2-7: Context-sensitive menu

- Parameters changed from preset
  Orange displayed parameters indicate that the setting is different from the default value.



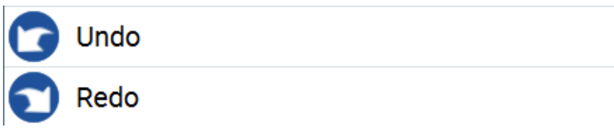
2.5.2 Means of manual operation

Like any software, you can control R&S WinIQSIM2 directly with the keyboard and mouse. At first, you can operate the application intuitively via the block diagram. Further functions are built in menus and dialogs using familiar elements such as selection lists, checkboxes and input fields.

The following overview provides a brief insight on the main operating elements:

- To open a dialog:
  – Select the required block and then the menu entry.
  – Select the minimized view (thumbnail) in the taskbar.
- To minimize a dialog, select the "Minimize" icon in the upper right corner.
- To close a dialog:
  – Select the "Close" icon in the upper right corner.
  – Press [ESC] on the keyboard.
- To select an item in a list, select the list, scroll in the list and select the required item.
- To enter data, select the entry field and insert the data and confirm with the [enter] key.
- To abort an entry, press the [ESC] key. R&S WinIQSIM2 cancels the entry without changing the settings.

Undo and redo actions



Accessed via the context-sensitive menu:

- "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.

2.5.3 Remote control

In addition to working with R&S WinIQSIM2 directly via the user interface, you can operate and control it from a remote computer. Remote control operation allows automation of the configuration process and is especially useful when a higher configuration speed is required.

In remote control mode, you can configure the settings of R&S WinIQSIM2 via a controller software using remote control commands (SCPI).

The controller software can run on the same computer as R&S WinIQSIM2 or another PC. For details on this topic, see also Chapter 10, "Automation of R&S WinIQSIM2", on page 231.

- R&S WinIQSIM2 and the controller software on the same PC
  The two programs communicate via the localhost link (IP address = 127.0.0.1).
- R&S WinIQSIM2 and the controller software on different PCs
  Communication requires a LAN connection.

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

See also:

- To operate R&S WinIQSIM2 via remote control, see Chapter 10.3, "How to set up a remote control connection", on page 239.
- For basic information on remote control, see Remote control via SCPI getting started available on the Rohde & Schwarz website.
- For SCPI commands specific to the basic function of R&S WinIQSIM2, see Chapter 11, "Remote control commands", on page 257.
  For SCPI commands specific to digital standards, see the description of the digital standard in the R&S WinIQSIM2 help.

2.6 Getting information and help

In some dialogs, graphics are included to explain the way a setting works. For further information, you can use the following sources:

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

To open the general help

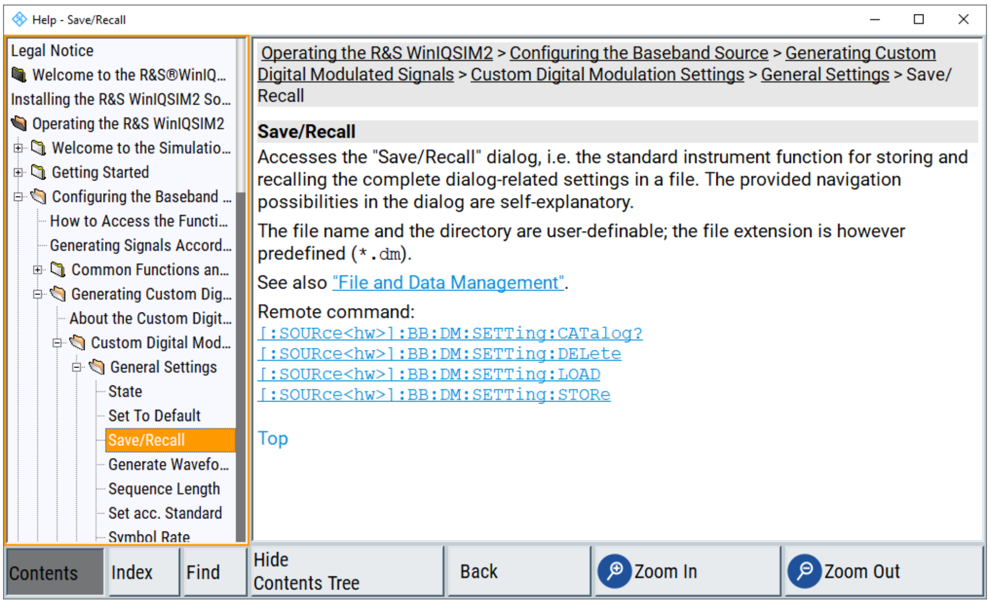
► In the menu bar, select "Help > Contents".

The start page of the online help appears.

To display context help

► For information on a specific parameter, press the [F1] key:

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



The help dialog contains two main panels:

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

The bottom of the help dialog provides buttons for accessing index information ("Index") and search functionality ("Find"). Also, it provides navigation aids ("Hide Contents Tree" and "Back") and zooming of the text in the help topic panel.

To navigate to help topics

1. To navigate within the table of contents entries, select an entry.
   Entries that contain further entries show a plus sign for folding out.
   When selected, you can immediately see the description in the "Topic" panel.
2. To navigate to another entry, scroll with the mouse or the [Up/Down] keys.
3. To scroll up or down in the directory tree or the help text, use the scroll bar on the right side of the panels. Alternatively, you can use the up/down cursor keys.
4. To follow a cross reference, select the link text (marked in blue font).
5. To return to the previous page, select "Back".
   This function scrolls back all steps that you have performed before.
6. To maximize the "Topics" window, you can hide the contents tree with the "Hide Contents" button, and vice versa.
7. To toggle between the "Contents" and "Topic" panels using the keyboard, use the right/left cursor keys.

8. To get from the "Contents" or "Topics" panel with the keyboard to the softkeys, press [ESC], and then use the cursor keys.

To use the index

1. Select the "Index" button in the "Help" display.
2. Enter the first characters of a topic that you are interested in. R&S WinIQSIM2 displays all entries that start with these characters.
3. Select the index entry.

   When selected, you can immediately see the description in the "Topic" panel.

To display tooltips

For information on the range of a specific parameter:

► Select the entry field.

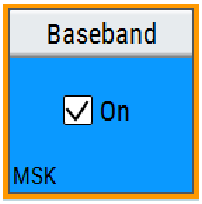
   In edit mode, the tooltip indicates the possible value range of a parameter.

3 Configuring the baseband source

The R&S WinIQSIM2 software enables you to simulate various digitally modulated signals in accordance with the definitions in the digital standards or with user-definable characteristics. In addition, you can configure multi carrier signals or multi segment waveforms.

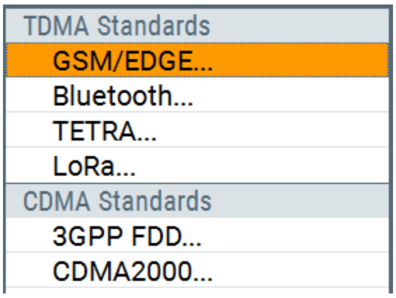
In addition, you can import unprocessed custom I/Q data via the TCP/IP interface. R&S WinIQSIM2 processes this data as well, i.e. you can add an interference signal, configure a filter, use the graphical display, or save and transmit the waveform.

3.1 Accessing baseband functions



To access the functions in the baseband block

1. In the block diagram, select "Baseband".
2. Select the corresponding entry of the context menu.



The "Baseband" block provides access to the configuration of the internal baseband source. It offers a selection list with all supported standard compliant digital standards, customer digital modulation and multi-carrier and multi-segment waveforms.
A short designation in the block indicates the currently selected digital standard or modulation.

3.2 Generating signals according to digital standards

R&S WinIQSIM2 generates digital signals in accordance with the specifications of the main communication and radio standards. This section lists the supported standard-compliant digital signals.

Related digital standard user manuals

See the webpage R&S®WinIQSIM2™ digital standards user manuals for an overview of digital standard user manuals that relate to R&S WinIQSIM2 software options.

The contents of the software options are available as help in the online version of the R&S WinIQSIM2 user manual. For download, the corresponding R&S SMW options user manuals are available.

GSM/EDGE

The GSM/EDGE and EDGE Evolution functionality generates signal waveforms in accordance with the GSM/EDGE standard. It is based on the GMSK and 8PSK modulation, and in accordance with the EDGE Evolution standard with simulation of higher order modulations.

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

Bluetooth® 5.x

The Bluetooth® enhanced data rate functionality generates signal waveforms in accordance with the latest Bluetooth® version 5.x specification.

For details, see the R&S SMW Bluetooth®Enhanced Data Rate, Bluetooth®5.x user manual.

TETRA Release 2

The "TETRA Release 2" functionality generates signal waveforms in accordance with the standard TETRA 2 ("Terrestrial Trunked Radio Release 2").

For details, see the R&S SMW TETRA Release 2 user manual.

LoRa

The LoRa functionality generates signals in accordance with the Semtech Corporation, Camarillo California, USA proprietary standard.

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

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

The 3GPP FDD functionality generates signal waveforms in accordance with the WCDMA standard 3GPP FDD incl. enhanced MS/BS tests, HSPA, HSPA+.

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

CDMA2000®

The CDMA2000 functionality generates signal waveforms in accordance with the CDMA2000 standard 3GPP2 C.S0002-C, version 1.0, May 2002 (release C).

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

TD-SCDMA and TD-SCDMA enhanced features

The TD-SCDMA and TD-SCDMA functionality generates signal waveforms in accordance with the TD-SCDMA (3GPP TDD LCR) standard.

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

1xEV-DO Rev. A and Rev. B

The 1xEV-DO functionality generates signal waveforms in accordance with the CDMA2000 1xEV-DO ("Evolution-Data Optimized"), Rev. A and Rev. B. Standard.

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

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

The IEEE 802.11a/b/g/n and IEEE 802.11 functionality generate signal waveforms in accordance with the WLAN standards IEEE 802.11a/b/g/n/ac/p/j/ax/be.

For details, see the R&S SMW IEEE 802.11a/b/g/n/ac/p/j/ax/be user manual.

IEEE 802.11ad, IEEE 802.11ay

The IEEE 802.11ad/ay functionality generates signal waveforms in accordance with the WLAN standards IEEE 802.11ad/ay.

With a suitable instrument type, you can generate waveforms with up to 4.8 GHz clock frequency (up to 4.32 GHz channel bandwidth), see also "To understand the instrument configuration" on page 189.

For details, see the R&S SMW IEEE 802.11ad/ay user manual.

ECMA-368 IEEE 802.15 3a

The ECMA-368 IEEE 802.15 3a functionality generates UWB MB-OFDM signal waveforms to generate in accordance with the "WiMedia Alliance" and "MultiBand OFDM Alliance Unapproved Release Candidate Version 1.2".

For details, see the R&S AFQ ECMA-368 IEEE 802.15 3a ("Ultra Wide Band") user manual.

HRP UWB 802.15.4

This HRP UWB 802.15.4 functionality generates signals in accordance with the HRP UWB standard.

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

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

The functionality generates signal waveforms in accordance with the 3GPP standard EUTRA/LTE Rel. 8, Rel. 9, Rel. 10, Rel. 11 Rel. 12, Rel. 13/14, cellular IoT.

For details, see the R&S SMW EUTRA/LTE user manual.

5G New Radio

This functionality generates signals in accordance with the 3GPP standard 5G New Radio release 15, release 16 and release 17.

With a suitable instrument type, you can generate waveforms with up to 4.8 GHz clock frequency, see also "To understand the instrument configuration" on page 189.

For details, see the R&S SMW 5G New Radio user manual.

Verizon 5GTF

The functionality generates signals based on the Verizon 5G open trial specifications http://5gtf.org/.

For details, see the R&S SMW Verizon 5GTF user manual.

OFDM Signal Generation

This functionality generates OFDM signals and signals according to predefined OFDM modulation schemes.

With a suitable instrument type, you can generate waveforms with up to 4 GHz occupied bandwidth, see also "To understand the instrument configuration" on page 189.

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

OneWeb

This functionality generates signals based on the OneWeb specification.

For details, see the R&S SMW OneWeb user manual.

IEEE 802.16 WiMAX™

The IEEE 802.16 WiMAX functionality generates signal waveforms in accordance with the IEEE 802.16 standard WiMAX.

For details, see the R&S SMW WiMAX user manual.

GNSS

The GNSS (global navigation satellite system) functionality generates signal waveforms in accordance with the GPS, Galileo, GLONASS and COMPASS/BeiDou.

For details, see the R&S WinIQSIM2 GNSS user manual.

DVB-H/T, DVB-S2/S2X/S2X-E, DVB-RCS2

The DVB options functionality generates signal waveforms in accordance with the DVB digital standard. For the specifications of DVB standards, that the generated waveforms conform with, see the R&S SMW DVB options user manual.

For details including the specifications of DVB standards, that the generated waveforms conform with, see the R&S SMW DVB options user manual.

DAB/T-DMB

The DAB-H/T functionality generates signal waveforms in accordance with the standards "Digital Audio Broadcasting" (DAB) and "Terrestrial Digital Multimedia Broadcasting" (T-DMB) standard.

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

NFC/EMV

The NFC/EMV functionality generates signal waveforms in accordance with the short-range wireless connectivity technology NFC-A/B/F and the EMV standard.

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

3.3 Common functions and settings in the baseband

Basic signal generation settings that are common to many generation tasks, regardless of the selected baseband source or digital standard, are described here. If you, e.g. generate a signal according to a digital standard, check the specific description for settings that can deviate from the common settings.

3.3.1 Basics on signals, modulation types and filters

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

3.3.1.1 Data and signal sources

This section describes the common characteristics of the signals used for generating the baseband waveform signal, irrespective of the selected digital standard or user-specific waveform. The provided selection in the dialogs depends on the parameter and corresponding standard. Some parameters are therefore not available in certain cases. Characteristics which are uniquely specific to particular standards are described in the corresponding user manuals.

For the generation of modulation signals, R&S WinIQSIM2 uses the following input signals:

- Modulation data
- Control signals

Internal modulation data

R&S WinIQSIM2 uses the following internal modulation data sources:

- **Data lists**
  Data lists are externally or internally created binary lists with modulation data. R&S WinIQSIM2 provides standard file select function for loading of existing data lists, creating internally new data lists or editing an existing one. Internally, data lists are created in the dedicated "Data List" editor (see Chapter 3.4.2.8, "Data list editor", on page 75). A separate file is created for each list and stored in the user-specific directory of R&S WinIQSIM2. The file name is user-defined; the file extension is `*.dm_iqd`.
  Note: The maximum length of a data list is determined by the size of the data list memory (see data sheet). For instrument-specific data, see the data sheet of the respective instrument. There is no restriction on the number of lists that can be stored.
  Settings for file handling, like transferring external data lists to the instrument, renaming of folders and files are accessed via the standard "File Manger" function (see also Chapter 8, "File and data management", on page 205).
- **Data patterns**
  You can use simple data patterns as internal modulation data, e.g. binary strings 0 or 1 ("All 0","All 1"), or variable bit strings with a maximum length of 64 bits.
- **PRBS data**
  The internal PRBS generators deliver 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.
  The pseudo-random sequence from a PRBS generator is uniquely defined by the register number and the feedback. The Table 3-1 describes the available PRBS generators.

Table 3-1: Overview of PRBS generators

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

Example:

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

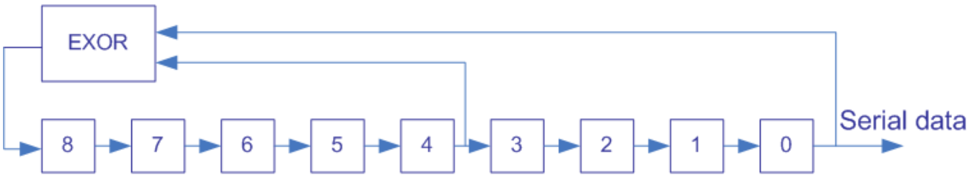
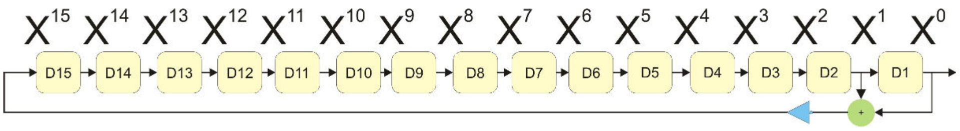


Figure 3-1: A 9-bit PRBS generator

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



Related settings:

- Chapter 3.4.2.3, "Data source", on page 66
- Chapter 3.4.2.8, "Data list editor", on page 75
- Chapter 3.4.2.9, "Control and marker lists editor", on page 77
- Data Source selection in the dialogs of the firmware options

Control signals

The following control signals are processed by R&S WinIQSIM2:

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

A dedicated internal "Control Data Editor" is provided for defining the control signals. Refer to Chapter 3.4.2.9, "Control and marker lists editor", on page 77 for a description on the provided settings.

Continuous Wave Mode

"CW" for controlling the CW (continuous wave) mode is not used in R&S WinIQSIM2. However, a control list generated for a Rohde & Schwarz instruments can contain CW controls.

A separate file with the file extension `*.dm_iqc` is created for each defined control signal.

Power ramping and level attenuation

The R&S WinIQSIM2 uses the two control signals "Burst Gate" and "Lev_Att" to trigger the power ramping and level attenuation functions.

The application internally generates control signals as configured in Chapter 3.4.2.9, "Control and marker lists editor", on page 77.

- *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 54.
- *Level attenuation control signal*
  The "Lev_Att" signal is a rectangular pulse signal with variable low and high periods. Level attenuation is applied, if the "Lev_Att" signal is high. If level attenuation is enabled, the modulation signal level is attenuated by a defined value.

Related settings:

- Chapter 3.4.2.6, "Power ramp control settings", on page 72

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 3-2 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.

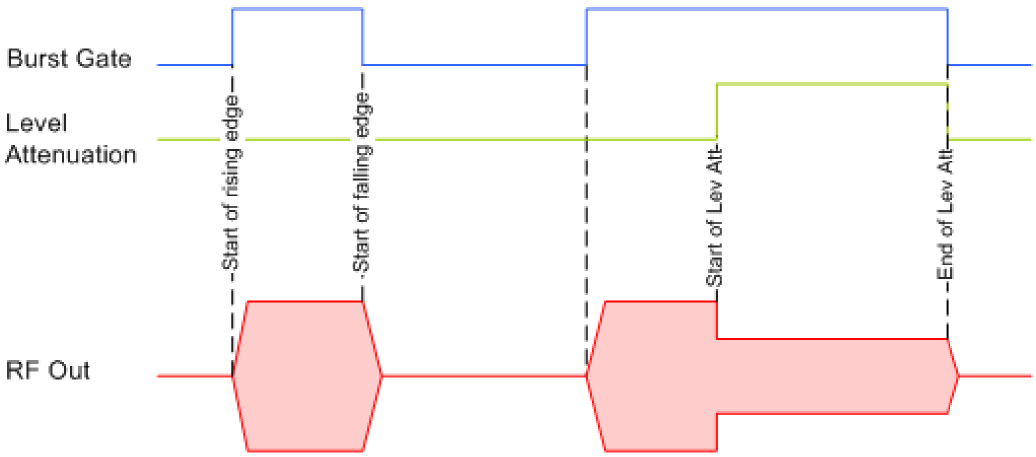


Figure 3-2: Signal behavior when power ramping and level attenuation are enabled

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

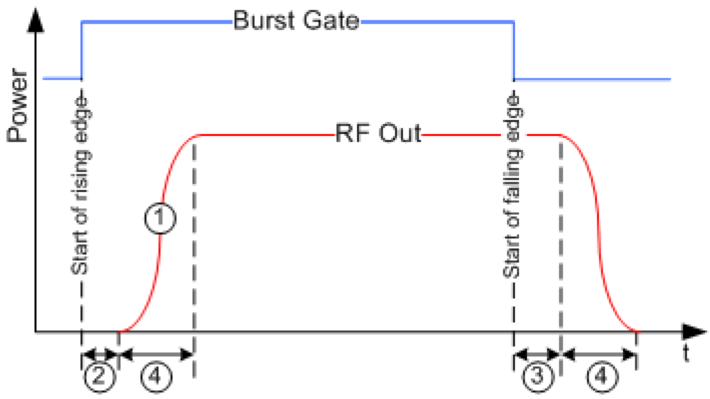


Figure 3-3: Impact of the ramp settings

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

3.3.1.2 Marker signals

R&S WinIQSIM2 generates user-definable marker information which can be processed by a Rohde & Schwarz instrument to provide the appropriate marker signals at the signal output.

You can define up to four marker signals according to the selection parameters required for the respective digital signal.

Marker modes

The marker mode is a characteristic for the shape and the periodicity of the marker. R&S WinIQSIM2 provides several different modes to define different marker signals. Most of them are specific for each of the digital standards. This section focuses only on the general commonly available marker signals. Generally, the marker signal can change from "On" (high) to "Off" (low) state or vice versa after some period of time. R&S WinIQSIM2 provides various ways to describe the marker signal. Use the method that best suits your needs.

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:

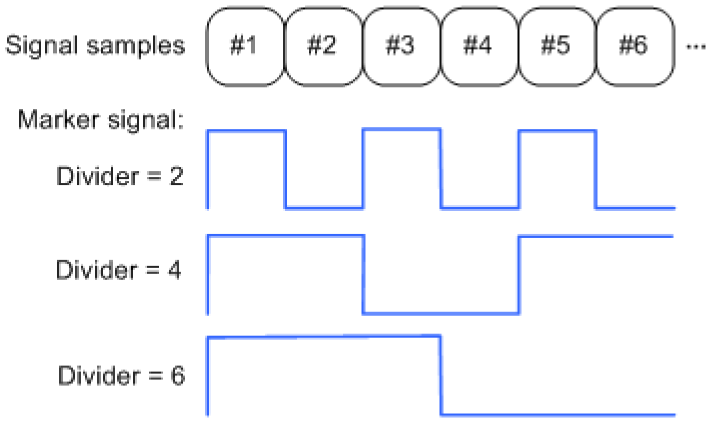
<Frequency> = "Symbol Rate"/"Sample Rate" / "Divider", respectively.

<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.

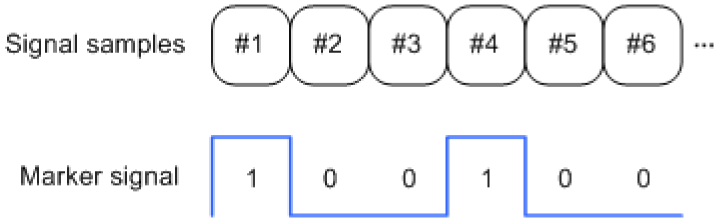


Marker mode pattern

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...*.

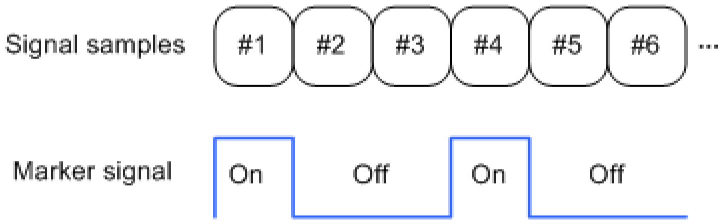


Marker mode On/Off Ratio

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".



3.3.1.3 Supported modulation types

R&S WinIQSIM2 supports a range of predefined digital modulation types.

In the communication techniques, the commonly used digital modulation schemes are based on keying. From the several existing keying techniques, R&S WinIQSIM2 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, i.e. by the assignment of I and Q values (PSK and QAM) or frequency shifts (FSK) to every modulation symbol. The resulting modulated signal is graphically represented by a constellation diagram, in that each possible symbol is represented by a discrete point on a complex plane. The number of used bits per symbol is a modulation parameter. The exact position of the symbols on the constellation diagram is determined by the used coding and can be influenced by also applied rotation.

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

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

In addition to the common modulation schemes, a variable FSK modulation with definable deviation per symbol is available. For even greater flexibility, you can apply a user-defined modulation mapping , see User mapping.

Predefined modulation types

Refer to Chapter 3.4.4.1, "Predefined modulation types", on page 88 for an overview of the available modulation types.

User mapping

A user-defined modulation-mapping file can also be selected as modulation-mapping source. The user modulation-mapping file must have extension `*.vam` and can be created with the Rohde & Schwarz software tool-mapping wizard. The mapping wizard (mapwiz) is a tool from Rohde & Schwarz designed for editing modulation schemes (e.g. QPSK, 32QAM). Its main purpose is the assignment of logical symbol numbers to constellation points and the selection of modulation-specific parameters. In addition, it supports the creation of nearly any arbitrarily chosen constellation diagram. The output of mapwiz is a mapping file (`*.vam`) that can be imported to a R&S WinIQSIM2. The program was developed on a 32-bit Microsoft Windows platform under MATLAB. For more information, refer to the description "Introduction to "mapwiz" Mapping Editor" on the Rohde&Schwarz Internet page.

The remote commands required to define the modulation settings are described in Chapter 11.9, "SOURce:BB:DM subsystem", on page 337.

Related settings:

- Chapter 3.4.2, "Custom digital modulation settings", on page 63

3.3.1.4 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, i.e. the modulation symbols are coded directly before I and Q values or frequency shifts are assigned. Hence, the applied coding is directly related to the selected modulation methods and explains why coding schemes are not freely combinable with modulation methods.

Refer to Chapter 3.4.4.2, "Common coding algorithms", on page 91 for overview on the available coding combinations. This section also defines the modulation types for which the various coding procedures can be used.

Related settings:

- "Coding" on page 65

3.3.1.5 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 baseband signal, especially while generating broadband signals. If the filter is too narrow, the signal is cut by the filter. If the filter is too wide, the signal could be distorted by some unwanted signals.

To fulfill the range of requirements, R&S WinIQSIM2 offers a large 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 additional filter parameters are provided for more precise adjustment of the filter characteristic, like more steeper edges or customization of the transition bandwidth. For more information on the provided settings, refer to "Impact of the filter parameters" on page 59.

The selection of user-defined filters offers more flexibility. User-defined filter configuration constitutes filters with complex or proprietary form are required. For more information, refer to "User filter" on page 59.

Predefined baseband filters

See Chapter 3.4.4.3, "Predefined baseband filters", on page 93 for an overview of the available baseband filters.

User filter

The user filter file must have the 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 WinIQSIM2. 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", Gaussian.

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

For more information, refer to the description "Introduction to "filtwiz" Filter Editor" on the Rohde & Schwarz Internet page.

The remote commands required to define the filter settings are described in Chapter 11.9, "SOURce:BB:DM subsystem", on page 337 and the corresponding section in the user manual of each firmware option.

Related settings:
- Chapter 3.4.2.5, "Filter settings", on page 70
- Filter settings in the dialogs of the firmware options

Impact of the filter parameters

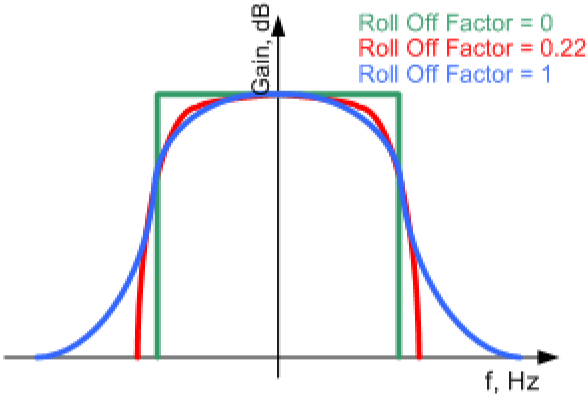
The following is a simple description of the filter parameters and the way they affect the main filter characteristics. Changing filter parameters is an effective way to ensure that the entire bandwidth of the desired signal is allowed to pass and adjust the filter form to reach the spectrum mask requirements.

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

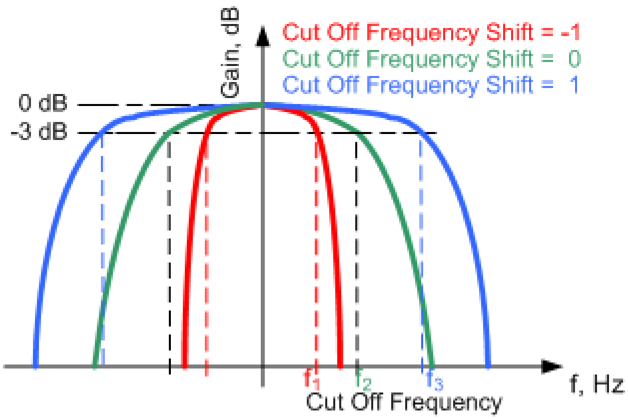
The passband describes the frequency span that the filter passes unchanged. The total passband of a filter is given as follows:

```
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".

3.3.1.6 Methods for optimizing the crest factor

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

The **crest factor** represents the ratio of the peak voltage value to the RMS voltage value, i.e. the peak to average ratio (**PAR**). The higher the crest factor and the resulting dynamics of a signal, the greater the requirement for a power amplifier fed by the signal to be linear. A high crest factor arises, for example, when in a multi-carrier signal the carriers feature an identical start phase. Since the carriers are periodically superposed, high peak voltage values occur compared 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. The result is a high quantization noise.

Both effects increase the adjacent-channel power.

Direct approaches

At the individual signal generation stages, R&S WinIQSIM2 offers different direct approaches aimed to reduce the crest factor. While the corresponding parameters are enabled, the implemented algorithms ensure minimizing the crest factor or achieving of predefined target crest factor by applying of automatic settings. Methods to reduce 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 multicarrier 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 digital standards, like 3GPP FDD, CDMA2000 , R&S WinIQSIM2 supports baseband clipping. Furthermore, you can select baseband filter and adjust the filter characteristics.

- **Clipping** is a technique that applies a wanted distortion to the signal.
  The principle includes specifying a threshold, finding out the signal peaks once the defined limits are exceeded and clipping them off. The level limit is specified as a

percentage of the highest peak value. Because clipping is done before filtering, the procedure does not influence the spectrum. The error vector magnitude (EVM) however increases.

R&S WinIQSIM2 offers two clipping modes:

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

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

- **Filtering** is applied later. The used filters are specially designed and should filter out the distortion.

3.3.2 Common settings

The start dialog of each digital standard follows a repeating dialog structure that comprises the tabs "General" and "Marker".

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

The "Marker" tab comprises the settings related to the corresponding function.

In the following, we use the "Custom Digital Modulation" dialog to explain the provided common settings.

This section focuses on the available settings. For more information, refer to Chapter 3.3.1, "Basics on signals, modulation types and filters", on page 51.

3.4 Generating custom digital modulated signals

R&S WinIQSIM2 can generate digital modulation signals with user-definable characteristics. The baseband filtering and the symbol rate can be set within wide limits.

3.4.1 About the custom digital modulation

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

- Chapter 3.3.1.5, "Supported baseband filters", on page 58
- Chapter 3.3.1.3, "Supported modulation types", on page 57
- Chapter 3.3.1.4, "Supported coding schemes", on page 58.

Required options

Playing custom digital modulation waveforms requires an ARB installed on your instrument. Some instruments can require also a waveform option, for example, the R&S SFI100A requires option R&S SFI-K499.

For more information, refer to the specifications document of the instrument.

Interdependency between modulation type and coding scheme

The applied coding is directly related to the selected modulation methods. The available coding schemes listed in Chapter 3.4.4.2, "Common coding algorithms", on page 91 are not freely combinable with modulation methods.

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

An inappropriate change of a parameter triggers a settings conflict. A conflicting setting is indicated by a message on the "Info" line in the display. Although R&S WinIQSIM2 displays the selected settings, the generated modulation signal does not correspond to this display. The displayed message disappears when a conflict-free setting is selected.

Refer to Chapter 12, "Troubleshooting and notifications", on page 402 for a list of the possible settings conflicts and messages in digital modulation.

3.4.2 Custom digital modulation settings

The "Custom Digital Modulation" dialog enables you to select the data source, standard, symbol rate, coding, modulation type and filter.

To access the "Custom Digital Modulation" settings:

► Select "Baseband > Custom Digital Mod".

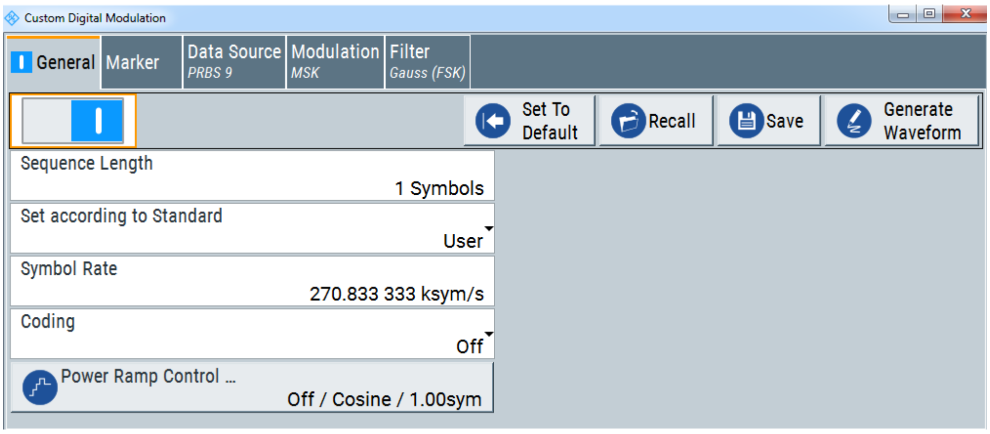
  The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name.

The remote commands required to define these settings are described in Chapter 11.9, "SOURce:BB:DM subsystem", on page 337.

3.4.2.1 General settings

To access the common settings:

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



This tab provides access to the default and the Save/Recall settings, to a quick selection of a digital modulation according to a predefined communication standard. Furthermore, you can configure symbol rate and coding.

Settings

State

Enables the custom digital modulation. Enabling custom digital modulation disables all other digital standards.

Remote command:

`[:SOURce<hw>]:BB:DM:STATe` on page 340

Set To Default

Sets all relevant parameters to default, see Table 3-2.

Remote command:

`[:SOURce<hw>]:BB:DM:PRESet` on page 338

Save/Recall

Accesses the "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The filename and the directory are user-definable; the file extension is however predefined (`*.dm`).

See also Chapter 8, "File and data management", on page 205.

Remote command:
[:SOURce<hw>]:BB:DM:SETTing:CATalog? on page 363
[:SOURce<hw>]:BB:DM:SETTing:DELete on page 363
[:SOURce<hw>]:BB:DM:SETTing:LOAD on page 364
[:SOURce<hw>]:BB:DM:SETTing:STORe on page 364

Generate Waveform File
With enabled signal generation, triggers the instrument to store the current settings as an ARB signal in a waveform file. Waveform files can be further processed as multicarrier or multi-segment signals.

The filename and the directory it is stored in are user-definable; the predefined file extension for waveform files is *.wv.

Remote command:
[:SOURce<hw>]:BB:DM:WAVeform:CREate on page 341

Sequence Length
Sets the sequence length of the signal in symbols. The signal is calculated in advance, saved as a waveform file, and output in the arbitrary waveform generator of the selected instrument.

Note: The product of "Sequence Length" * "Oversampling" must not exceed the maximum number of samples of the arbitrary waveform generator.

Remote command:
[:SOURce<hw>]:BB:DM:SLENgth on page 340

Set acc. Standard
Selects a predefined communication standard. A subset of parameters is automatically adjusted: "Modulation Type", "Symbol Rate", "Filter" and "Coding".

A subsequent modification of one of these parameters sets the standard to "User". Use the "Save/Recall" function to store and recall customized settings.

Refer to Table 3-3 for an overview of the available standards and the associated settings of the modulation parameters.

Remote command:
[:SOURce<hw>]:BB:DM:STANdard on page 339

Symbol Rate
Selects the symbol rate. The value range of this parameter depends on the selected modulation type; the range is automatically redefined. R&S WinIQSIM2 generates an error message if the selected symbol rate is outside of the redefined range and sets the symbol rate to the maximum allowed value for the new modulation.

With a suitable instrument type, you can set for high symbol rates of several Msym/s, see also "To understand the instrument configuration" on page 189.

Remote command:
[:SOURce<hw>]:BB:DM:SRATe on page 339

Coding
Selects the coding (see Chapter 3.3.1.4, "Supported coding schemes", on page 58).

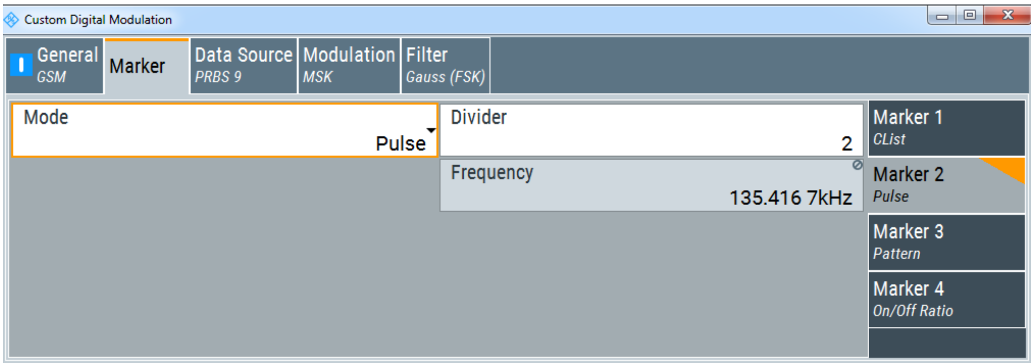
The dialog offers only the coding settings that are permissible for the selected modulation type. All other coding methods are grayed out. A subsequent modification to a modulation type for which the selected coding is not available, automatically disables the coding ("Coding = Off").

Remote command:
[:SOURce<hw>]:BB:DM:CODing on page 349

Power Ramp Control
Accesses the power ramp control dialog, see Chapter 3.4.2.6, "Power ramp control settings", on page 72.

3.4.2.2 Marker settings

This tab provides access to the settings necessary to select and configure the marker mode.



Marker 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 four. The marker configuration changes with the selected marker mode.

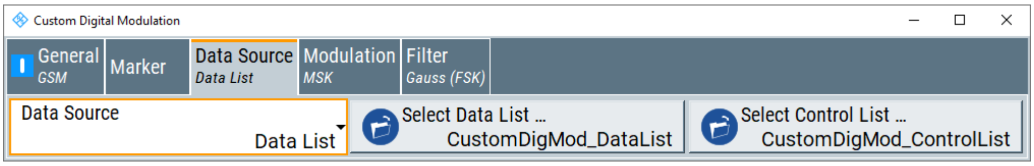
Use the settings to define the shape and periodicity of the markers. See Chapter 3.3.1.2, "Marker signals", on page 55 for description of the regular marker signals.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE on page 342
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider on page 343
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?
on page 344
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern on page 343
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime on page 342
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime on page 343

3.4.2.3 Data source

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

For an overview of the supported data sources, refer to Chapter 3.3.1.1, "Data and signal sources", on page 51.



Data Source

Selects the data source (see "Internal modulation data" on page 52).

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 338

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

"Data List"
Uses binary data from a data list, see Select Data List....

Remote command:
[:SOURce<hw>]:BB:DM:DLISt:CATalog? on page 355
[:SOURce<hw>]:BB:DM:DLISt:SELect on page 360

Remote command:
[:SOURce<hw>]:BB:DM:SOURce on page 338

Select Data List...

Accesses the standard "Select Data List" browser dialog to select a data list file.

To load an existing data list, select the list file `*.dm_iqd` and confirm with "Select", see Chapter 3.4.2.7, "List management settings", on page 74.

See also Chapter 3.4.3.2, "How to create and assign a data list", on page 84.

Remote command:
[:SOURce<hw>]:BB:DM:DLISt:SELect on page 360
[:SOURce<hw>]:BB:DM:DLISt:CATalog? on page 355
[:SOURce<hw>]:BB:DM:DLISt:COPY on page 356
[:SOURce<hw>]:BB:DM:DLISt:DELete on page 360

Select Control List...

Accesses the standard "Select Control List" browser dialog to select a control list file.

To load an existing control list, select the list file `*.dm_iqc` and confirm with "Select", see Chapter 3.4.2.7, "List management settings", on page 74.

Control lists can be generated in the "Control and Marker Lists" editor, see Chapter 3.4.2.9, "Control and marker lists editor", on page 77.

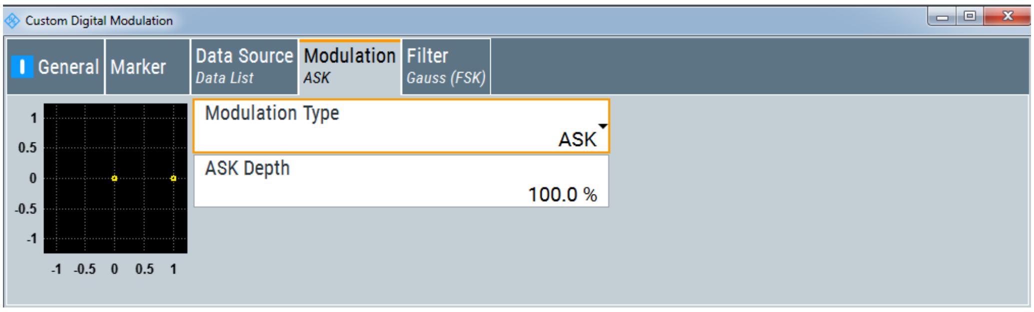
Irrespective of the way they are created, control lists are not automatically assigned (see "To assign and activate control signals from a control list" on page 83).

Remote command:
`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 355
`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 358
`[:SOURce<hw>]:BB:DM:CLISt:COPY` on page 356
`[:SOURce<hw>]:BB:DM:CLISt:DELete` on page 357

3.4.2.4 Modulation settings

This tab provides access to the modulation settings, e.g modulation type, FSK deviation or modulation depth. The dialog shows the theoretical constellation diagram of the selected modulation.

This section focuses on the available settings. For background information on how these settings affect the signal and the filter characteristics, refer to Chapter 3.3.1.3, "Supported modulation types", on page 57.



Modulation Type

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

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

Refer to Table 3-4 for an overview of the allowed combinations.

Remote command:
[:SOURce<hw>]:BB:DM:FORMat on page 350

Load User Mapping

Opens the "Select List File User Mapping" dialog to select the mapping table (see "User mapping" on page 58). The dialog provides all standard file management functions.

Remote command:
[:SOURce<hw>]:BB:DM:MLISt:SELect on page 363
[:SOURce<hw>]:BB:DM:MLISt:CATalog? on page 355
[:SOURce<hw>]:BB:DM:MLISt:DELete on page 362

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 349

FSK Deviation

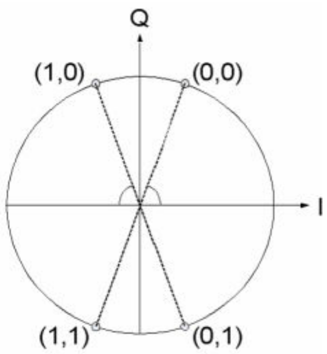
Sets the frequency deviation for FSK modulation. The range of values depends on the selected Symbol Rate.

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

Remote command:
[:SOURce<hw>]:BB:DM:FSK:DEViation on page 350

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 348

FSK Type

(Variable FSK only)

Selects the FSK modulation type for selection "Variable FSK".

Available are 4FSK, 8FSK and 16FSK.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE on page 351

Deviation xxxx
(Variable FSK only)

Sets the deviation of the associated symbol. The number of symbols depends on the selected modulation type. The value of each symbol is indicated in binary format.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation on page 350

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

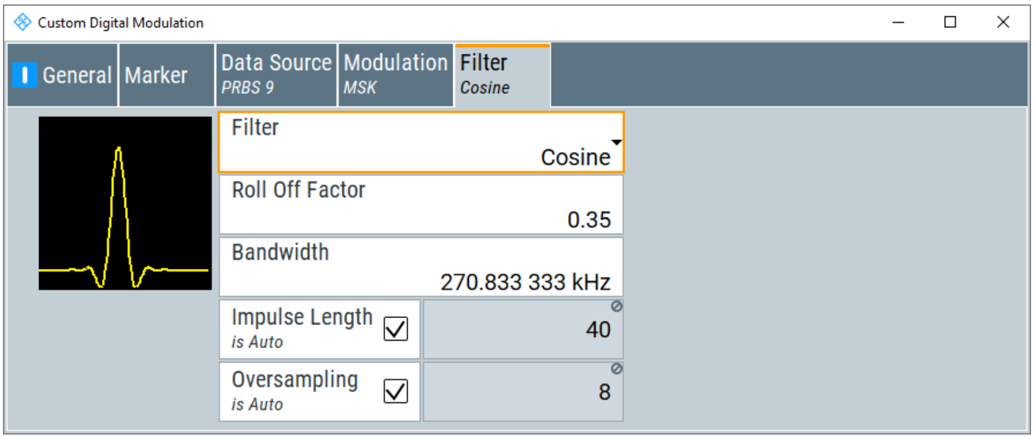
The values in brackets indicate the used code rate according to the DVB-S2 specification.

Remote command:
[:SOURce<hw>]:BB:DM:APSK16:GAMMa on page 341
[:SOURce<hw>]:BB:DM:APSK32:GAMMa on page 341

3.4.2.5 Filter settings

This tab provides access to the 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 these settings affect the signal and the filter characteristics, refer to Chapter 3.3.1.5, "Supported baseband filters", on page 58.



Filter
Selects the baseband filter.

See Chapter 3.4.4.3, "Predefined baseband filters", on page 93 for information on the available filter types.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:TYPE on page 347

Filter Parameter
Sets the corresponding filter parameter.

The filter parameter offered ("Roll Off Factor" or "B x T") depends on the currently selected filter type.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff] on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase on page 346

Cut Off Frequency Factor
(Available for filter parameter Lowpass and APCO25 (LSM) only)

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

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM on page 346
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs on page 347
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass on page 347

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

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth on page 347

Impulse Length
Displays the number of filter taps. If the checkbox "Auto" is activated, the most sensible parameter value is used. The value depends on the coherence check. If the checkbox is deactivated, you can set the value manually.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:ILENgth:AUTO on page 345
[:SOURce<hw>]:BB:DM:FILTer:ILENgth on page 345

Oversampling

Determines the upsampling factor. If the checkbox "Auto" is activated, the most sensible parameter value is used. The value depends on the coherence check. If the checkbox is deactivated, you can set the value manually.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:OSAMpling:AUTO on page 345
[:SOURce<hw>]:BB:DM:FILTer:OSAMpling on page 345

Load User Filter

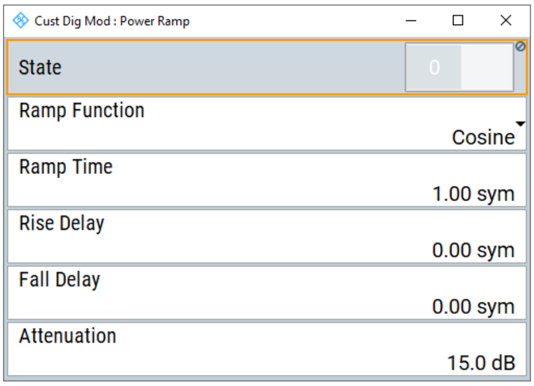
Accesses the "Select User Filter" dialog for selecting a user-defined filter file with extension `*.vaf` (see "User filter" on page 59). The dialog provides access to the standard file management functions, like store, load, delete.

Remote command:
[:SOURce<hw>]:BB:DM:FLISt:SELect on page 361
[:SOURce<hw>]:BB:DM:FLISt:CATalog? on page 355
[:SOURce<hw>]:BB:DM:FLISt:DELete on page 361

3.4.2.6 Power ramp control settings

To access these settings:

► Select "Baseband > Custom Digital Modulation > General > Power Ramp Control".



The dialog provides access to the settings used to configure the power ramping. It includes the source for the necessary control signals "Burst" and "Lev_Att", the form of the ramp function and the applied attenuation (see "Power ramping and level attenuation" on page 53).

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

State
Enables/disables power ramping.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp[:STATe] on page 353

Ramp Function
Selects the ramp function that describes the shape of the rising and falling edges during power ramp control, see Figure 3-3.

"Linear" The transmit power rises and falls in a linear fashion.

"Cosine" The transmit power rises and falls with a cosine-shaped edge. This setting causes a more favorable spectrum than the "Linear" setting.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe on page 352

Ramp Time
Enters the power ramping rise time and the fall time for a burst. The setting is expressed in symbols. See also Figure 3-3.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:TIME on page 353

Rise Delay
Sets the offset in the rising edge of the envelope at the start of a burst, see Figure 3-3.

A positive value causes a delay (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 352

Fall Delay
Sets the offset in the falling edge of the envelope at the end of a burst, see Figure 3-3.

A positive value causes a delay (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 352

Attenuation
Determines the level by which the average signal level is attenuated during the signal attenuation period. During this period, the "Lev_Att" signal is high. See also Figure 3-2.

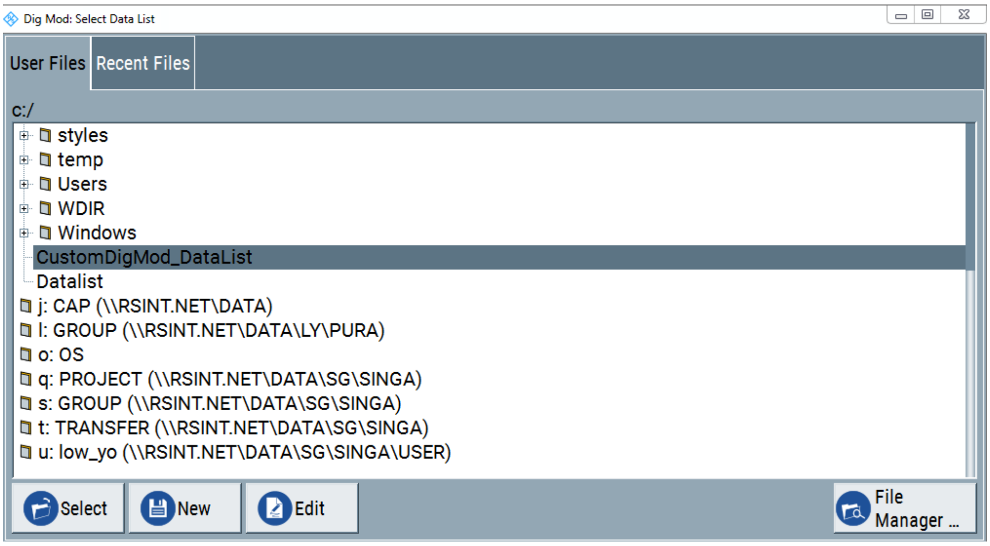
For information about the required control signal LEV_ATT, refer to "Power ramping and level attenuation" on page 53.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation on page 351

3.4.2.7 List management settings

To access the list management dialog:

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



The dialog provides access to the respective file functions and editors for selecting, creating or editing data and control lists.

Select Data List
Selects or creates a data list file, and provides access to the file manager.

You can perform the following tasks:
- "New"
  To create a file, navigate to the target folder, enter the filename and confirm with "Save". R&S WinIQSIM2 automatically assigns the extension .dm_iqd to the filename.
- "Select"
  To load an existing data list file, navigate to the target folder, select the file *.dm_iqd and confirm with "Select".
- "Edit"
  To edit an existing data list file, navigate to the target folder, select the file to access the data list editor. See Data list editor.
- "File Manager"
  To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function, see Chapter 8.6, "Using the file manager", on page 217.

See also Chapter 3.4.3.2, "How to create and assign a data list", on page 84.

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 360
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 355
`[:SOURce<hw>]:BB:DM:DLISt:COPY` on page 356
`[:SOURce<hw>]:BB:DM:DLISt:DELete` on page 360

Select Control List
Enables you to select or create a control list file, and provides access to the file manager.

You can perform the following tasks.

- "New"
  To create a file, navigate to the target folder, enter the filename and confirm with "Save". R&S WinIQSIM2 automatically assigns the extension `.dm_iqc` to the filename.
- "Select"
  To load an existing control list file, navigate to the target folder, select the file `*.dm_iqc` and confirm with "Select".
- "Edit"
  To edit an existing control list file, navigate to the target folder, select the file to access the control and marker list editor. See Chapter 3.4.2.9, "Control and marker lists editor", on page 77.
- "File Manager"
  To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function, see Chapter 8.6, "Using the file manager", on page 217.

Irrespective on the way they are created, control signals are not automatically assigned (see "To assign and activate control signals from a control list" on page 83).

Remote command:
`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 355
`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 358
`[:SOURce<hw>]:BB:DM:CLISt:COPY` on page 356
`[:SOURce<hw>]:BB:DM:CLISt:DELete` on page 357

3.4.2.8 Data list editor

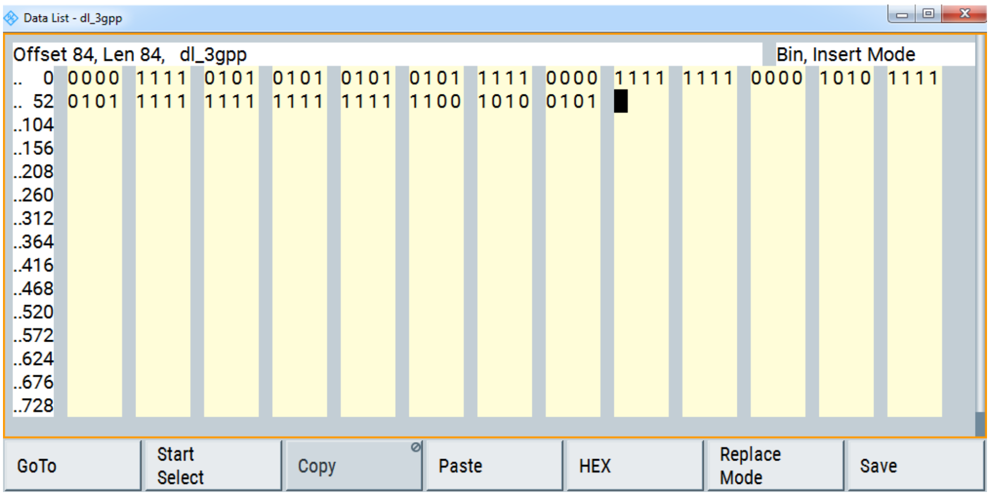
R&S WinIQSIM2 provides the following ways to create a data list file:

- Using the dedicated data list editor and creating a file with extension `*.dm_iqd`, see "To create a data list manually" on page 84
- Using the tag-oriented format and creating a data list file, see "To create a data list using tag file format" on page 283

To access the "Data List Editor" dialog:

1. Select "Baseband > Custom Digital Mod > Data Source > Data List".
2. Select "Select Data List...".
3. In the "Select Data list" dialog, navigate to the required directory.

4. In the directory, you have two options:
   a) Select the file directory, e.g., `D:\user\`.
   b) Enter a filename, e.g., `dl_3gpp`.



The "Data List Editor" is a list of binary values with a maximum length of 2^{31} bits. This value corresponds to a file size of approx. 268 Mbyte.
To increase readability, the bits are displayed in groups of four. The current cursor position, the length of the list and the list filename are displayed above the list. The offset starts with the value 0 which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.
You can edit the list either in "Insert" or "Replace" mode, toggled with the "Insert" key.
SCPI command:
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 360
`[:SOURce<hw>]:BB:DM:DLISt:DATA` on page 358
`[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend` on page 359
The buttons below the binary list simplify the editing. The following table lists the provided functions.

GUI Element	Description
"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

GUI Element	Description
"Hex"	Switch over to a hexadecimal display. Displays the 4 bits in hexadecimal representation: To increase readability, the hexadecimal values in turn are displayed in pairs of two.
"Replace Mode"	Set editing to insert or replace mode.
"Save"	Stores the changes made to the data list file selected for editing.

3.4.2.9 Control and marker lists editor

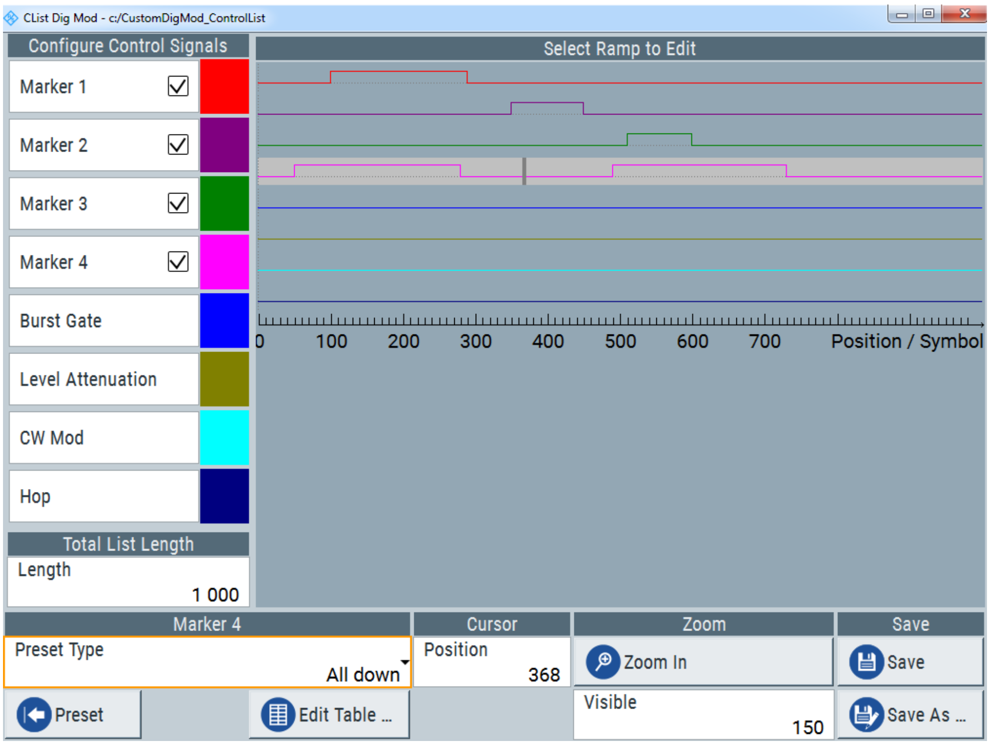
R&S WinIQSIM2 provides the following ways to create a file containing control signals:

- Using the dedicated "Control Data Editor" and creating a file in ASCII format and with an extension `*.dm_iqc`.
  The "Control Data Editor" is described in this section. See "To create a control list in ASCII format manually" on page 82 for step-by-step instructions.
- Using the tag-oriented format and creating a control list file, see "To create a control list using tag file format" on page 282

Access:

1. Select "Baseband > Custom Digital Mod > Data Source".
2. Select "List Management".
3. In the "List Management" dialog, select "Select Control List To Edit... > Select List / New List".
4. Navigate to the required directory.
5. In the directory, you have two options:
   a) Select the directory, e.g. `D:\user\`.
   b) Enter a filename, e.g. "File Name > 'cl_3gpp'".

6. Select "Edit Control List...".



The dedicated internal "Control Data Editor" is an intuitive graphical interface provided for defining and managing of:

- Marker signals
- Control signals, like the CW, Hop, Burst Gate and Lev_Att control signals
  (See also "Control signals" on page 53)

A separate file with the file extension `*.dm_iqc` is created for each defined control signal kept on the 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 Chapter 3.4.3.1, "How to create and assign a control list", on page 82).

SCPI command:

`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 358

`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 355

Configure Control Signal

Displays the color the marker/control signal has been assigned.

The status checkbox indicates whether the individual marker or control signal is assigned or enabled (see Chapter 3.4.3.1, "How to create and assign a control list", on page 82).

Remote command:
n.a.

Select Ramp to Edit

Graphical representation for editing of the marker/control signals.

Refer to Chapter 3.4.3.1, "How to create and assign a control list", on page 82 for an overview of the editing capabilities of the display.

Remote command:
`{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}` on page 270
`[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 356

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 267

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 high to low is configured in the center of the displayed signal area. You can shift the ramp position later 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.

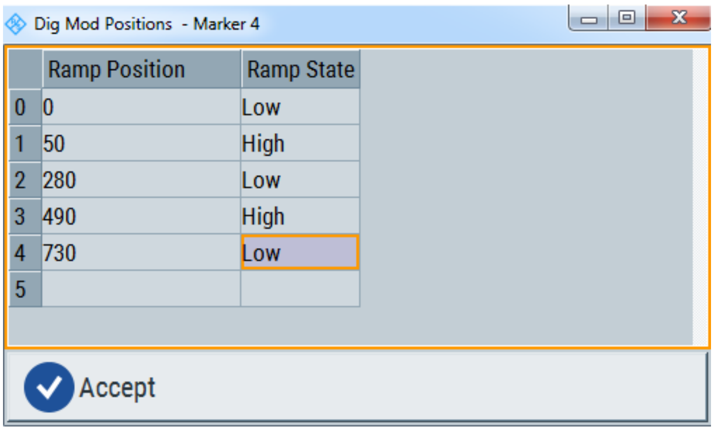
Remote command:
n.a.

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 Table" 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 can be helpful to display only a part of the control list. In such cases, set the "Visible/Bits Visible" to determine the number of symbols/bits to be displayed and select "Zoom" to focus the displayed area around the current "Cursor Position".

Ramps outside the displayed area are not lost by zooming.

Remote command:
n.a.

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

Remote command:
n.a.

3.4.3 Generating custom digital modulation signals

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings, see Chapter 3.4.2, "Custom digital modulation settings", on page 63.

To generate 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.

1. In the main application window, select "File > New" to start the application in a defined initial state.
2. Select "Baseband > Custom Digital Mod".

   The "Custom Digital Modulation" dialog opens.
3. Select "General > Set acc to standard > WCDMA-3GPP".
4. Select "General > State > On" to enable signal generation.

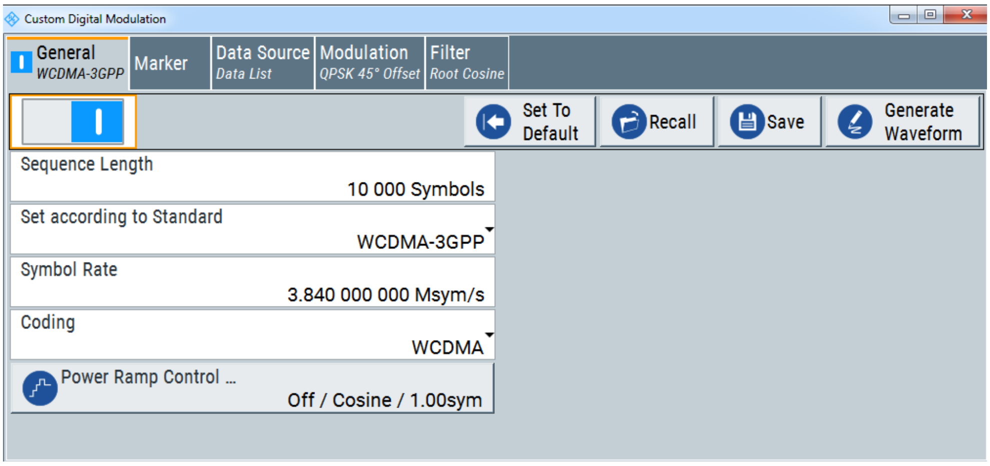


Figure 3-4: Selecting a WCDMA-3GPP standard signal

5. In the "Modulation" tab, consider the used "Modulation Type".

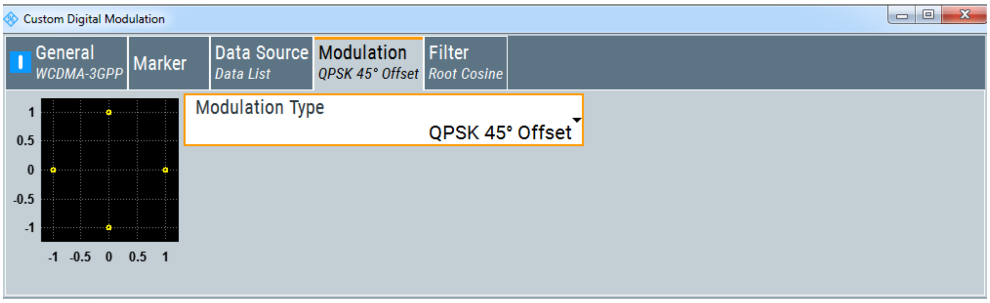


Figure 3-5: Display of the used modulation type

R&S WinIQSIM2 generates a WCDMA-3GPP signal, modulated with a QPSK 45° Offset modulation.

3.4.3.1 How to create and assign a control list

R&S WinIQSIM2 provides the following ways to create a file containing control signals:

- Using the dedicated Control and marker lists editor and creating a file in ASCII format and with extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 82
- Using the tag-oriented format and creating a control list file, see "To create a control list using tag file format" on page 282

To create a control list in ASCII format manually

Use the intuitive built-in Control and marker lists editor dialog:

1. To access the "Control Data Editor", select "Baseband" > "Custom Digital Mod" > "Data Source" > "Select Control List".
2. Select an existing file.
   Tip: To create a control list, select "List Management..." > "Select Control List To Edit..." > "New List".
3. Select "List Management" > "Edit Control List...".
   The "CList Dig Mod" dialog opens.
4. Adjust the control signals as required:
   a) Define the "Total List Length", e.g. "Length > 1000".
   b) In the "CList DigMod" dialog, select the graphic editor "Select Ramp to Edit".
   c) Select the color-coded trace of the required signal.
   d) To insert a ramp, double-click the position where you want to the ramp.
   There is no limit of the number or ramps per marker.
   e) To remove a ramp, use the [BACKSPACE] key at the selected ramp.
   f) For faster marker and control signal definition, apply them with "Preset" via the predefined ramp functions ("Preset Type").
   g) If necessary, readjust the ramps with the help of the "Edit Table" function.
   h) Define the "Total List Length".
   i) To display only a part of the control list, select "Visible"/"Bits Visible".

j) Select "Zoom" to focus the displayed area around the current "Cursor Position". Ramps outside the displayed area remain during zooming.

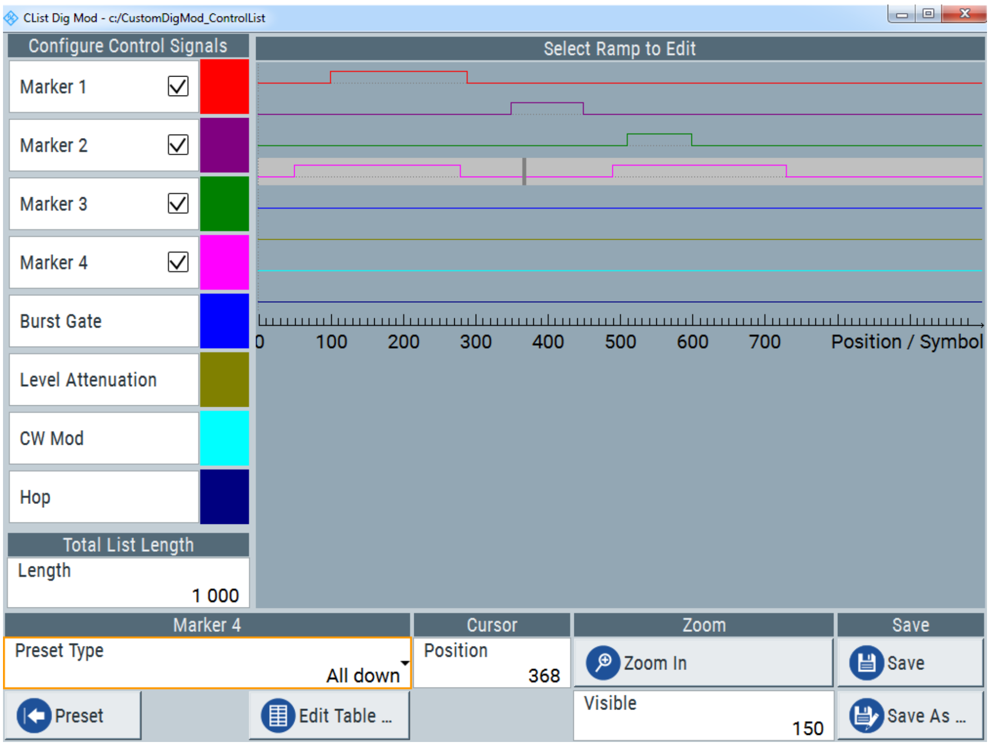


Figure 3-6: Example of control list settings

5. To store the settings in a control list file, select "Save / Save As".

   The created file is an ASCII file with the extension `*.dm_iqc`.

6. To include marker and control signals in the waveform signal, select the corresponding signals in the "Configure Control Signals" section.

To assign and activate control signals from a control list

Irrespective of the way they are created, generated control lists are not automatically included.

1. To use a marker/control signal from a control list, perform the following:
   a) Select "Baseband > Custom Digital Mod > Marker".
   b) Select "Marker x > CList"
2. To enable R&S WinIQSIM2 to include the Burst Gate and Level Attenuation control signals as defined in a control list:
   a) Select "Baseband > Custom Digital Mod > General".
   b) Select "Power Ramp Control > State > On".

   R&S WinIQSIM2 includes the control signals in the waveform signal.

3.4.3.2 How to create and assign a data list

R&S WinIQSIM2 provides the following ways to create a data list file:

- Using the dedicated Data list editor and creating a file with extension `*.dm_iqd`, see "To create a data list manually" on page 84
- Using the tag-oriented format and creating a data list file, see "To create a data list using tag file format" on page 283

To create a data list manually

Use the intuitive build in Data list editor dialog:

1. To access the "Data List Editor":
   a) Select "Baseband > Custom Digital Mod... > Data Source > Data List"
   b) Select "Select Data List ...".
   c) In the "List Management" dialog, select "Select Data List To Edit... > New List".
   d) Navigate to the required directory.
   e) Enter a filename.
   For example, select the directory `D:\user\`.
   f) Enter "File Name" > `dl`.

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

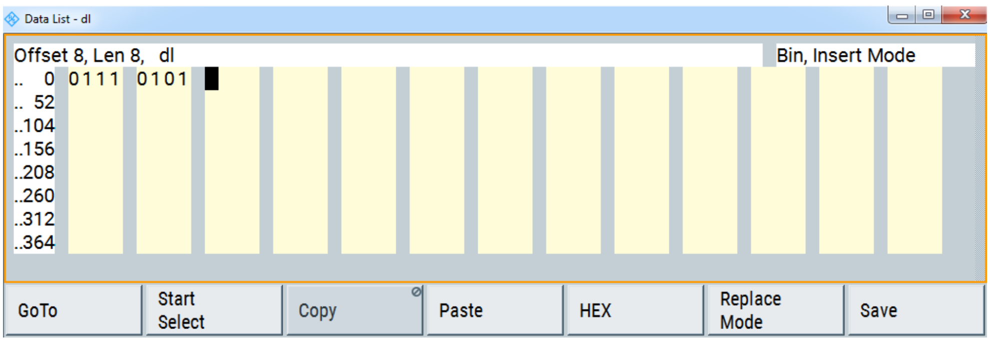


Figure 3-7: Example of data list

3. Select "Save" to store the used settings as a data list file.
   R&S WinIQSIM2 stores the `dl.dm_iqd` file in the `D:\user\` directory.

To assign and activate data lists

Irrespective of the way they are created, generated data lists are not automatically used.

1. To enable R&S WinIQSIM2 to use the data list as a data source for the custom digital modulation:
   a) Select "Baseband > Custom Digital Mod... > Data Source > Data List"
   b) Select "Select Data List..."
   c) In the destination folder, select the file.

d) Confirm with "Select".

2. To enable R&S WinIQSIM2 to use the data list as a data source for any of the digital standards:
   a) Select the "Data List Name" in the individual dialog.
   For example, for "Baseband > 3GPP FDD > Basestations > BS1 > Channel Table > P-CCPCH > Data = Data List"
   b) Select "DList = None".
   c) In the destination folder, select the file.
   d) Confirm with "Select".
   e) Select "State > On".

   If you now activate the corresponding standard, R&S WinIQSIM2 creates the waveform signal of the standard using the list as the data source.

3.4.4 References

Table 3-2: Custom digital modulation default values

Parameter	Value
State	Not affected by "Set to Default"
Data Source	PRBS 9
Standard	GSM
Symbol Rate	270.833 ksymb/s
Coding	GSM
Modulation Type	MSK
Filter	Gauss (FSK)
Filter Parameter BxT	0.3
Power Ramp Control	
Attenuation	15 dB
Ramp Time	1.00 sym
Ramp Function	Cosine
Fall Delay	0
Rise Delay	0
Source	Internal
State	Off
Source	Internal
Mode	Symbol

Table 3-3: Communication standards with their predefined settings

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
APCO Phase1 C4FM	4FSK, Deviation 1.8 KHz	4.8 ksym/s	APCO25, roll off = 0.2	APCO25(FSK)	`APCOPH1C4fm`
APCO Phase1 CQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 0.2, BW = 4.8 KHz	APCO25(PSK)	`APCOPH1CQpsk`
APCO Phase2 H-CPM	4FSK, Deviation 3 KHz	6 ksym/s	APCO25 (H-CPM)	APCO25(FSK)	`APCOPH2HCpm`
APCO Phase2 H-DQPSK	pi/4-DQPSK	6 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(PSK)	`APCOPH2HDQpsk`
APCO Phase2 H-D8PSK Wide	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(8PSK)	`APCOPH2HD8PSKW`
APCO Phase2 H-D8PSK Narrow	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 5 KHz	APCO25(8PSK)	`APCOPH2HD8PSKN`
APCO Phase1 LSM	pi/4-DQPSK	4.8 ksym/s	APCO25 (LSM), Gauss Cut Off = 2.04 KHz, Low-pass Cut Off = 6.2 KHz	APCO25(8FSK)	`APCOPH1Lsm`
APCO Phase1 WCQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(8FSK)	`APCOPH1Wcqpsk`
Bluetooth	2FSK, Deviation 160.0 kHz	1.0 Msym/s	Gauss, B*T = 0.5	OFF	`BLUetooth`
DECT	2FSK, Deviation 288.0 kHz	1.152 Msym/s	Gauss, B*T = 0.5	OFF	`DECT`
ETC (ARIB STD T55)	ASK, ASK Depth 100%	1.024 Msym/s	Split Phase, B*T = 2.0	OFF	`ETC`
GSM	MSK	270.833333 ksym/s	Gauss, B*T = 0.3	GSM	`GSM`
GSM EDGE	8PSK EDGE (3pi/8 8PSK)	270.833333 ksym/s	Gauss linear	OFF	`GSMEdge`
NADC	pi/4 DQPSK	24.3 ksym/s	Root Cosine, alpha = 0.35	NADC	`NADC`
PDC	pi/4 DQPSK	21.0 ksym/s	Root Cosine, alpha = 0.50	PDC	`PDC`
PHS	pi/4 DQPSK	192.0 ksym/s	Root Cosine, alpha = 0.50	PHS	`PHS`
TETRA	pi/4 DQPSK	18.0 ksym/s	Root Cosine, alpha = 0.35	TETRA	`TETRa`
WCDMA 3GPP	QPSK 45° Offset	3.84 Msym/s	Root Cosine, alpha = 0.22	WCDMA 3GPP	`W3GPp`
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	Root Cosine, alpha = 0.22	OFF	`TCSCdma`
cdma2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	`CFORward`
cdma2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	`CREVerse`

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
Worldspace	QPSK	1.84 Msym/s	Root Cosine, alpha = 0.40	OFF	`WORLdspace`
TFTS	pi/4 DQPSK	22.1 ksym/s	Root Cosine, alpha = 0.40	TFTS/ TETRA	`TFTS`

Table 3-4: Permissible coding combinations for modulation symbols and modulation type

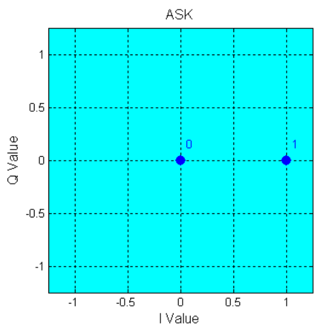
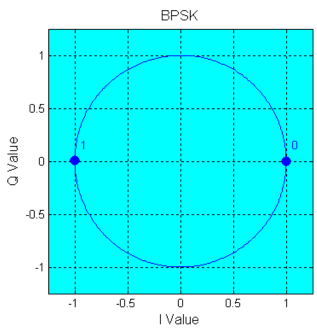
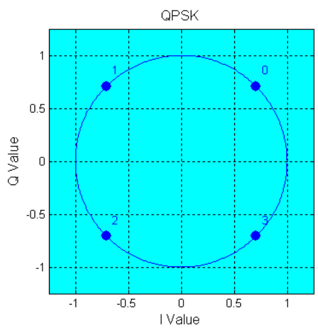
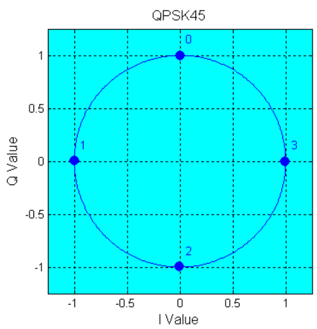
	OFF	Differ-ential	Phase Diff.	Diff.+ Gray	Gray	GSM	NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT	TFTS/ TETRA	INMARSAT, ICO, WCDMA, cdma2000	VDL	APCO25 (FSK)	APCO25 (8PSK)
ASK	X	X		X	X							
BPSK	X	X		X	X							
pi/2 DBPSK	X				X							
QPSK	X	X		X	X				X			
QPSK EDGE	X											
QPSK45° Off-set	X	X		X	X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

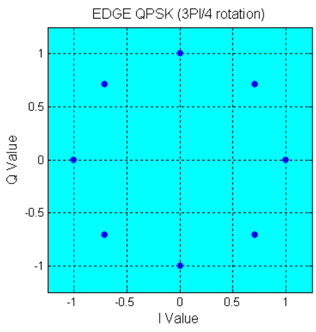
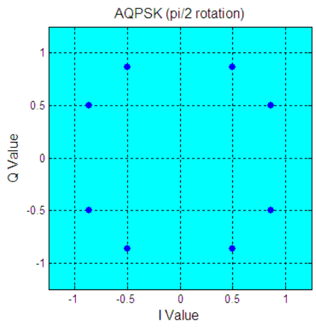
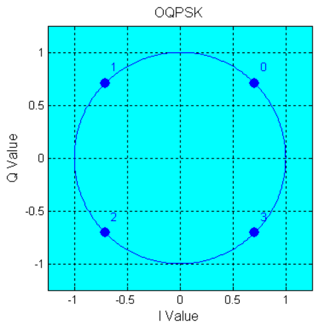
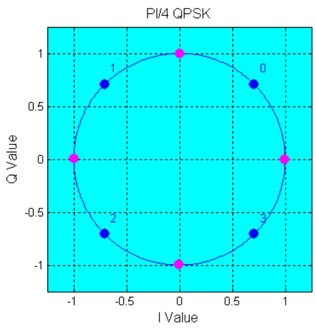
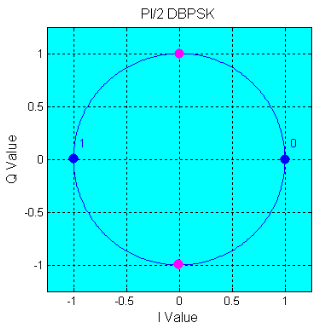
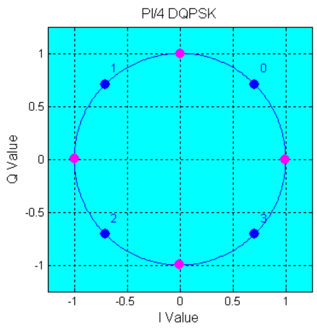
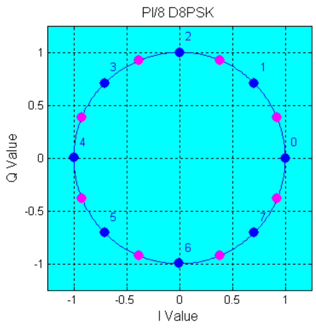
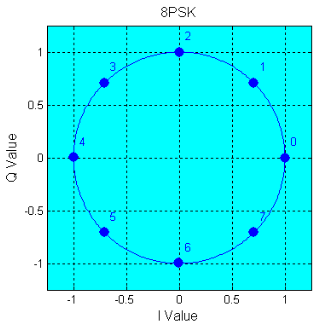
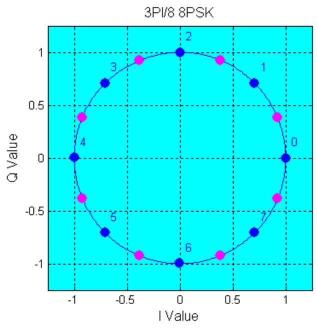
	OFF	Differ-ential	Phase Diff.	Diff.+ Gray	Gray	GSM	NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT	TFTS/ TETRA	INMARSAT, ICO, WCDMA, cdma2000	VDL	APCO25 (FSK)	APCO25 (8PSK)
128QAM	X	X	X	X	X							
256QAM	X	X	X	X	X							
1024QAM	X	X	X	X	X							

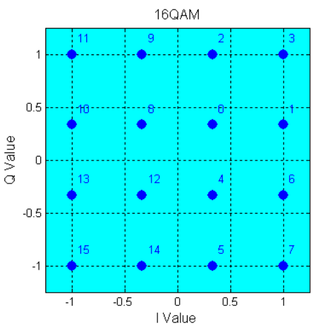
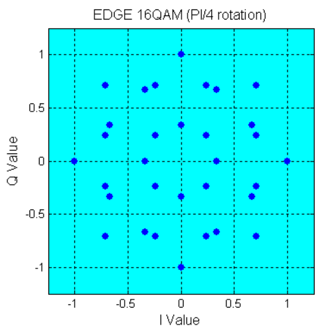
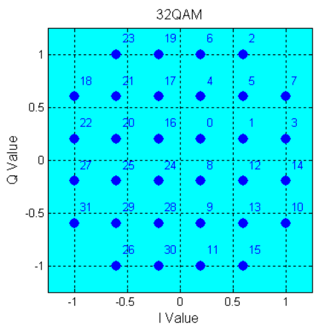
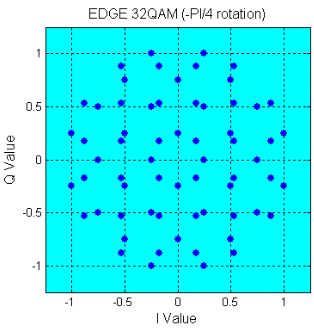
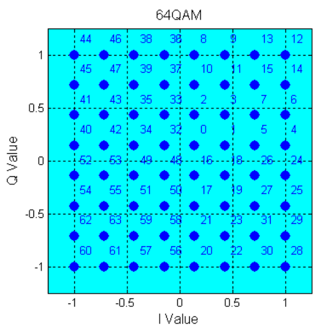
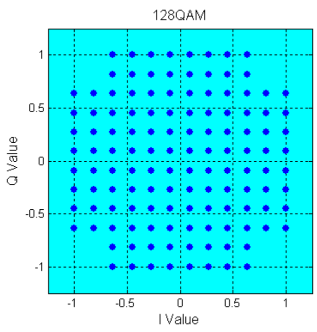
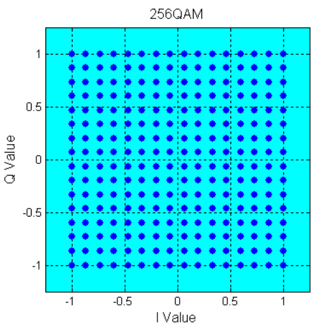
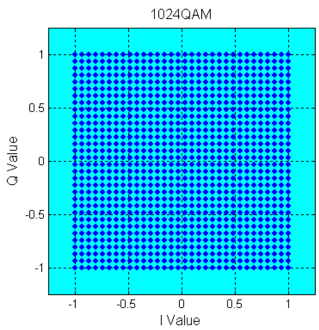
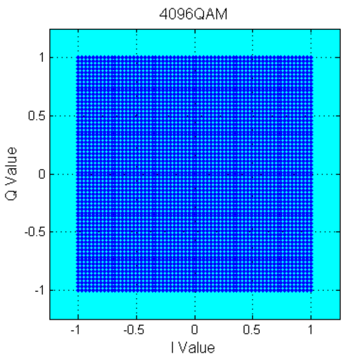
3.4.4.1 Predefined modulation types

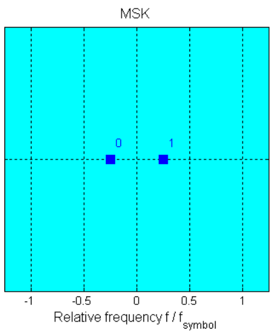
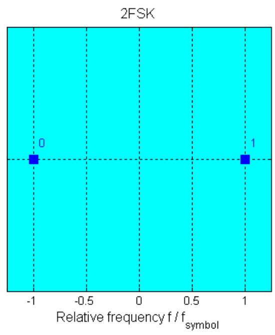
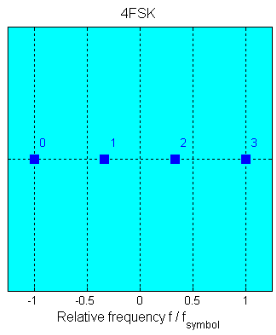
In Table 3-5, you can see the available modulation types and the associated parameters. The mapping for the selected modulation type is displayed in graphical form.

Table 3-5: Modulation type and associated mapping

ASK 1 bit per symbol		
		
PSK		
BPSK 1 bit per symbol	QPSK 2 bits per symbol	QPSK 45° Offset 2 bits per symbol, 45° rotation
		
QPSK EDGE 2 bits per symbol, 3pi/4 rotation	AQPSK 2 bits per symbol, pi/2 rotation	OQPSK 2 bits per symbol, Q offset

		
pi/4-QPSK 2 bits per symbol pi/4rotation	pi/2-DBPSK 1 bit per symbol Differential coding, pi/2 rotation	pi/4-DQPSK 2 bits per symbol Differential coding, pi/4 rotation
		
pi/8-D8PSK 3 bits per symbol Differential coding, pi/8 rotation	8PSK 3 bits per symbol	8PSK EDGE (3pi/8 8PSK) 3 bits per symbol Edge coding, 3pi/8 rotation
		
QAM		
16QAM 4 bits per symbol	16QAM EDGE 4 bits per symbol, pi/4 rotation	32QAM 5 bits per symbol

		
32QAM EDGE 5 bits per symbol, -pi/4 rotation	64QAM 6 bits per symbol	128QAM 7 bits per symbol
		
256QAM 8 bits per symbol	1024QAM 10 bits per symbol	4096QAM 12 bits per symbol
		
FSK		

MSK 1 bit per symbol	2FSK 1 bit per symbol FSK deviation	4FSK 2 bites per symbol FSK deviation
		

3.4.4.2 Common coding algorithms

In the notation used below, a_n denotes the n^{th} input symbol and b_n denotes the correspondingly coded output symbol. Individual bits in the symbols from the LSB (least significant bit) to the MSB (most significant bit) are denoted by a_{0n}, a_{1n}, etc. The same applies to the output symbols.

Common coding types are listed in Table 3-6.

Table 3-6: Common coding algorithms

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

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

Examples

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

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

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

According to Table 3-6 and for $k = 2$, the recursive coding is defined as $b_n = (a_n + b_{n-1})$ *modulo 4*.

For example, for modulation symbol $a_n = 2$, obtain the coded modulation symbol b_n from a preceding modulation symbol b_{n-1} as follows:

b_{-1}	0	1	2	3
b_n	2	3	0	1

By 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 3-7: Phase difference for QPSK

Modulation symbol a_n	00	01	10	11
Phase difference	0°	90°	180°	270°

Example: Differential coding for modulation type pi/4DQPSK

With differential coding switched on at the same time, the obtained constellation diagram for pi/4DQPSK is similar to that of 8PSK. Phase shifts are however assigned to the individual modulation symbols. The Table 3-8 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 3-8: Phase shifts for pi/4DQPSK

Modulation symbol a_n	00	01	10	11
"Coding = OFF"	+ 45°	+ 135°	- 135°	- 45°
"Coding = NADC, PDC, PHS, TETRA or APCO25 (PSK)"	+ 45°	+ 135°	- 45°	- 135°
"Coding = TFTS"	- 135°	+ 135°	- 45°	+ 45°

Example: Gray and differential coding for 8PSK modulation

When this coding scheme is used, the gray coding according to the gray code is performed before the differential coding. The latter uses the recursive coding algorithm quoted above (see Table 3-6). The assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

Table 3-9: Differential coding according to VDL[1)]

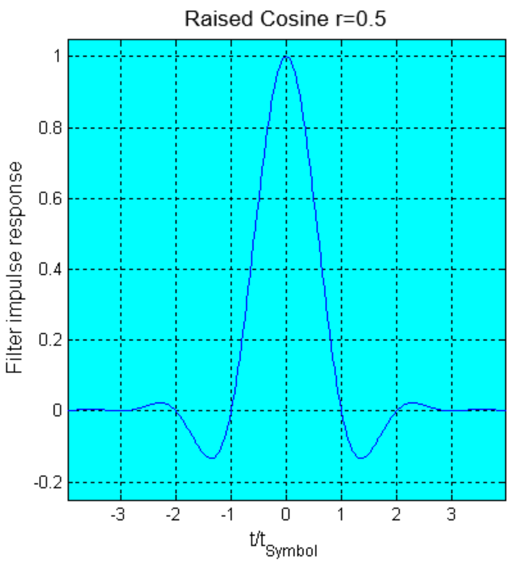
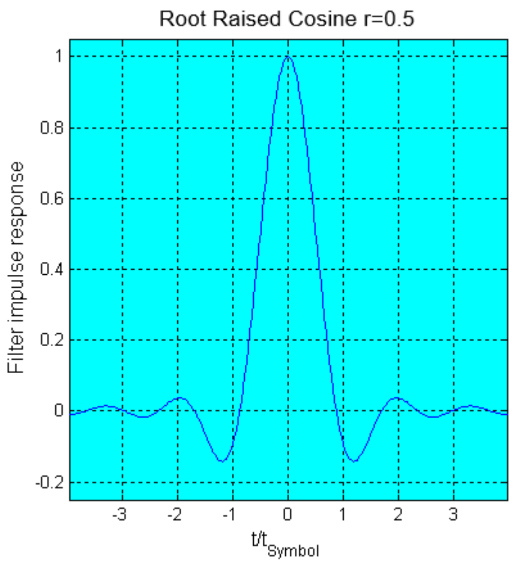
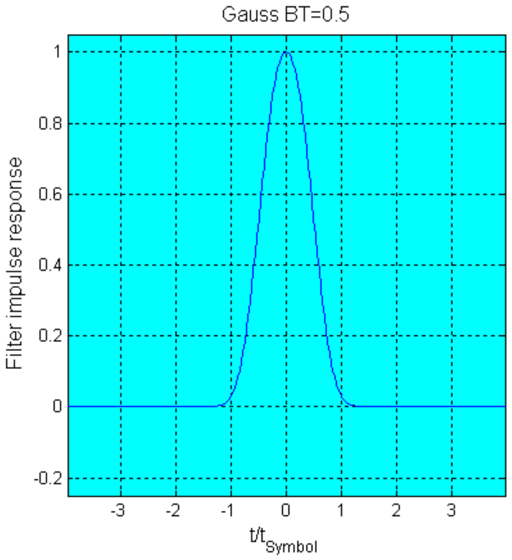
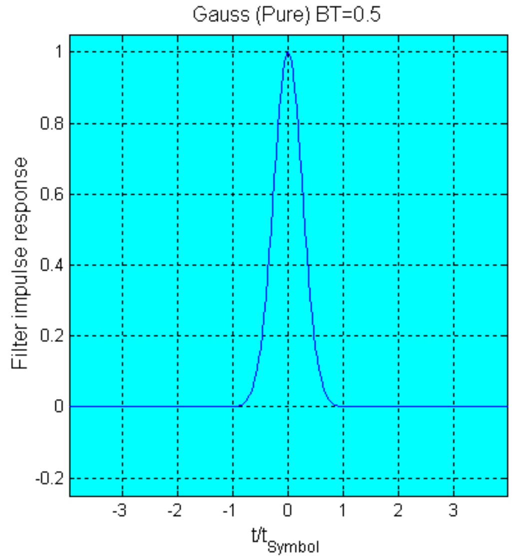
Modulation symbol d_n	000	001	010	011	100	101	110	111
Phase difference	0°	45°	135°	90°	270°	315°	225°	180°

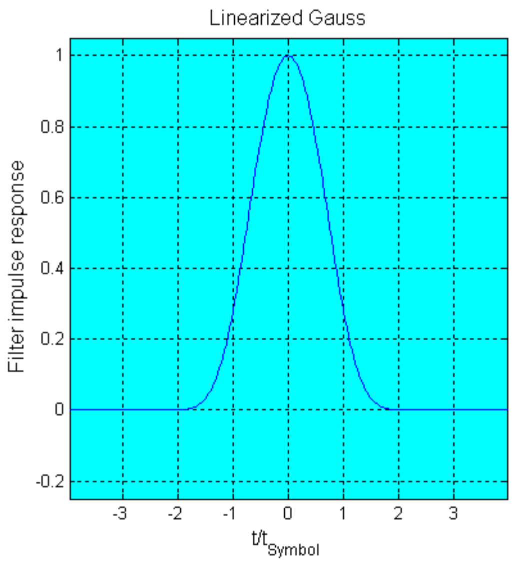
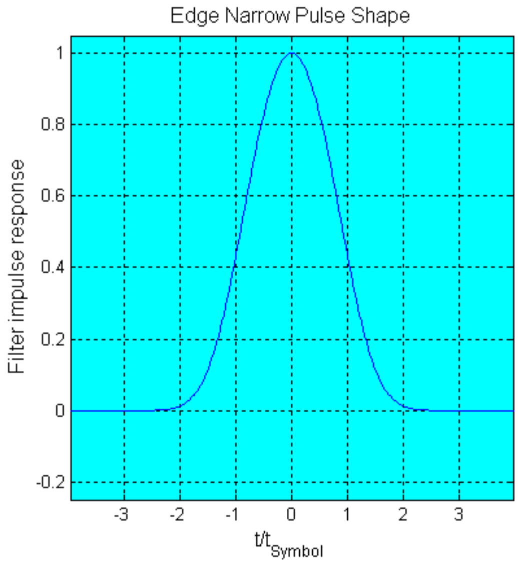
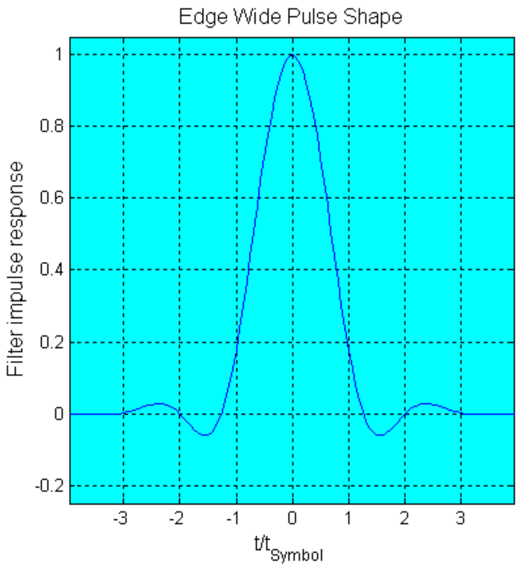
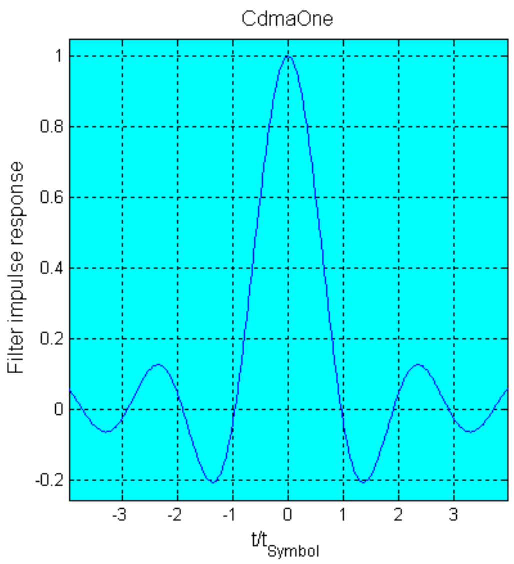
[1)] "Differential coding according to VDL" can be used for modulation types with 3 bits/symbol, e.g. 8PSK.

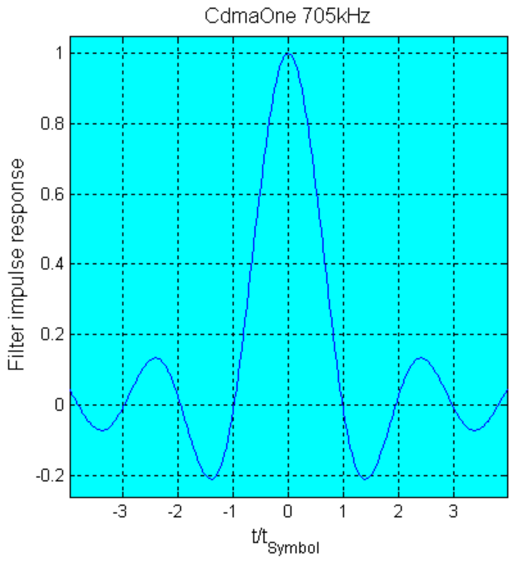
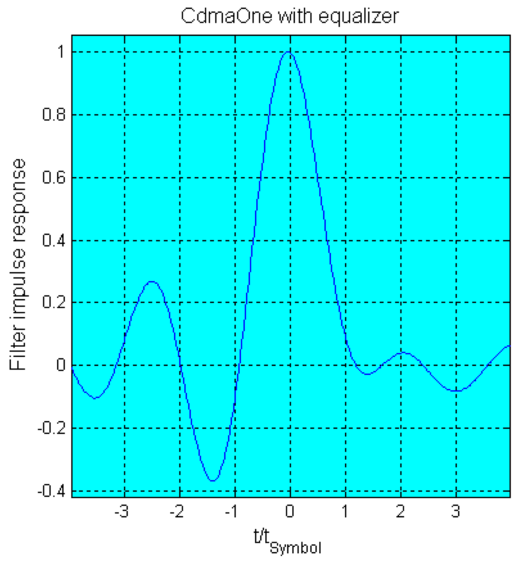
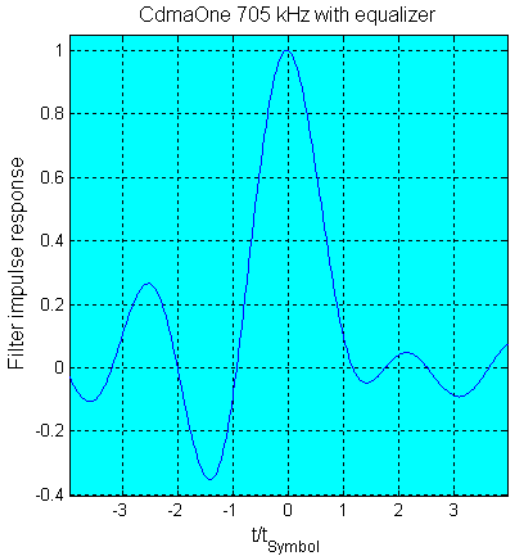
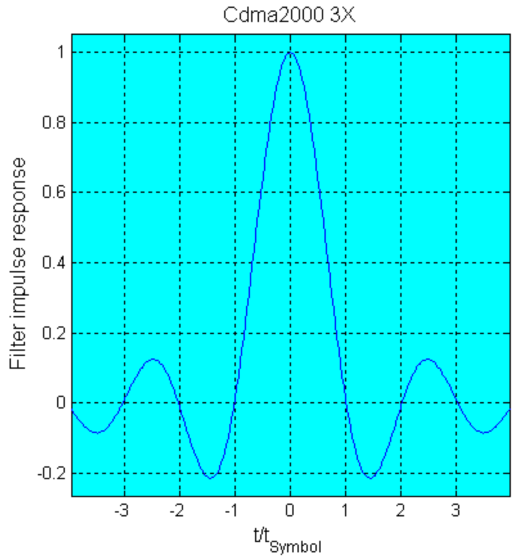
3.4.4.3 Predefined baseband filters

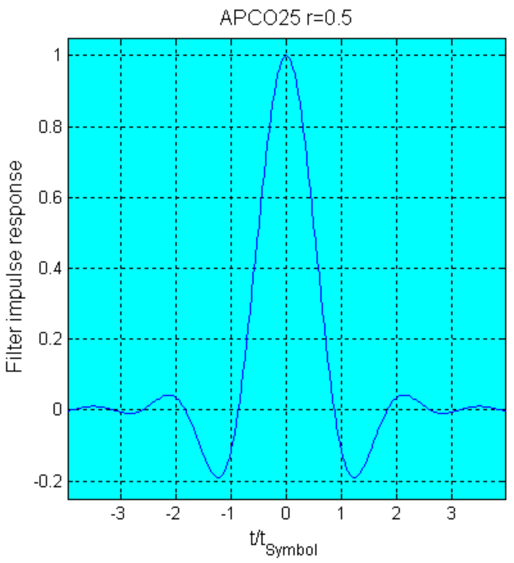
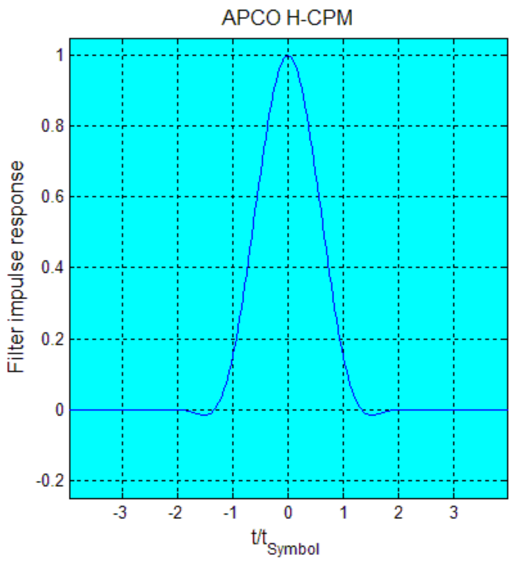
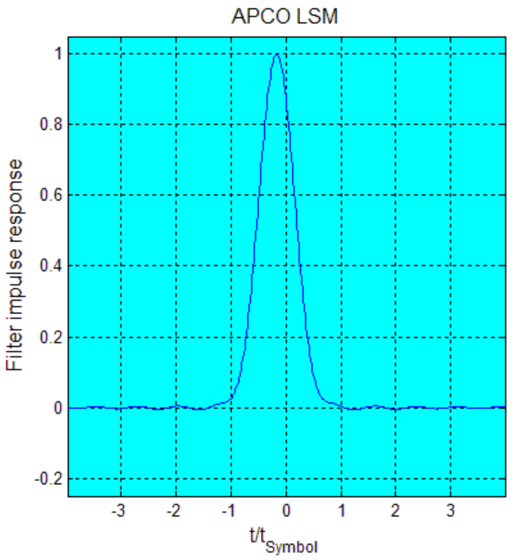
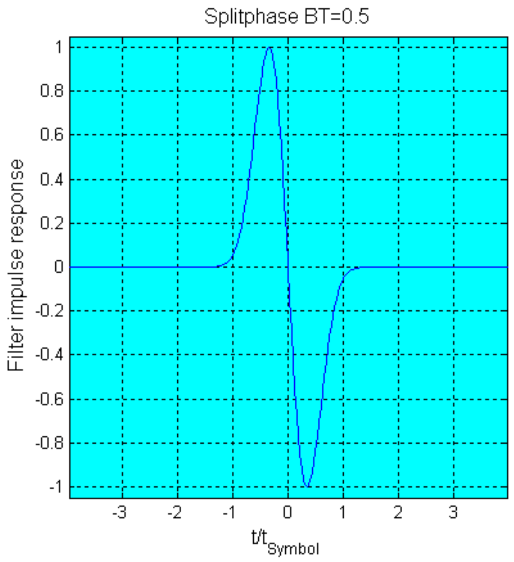
The Table 3-10 shows the filters that are available, together with their associated parameters. The filter characteristic is displayed in graphical form.

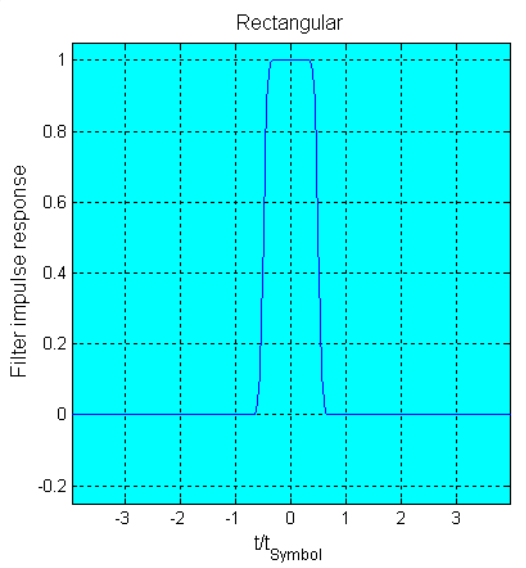
Table 3-10: Overview of the baseband filters

"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"

<table>
<tr>
<td>
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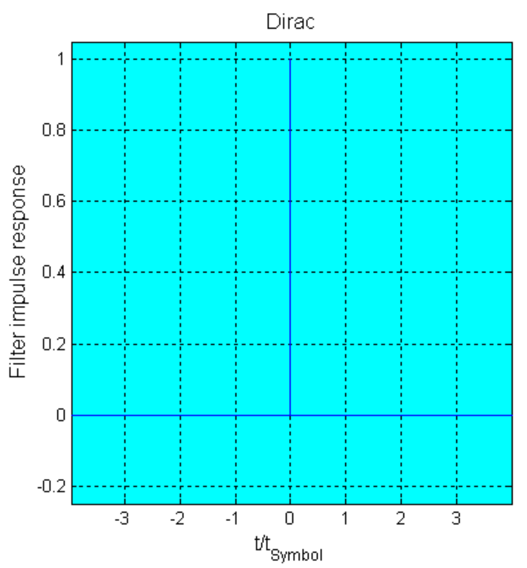
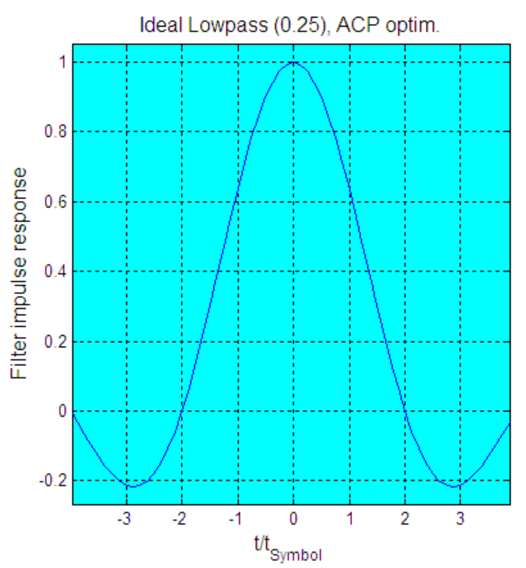
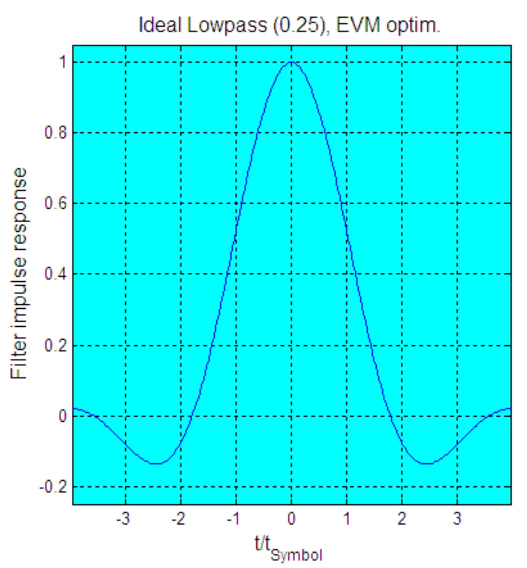
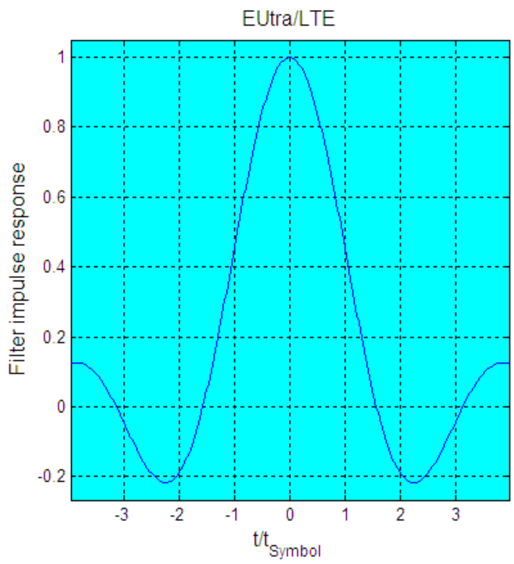
<td>
</td>
</tr>
<tr>
<td>"Lowpass (ACP optim.)"</td>
<td>"Lowpass (EVM optim.)"</td>
</tr>
<tr>
<td>
</td>
<td>
</td>
</tr>
</table>

"EUTRA/LTE"	
	

3.5 Generating multi-carrier continuous wave signals

The multi-carrier continuous wave (MCCW) function enables you to calculate wave-forms with up to 8192 continuous wave carriers with R&S WinIQSIM2.

3.5.1 About the MCCW

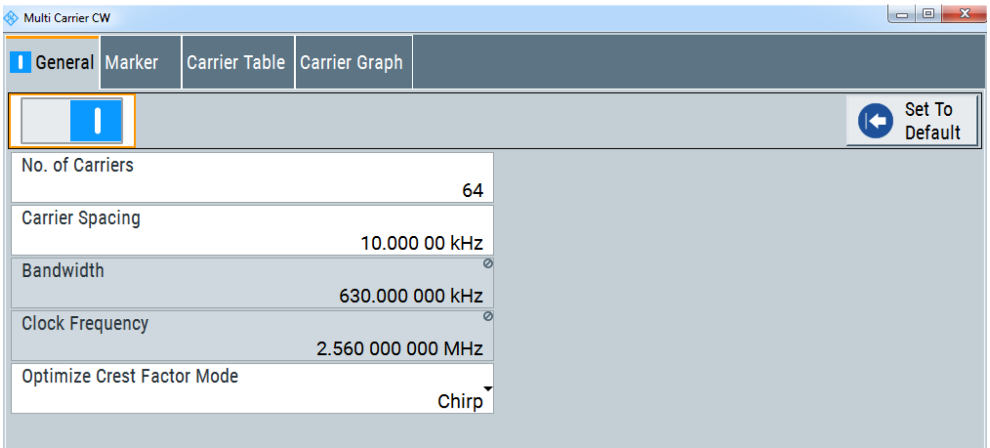
R&S WinIQSIM2 can calculate and generate a multi-carrier continuous wave signal build from up to 8192 unmodulated carriers. The carrier offset and the power level of the carriers are user-definable. The provided settings allow individual configuration of each carrier and the joint configuration of subsets of carriers. Automatic start phase setting is provided to minimize the crest factor.

The common application fields of the multi-carrier CW signals are receiver tests with broadband test signals.

3.5.2 MCCW settings

Access:

► Select "Baseband" > "Multi Carrier CW...".



The "Multi Carrier CW" dialog provides settings to configure the carriers directly and provides access to the carrier table and the graphical representation.

The remote commands required to define these settings are described in Chapter 11.11, "SOURce:BB:MCCW subsystem", on page 376.

Settings:

3.5.2.1 General carrier settings

This tab contains the common multi-carrier continuous wave parameters.

Settings:

State

Activates the multi-carrier CW signal generation.

Note: Switching on MCCW turns off all the other digital standards and digital modulation modes.

Since multi-carrier CW signals are computed in arbitrary waveform mode, R&S WinIQSIM2 adjusts the modifications of the "Carrier Table" and "Table Setup Assistant" settings only when confirmed with "Accept" (see Chapter 3.5.2.2, "Carrier table", on page 101).

Remote command:
`[:SOURce<hw>]:BB:MCCW:STATe` on page 377

Set to Default

Sets all relevant parameters to default, see Table 3-11.

Remote command:
`[:SOURce<hw>]:BB:MCCW:PRESet` on page 378

Number of Carriers

Sets the number of carriers composing the multi-carrier CW signal.

Note: Cross-reference between total bandwidth, carrier spacing, and number of carriers. The total bandwidth of the multi-carrier CW signal is calculated as follows:
Total Bandwidth = ("Number of Carriers" - 1) * "Carrier Spacing"

The result must not exceed the system bandwidth of the instrument (see data sheet).

If the total bandwidth is not respected, the value selected as "Carrier Spacing" is reduced. Hence, the selected number of carriers defines the maximum carrier spacing.

By default the multi-carrier table already lists 64 carriers that are preset to the settings "State > On", "Power > 0 dB", "Phase > 0°".

If you use fewer carriers than listed in the table, it is recommended that you delete the superfluous entries. Vice versa, if you extend the number of carriers, R&S WinIQSIM2 adds the new entries at the end of the table.

Remote command:
`[:SOURce<hw>]:BB:MCCW:CARRier:COUNt` on page 378

Carrier Spacing

Sets the spacing between carriers for the multi-carrier CW signal. The carriers are arranged symmetrically around the RF carrier.

Remote command:
`[:SOURce<hw>]:BB:MCCW:CARRier:SPACing` on page 381

Bandwidth

Indicates the resulting occupied signal bandwidth, calculated from the selected Number of Carriers and Carrier Spacing.

Clock Frequency

Displays the clock rate at which the multi-carrier CW signal is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers and the selected carrier offset. The value indicates the resolution during the marker generation.

With a suitable instrument type, you can generate MCCW waveforms with up to 4.8 GHz clock frequency, see also "To understand the instrument configuration" on page 189.

Remote command:
`[:SOURce<hw>]:BB:MCCW:CLOCk?` on page 383

Optimize Crest Factor Mode
Selects the mode for automatically minimizing the crest factor. The carrier start phases are automatically configured according to the selected mode.

Methods of reducing the crest factor differ regarding both the achievable optimization and the time required for computing. For more information, refer to Chapter 3.3.1.6, "Methods for optimizing the crest factor", on page 61.

"Off" There are no automatic settings for minimizing the crest factor. The "Phase" setting as defined in the carrier table is in use.

"Chirp" Rapid crest factor optimization regardless of the number of carriers. A minimal crest factor of < 3 dB is only obtained for multi-carrier signals in which all carriers are switched on and the power of the carriers is identical. In a different configuration, the achievable crest factor is worse.

"Target Crest" Optimization of the crest factor to a desired value for all carrier configurations. The optimization time depends on the number of carriers and the desired crest factor. The computing time increases only when the number of carriers exceeds 256 and the crest factor is below 4 dB. The desired value can be entered in "Desired Crest Factor".

Note: You can cancel the optimization at any time. R&S WinIQSIM2 uses the last displayed value.

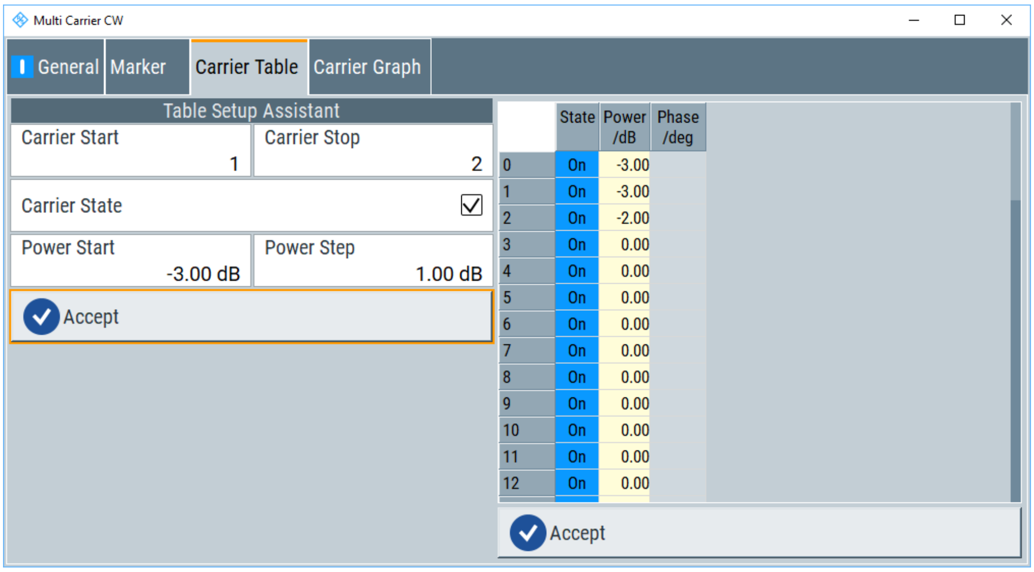
Remote command:
`[:SOURce<hw>]:BB:MCCW:CFACtor:MODE` on page 383

Desired Crest Factor
Defines the desired "Target Crest" factor for optimization.

Remote command:
`[:SOURce<hw>]:BB:MCCW:CFACtor` on page 382

3.5.2.2 Carrier table

This tab contains the settings required for configuring the selectable range of carriers.



Settings:

Table Setup Assistant

Enables joint configuration of a selectable range of carriers.

Carrier Start/Stop ← Table Setup Assistant

Defines the start/stop index of the carrier range to which the following settings are intended to apply.

Remote command:

`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt` on page 386
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP` on page 386

Carrier State ← Table Setup Assistant

Switches the carriers in the carrier range on/off.

Remote command:

`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe` on page 386

Power Start ← Table Setup Assistant

Sets the power of the starting carrier.

Remote command:

`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt]` on page 385

Power Step ← Table Setup Assistant

Sets the step width that is used to increment the power from carrier to carrier.

The individual power of each carrier ("Carrier Table > Carrier# >Power") is calculated as "Power Start" + n*"Power Step".

Remote command:
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP` on page 385

Phase Start ← Table Setup Assistant

Sets the phase of the starting carrier. This setting is only available for "Optimize Crest Factor Mode > Off".

Remote command:
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt]` on page 384

Phase Step ← Table Setup Assistant

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

The individual phase of each carrier ("Carrier Table > Carrier# >Phase") is calculated as "Phase Start" + n*"Phase Step".

Remote command:
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP` on page 384

Accept ← Table Setup Assistant

Adopts the carrier range setting into the "Carrier Table".

Remote command:
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute` on page 384

Carrier Table

A table with additional settings for the configuration of the individual carriers.

R&S WinIQSIM2 computes the multi-carrier CW signal only after you have confirmed the settings with "Accept". As long as you have not confirmed changes, the table background is yellow.

Note: The phase/deg settings are only effective if you have deactivated optimization of the crest factor ("Optimize Crest Factor > Off").

Tip: Use the Carrier graph function to display the current carrier configuration.

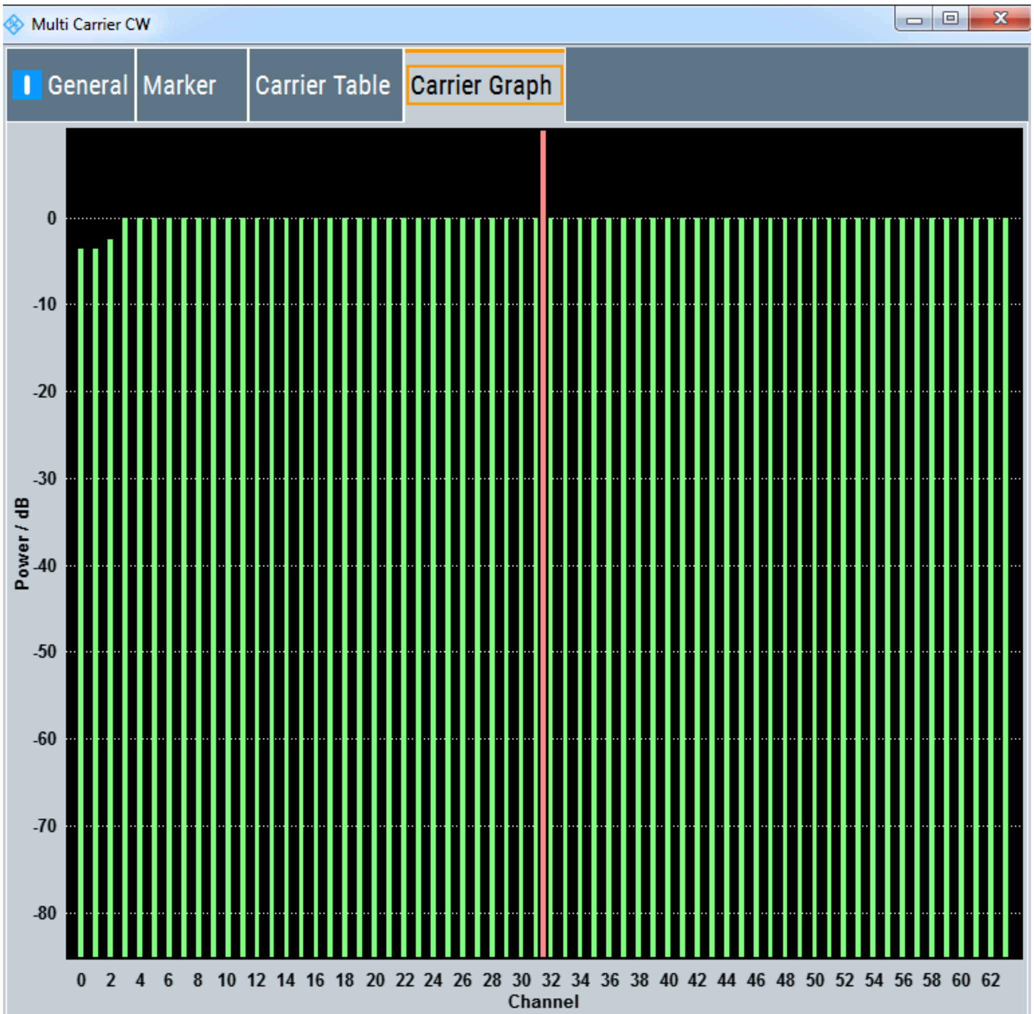
"No."	Indicates the carrier index.
"State"	Switches a carrier on/off
"Power"	Sets the power of a carrier. If you use the Table Setup Assistant settings to fill the individual carrier powers, the power of a carrier is calculated as "Power Start" + n*"Power Step".
"Phase"	Sets the starting phase of a carrier. If you use the Table Setup Assistant settings to fill the individual carrier powers, the power of a carrier is calculated as "Phase Start" + n*"Phase Step".
"Accept"	Applies the settings in the carrier table for signal generation.

Remote command:
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe on page 380
[:SOURce<hw>]:BB:MCCW:CARRier:STATe on page 381
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer on page 379
[:SOURce<hw>]:BB:MCCW:CARRier:POWer on page 381
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe on page 378
[:SOURce<hw>]:BB:MCCW:CARRier:PHASe on page 380

3.5.2.3 Carrier graph

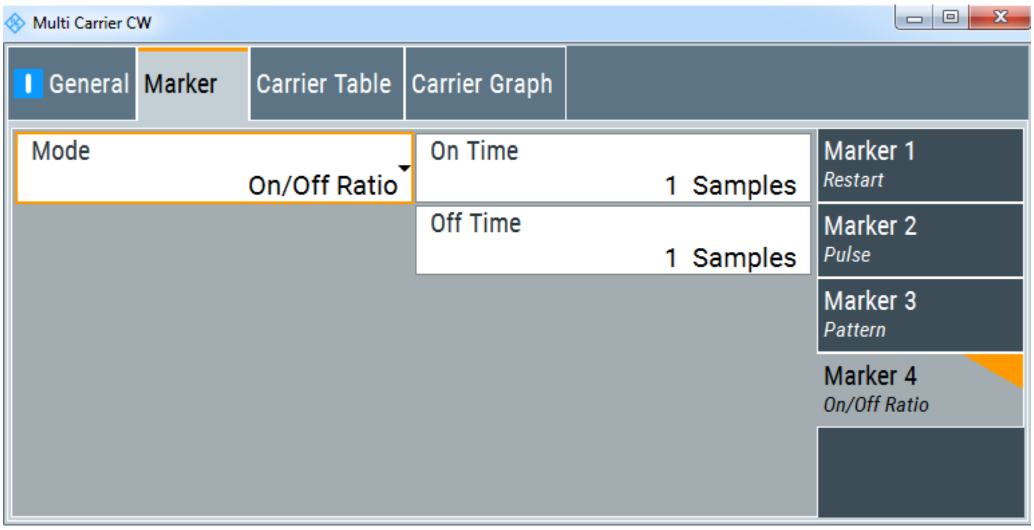
The "Carrier Graph" tab represents the current carrier configuration graphically.

The X-Axis covers the carriers, and the colored bars represent the active carriers. The Y-axis represents the power, that is, the height shows the set power of each individual carrier.



3.5.2.4 Marker settings

This tab provides access to the settings necessary to select and configure the marker mode settings.



Settings:

Marker 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 four. The marker configuration changes with the selected marker mode.

Use the settings to define the shape and periodicity of the markers. See Chapter 3.3.1.2, "Marker signals", on page 55 for description of the regular marker signals.

Remote command:

`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE` on page 387
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 388
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 388
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern` on page 388
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime` on page 387
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime` on page 387

3.5.3 How to use the multi-carrier continuous wave function

This section provides examples on how to configure a multi-carrier continuous wave signal for some general test cases:

- To generate a test signal for testing the frequency response of a DUT
- To generate a single sideband test signal for testing image rejection

Information on test setups or instrument configurations is not considered here.

To generate a test signal for testing the frequency response of a DUT

To create a test signal with a bandwidth of 80 MHz, e.g. to test a power amplifier or filter, configure the signal as follows:

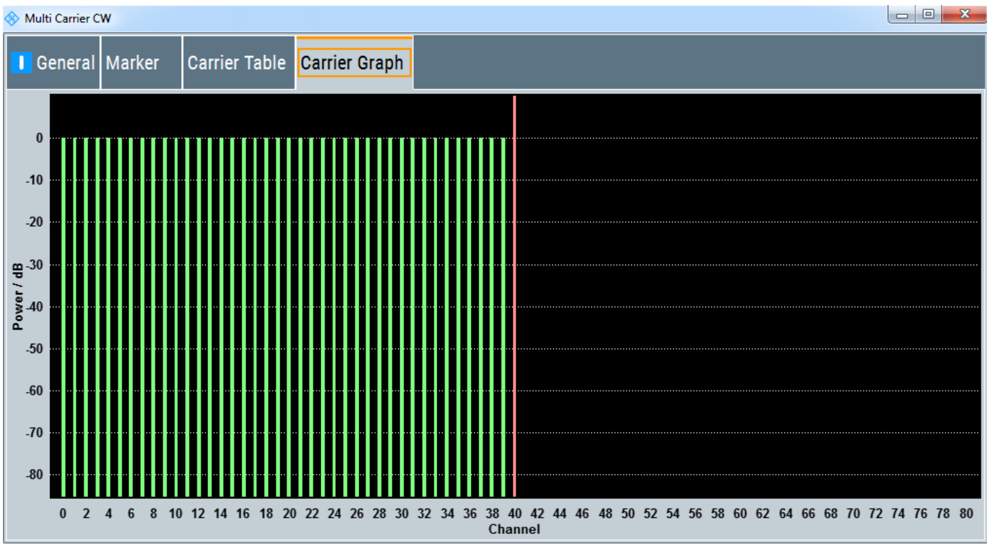
1. Select "Baseband > multi-carrier Continuous Wave".
2. In the "General" tab, set "Number of Carriers > 81".
3. Set "Carrier Spacing > 1 MHz".
4. Adjust further settings, e.g. the marker signals.
5. Enable signal generation with "multi-carrier Continuous Wave > State > On".

   R&S WinIQSIM2 computes the multi-carrier CW signal and provides the waveform for storing or transmitting to a connected instrument.

To generate a single sideband test signal for testing image rejection

If a single sideband test signal for testing the image rejection capabilities of DUT is required, proceed as follows:

1. Select "Baseband > multi-carrier Continuous Wave".
2. In the "General" tab, set "Number of Carriers > 80".
3. Set "Carrier Spacing > 1 MHz".
4. In the "Carrier Table" tab, perform the following settings:
   a) Set "Carrier Start > 40"
   b) Set "Carrier Stop > 80"
   c) Select "Carrier State > Off".
   d) Confirm with "Accept".
5. Select the "Carrier Graph" tab, to visualize the configured sideband signal.



6. Adjust further settings, e.g. marker signals.
7. Enable signal generation with "multi-carrier Continuous Wave > State > On".

   R&S WinIQSIM2 computes the multi-carrier CW signal and provides the waveform for storing or transmitting to a connected instrument.

3.5.4 References

Table 3-11: MCCW default values

Parameter	Value
State	Not affected by "Set to Default"
Carrier Setup	
Number of Carriers	64
Carrier Spacing	10 kHz
Optimize Crest Factor	Chirp
Desired Crest Factor	3 dB
Marker	
Channel 1...4	Restart
Multi Channel Setup	
Start Carrier	0
Stop Carrier	0
State	On
Power	0 dB
Power Step	0 dB
Initial Phase	0°
Phase Step	0°
Channel Setup	
State	On
Phase	0°
Power	0 dB

3.6 Generating multi carrier signals

To simulate complex multi carrier scenarios with different baseband signals, R&S WinIQSIM2 provides the possibility to generate multi carrier waveforms. These waveforms can consist of up to 512 carriers, each modulated by the same or by different user-selectable baseband signals.

The multi carrier waveform is a practical solution for the generation of a complex broadband signal. You can compose the signal based on various communication standards, e.g. CDMA2000 or 3GPP FDD. In addition, R&S WinIQSIM2 supports multi carrier signals composed of several signals from the same communication standard as it is the case with LTE Advanced.

3.6.1 Required options

R&S WinIQSIM2 offers all included digital standards for the creation of multisegment waveform files. However, the used instrument must be fitted with the associated R&S WinIQSIM2 options for the generation of the individual carrier signals.

3.6.2 About multi carrier waveforms

This chapter provides background information on the ARB functionality for generating multi carrier signals and the impact of the provided settings. Refer to Chapter 3.6.4, "How to use the multi carrier function", on page 122 for information on how to use the provided settings to configure a multi carrier signal.

Multi carrier waveforms are a convenient way to configure broadband test signals required for transmitter or receiver tests. Even complex multi carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Multi carrier files can be processed by an ARB generator, therefore the composed waveform file must be created before loading and playing by the ARB. Using R&S WinIQSIM2, you can configure and create multi carrier waveforms and transmit the computed waveform directly to a connected instrument or store it in a file. The filename is user-definable; as with the single carrier waveforms, and the file extension is `*.wv`.

General principle for composing a multi carrier signal

The following is a list of the general steps used for composing a multi carrier signal:

- In the default mode, the up to 512 carriers are equidistantly distributed, centered on the carrier index, which represents the RF frequency or baseband DC line. The carrier spacing is adjustable within the total available bandwidth. The total RF bandwidth of the composed multi carrier signal must not exceed the bandwidth of the instruments' ARB (see data sheet).
- Another possibility is to define the center frequency of each of the carrier individually, see also Chapter 3.6.2.1, "Defining the carrier frequency", on page 109.
- Each carrier can be separately defined in terms of power, phase and modulated input signal.
  To define the leveling of the composed multi carrier signal, use the parameter "Power Reference" on page 114
- Optionally, crest factor optimization can be applied (see Chapter 3.6.2.2, "Optimizing the crest factor", on page 109).

- After all multi carrier processing steps are completed, R&S WinIQSIM2 calculates the resulting peak and RMS power over the total signal and enters the values in the waveform file.

3.6.2.1 Defining the carrier frequency

There are two ways to define the carrier frequency of the individual carriers in the multi carrier signal.

- Enabling the **arbitrary carrier frequency** distribution and specifying the carrier frequency of each carrier individually.
- Using the built-in **equidistant carrier spacing** distribution function, i.e. enabling the carriers to be equally spaced and centered toward the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.
  The maximum carrier spacing is calculated as a function of the available total bandwidth and the selected number of carriers as follows:
  Max Carrier Spacing = Total bandwidth /(Number of Carriers - 1)
  To avoid wrap-around problems, the effective applied carrier spacing can be slightly modified.

  The value of the carrier spacing is rounded in that way that the carrier closest to the baseband DC line shows no phase jump assuming that the carrier is unmodulated.
  - For odd number of carriers:
    *RoundedCarrierSpacing = 1/OutputSignalDuration*round(CarrierSpacing*OutputSignalDuration)*
  - For even number of carriers:
    *RoundedCarrierSpacing=2/OutputSignalDuration*round(0.5*CarrierSpacing*OutputSignalDuration)*

R&S WinIQSIM2 provides the parameter Mode for this purpose.

3.6.2.2 Optimizing the crest factor

An introduction to the topic is provided in Chapter 3.3.1.6, "Methods for optimizing the crest factor", on page 61. This section focuses on the settings provided for and related to the multi carrier signals.

R&S WinIQSIM2 provides a crest factor reduction in form of an automatic optimization upon selected values for the following parameters:

- **Crest factor optimization mode**: determines whether the phase settings are selectable or internally calculated to fulfill a requirement for the crest factor value.
- **Clipping:** reduces the peak power of the resulting multi carrier signal according to the input parameter "Target Crest Factor"
  The resulting clipped peak power is defined by sum of the RMS level of the unclipped multi carrier signal and the input parameter "Target Crest Factor".
  Since clipping reduces also the RMS level, the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".

- **Target Crest Factor:** determines the desired crest factor. A value above the crest factor of the unclipped multi carrier signal has no effect.
- **Filter Cut Off Frequency:** determines the filter parameter of the final lowpass filter. When the cut-off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multi carrier signal. However, it can also increase the resulting crest factor.

3.6.3 Multi carrier settings

Access:

► Select "Baseband > multi carrier".

The "ARB: multi carrier" dialog enables direct configuration of the carrier distribution around the center frequency and adjusting some parameters for improving the signal characteristics.
The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name. In the tab "Carrier Table", you can select the waveform file to be processed. Use the "Carrier Graph" to visualize the configured signal.

The remote commands required to define these settings are described inChapter 11.7, "SOURce:BB:ARB:MCAR subsystem", on page 313.

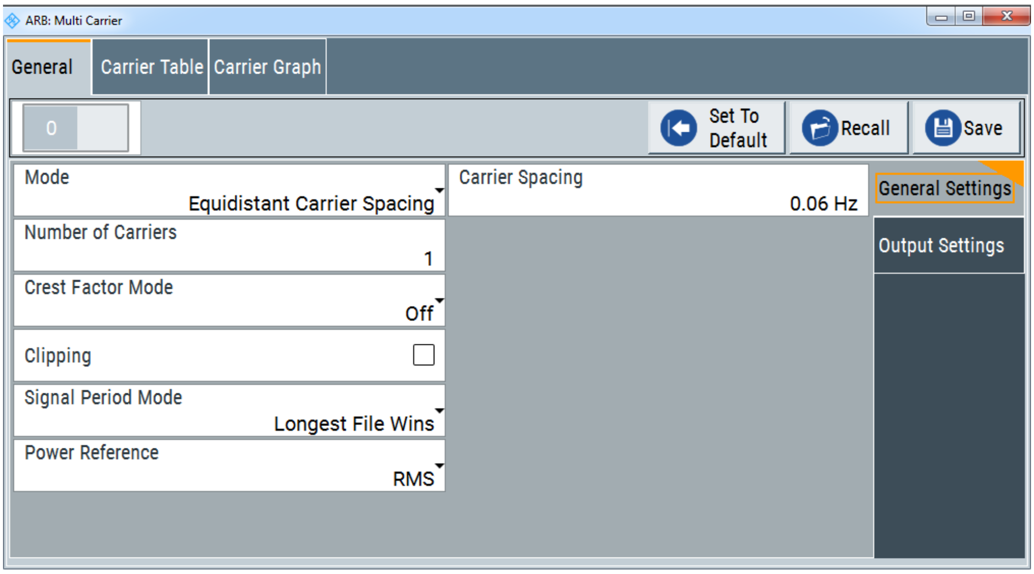
Settings:

3.6.3.1 General settings

Access:

► Select "Baseband > multi carrier".

This tab provides access to the default settings, selecting the output waveform file, enabling the generation, and the configuration of the carrier distribution.



Settings:

State

Activates multi carrier generation.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:STATe` on page 327

Set to Default

Sets all relevant parameters to default, see Table 3-12.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet` on page 325

Save/Recall Frame
Accesses the standard "Save/Recall" dialog, i.e. the standard function for storing and recalling the complete dialog-related settings. Refer to Chapter 8.2, "Storing and recalling application settings", on page 207 for a detailed description.

The multi carrier settings are stored as files with the predefined file extension `*.arb_multcarr`. The filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?` on page 326
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD` on page 326
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe:FAST` on page 327
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe` on page 326

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 on the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.

"Arbitrary Carrier Frequency"
Enables the specification of the carrier frequency of each carrier individually.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE` on page 314

Number of Carriers
Sets the number of carriers for the multi carrier waveform. By default the multi carrier table lists 1 carrier. A maximum of 512 carriers can be configured and activated.

Tip: You can find and modify the number of carriers in both, the "General" tab as well as in the dialogs "Carrier Table" and "Carrier Table Assistant".

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

See also Chapter 3.6.2.1, "Defining the carrier frequency", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 314

Carrier Spacing
Sets the frequency spacing between adjacent carriers of the multi carrier waveform.

The carriers are arranged symmetrically around the RF carrier and the maximum carrier spacing is limited to:

"Carrier Spacing" = Total baseband bandwidth /("Number of Carriers" - 1).

The total baseband bandwidth depends on the used ARB generator which replays the waveform. The total bandwidth is specified in the data sheet of the corresponding instrument.

For more information, see Chapter 3.6.2.1, "Defining the carrier frequency", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing` on page 315

Crest Factor Mode
Selects the mode for optimizing the crest factor by calculating the carrier phases. For more information, refer to Chapter 3.6.2.2, "Optimizing the crest factor", on page 109.

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 318

Clipping
Switches the baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the input parameter "Target Crest Factor". For more information, refer to Chapter 3.6.2.2, "Optimizing the crest factor", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 319

Target Crest Factor
Sets the value of the desired crest factor, if baseband clipping is enabled.

A "Target Crest Factor" above the crest factor of the unclipped multi carrier signal has no effect. For more information, refer to Chapter 3.6.2.2, "Optimizing the crest factor", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor` on page 318

Filter Cut Off Frequency
Sets the cut-off frequency of the final lowpass filter, if baseband clipping is enabled.

When the cut-off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multi carrier signal. However, it also increases the resulting crest factor. See also Chapter 3.6.2.2, "Optimizing the crest factor", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff` on page 319

Signal Period Mode
Defines the way the resulting signal period of the multi carrier waveform is calculated. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (On/Off). Use the "Carrier Table > Info" function to obtain information on the sample rate and file length data of each carrier.

Note: Wrap-around and timing problems occur when I/Q signals of different length are used. Thus, demodulation of a carrier can be difficult or even impossible. It is therefore recommended, that you consider the timing when creating the input I/Q files or to adjust the signal duration to the carrier which is later demodulated. In this case, the other carriers are for interfering the signal only. These problems do not arise with signals of the same standard (e.g. 3GPP).

The following modes are available:

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

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

"User"
Enables you to define a user-specific Signal Period.
Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

"Least Common Multiple"
The output file duration is the least common multiple of all input file durations.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE` on page 328

Signal Period
Sets the signal period in "Signal Duration Mode > User". Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME` on page 327

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

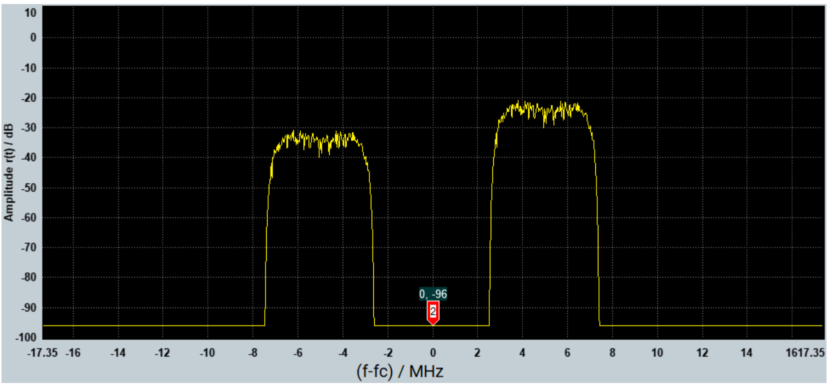
A multicarrier signal is composed from two waveform files with the following characteristics:

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	.../ArbMccwDummy.wv	Info...	
1	On	5.000 000	0.00	0.00	0	.../ArbMccwDummy.wv	Info...	

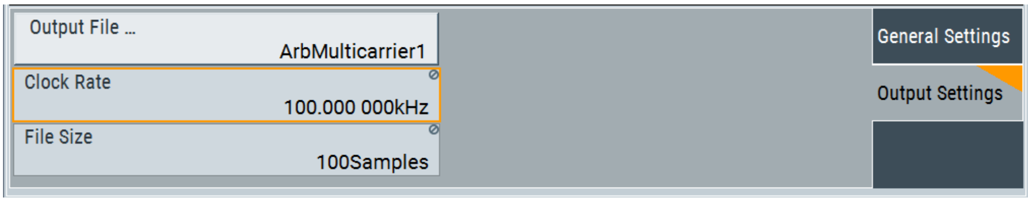


The peak values of the carrier signals are equal, but the RMS values are different.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 317

Output Settings

The output settings indicate the name, the size and the clock rate of the currently calculated multi carrier output file.



Output File ← Output Settings
Accesses the standard "File Select" function to specify the output file name of the multi carrier waveform to be calculated. As with normal waveforms, the file extension is `*.wv`.

To trigger the calculation and storage of this multi carrier waveform, select "State > On".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe` on page 325

Clock Rate ← Output Settings
Displays the resulting sample rate at which the multi carrier waveform is output by the ARB generator. The output clock rate depends on the number of carriers, carrier spacing and input sample rate of the leftmost or rightmost carriers.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?` on page 320

File Size ← Output Settings
Displays the resulting number of samples of the multi carrier waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?` on page 325

Create/Create and Load
Creates a multi carrier waveform defined by the multi carrier table and general setting entries. If the calculation is triggered by the "Create and Load" function, the instrument creates the waveform and loads it later in the ARB generator.

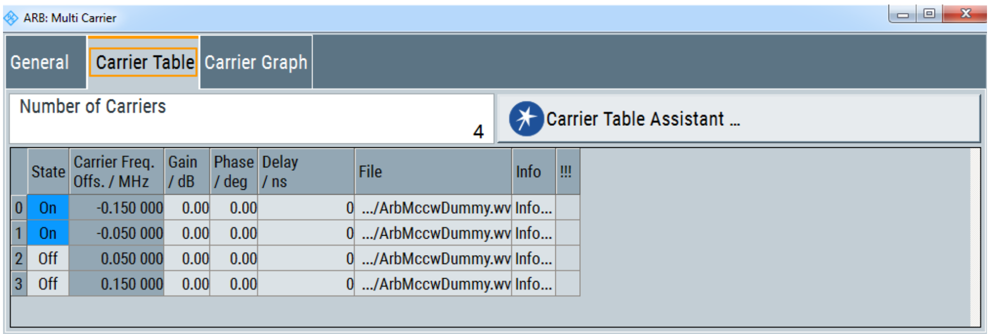
This multi carrier waveform is stored with file name specified in "Output File". Depending on the configuration of the multi carrier waveform, calculation can take some time. To stop the calculation, use the "Abort" function.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate` on page 321
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` on page 320

3.6.3.2 Carrier table settings

Access:

► Select "Baseband > multi carrier > Carrier Table".



This tab comprises additional settings for configuring individual carriers. A selectable carrier range can be set with the aid of the optional "Carrier Table Assistant". The settings of all available carriers are displayed in table form. Previously applied assistant settings can be further refined. The number of lines corresponds to the number of carriers.

The phase/deg settings are only effective if you have deactivated optimization of the crest factor ("Optimize Crest Factor > Off").

Use the "Carrier Graph" tab to visualize the selected multi carrier configuration.

Settings:

Number of Carriers

Sets the number of carriers for the multi carrier waveform. By default the multi carrier table lists 1 carrier. A maximum of 512 carriers can be configured and activated.

Tip: You can find and modify the number of carriers in both, the "General" tab as well as in the dialogs "Carrier Table" and "Carrier Table Assistant".

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

See also Chapter 3.6.2.1, "Defining the carrier frequency", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 314

No
Indicates the carrier index ranging from 0 to (number of carriers -1).

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

State
Activates a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe` on page 324

Carrier Freq [MHz]
Sets the carrier frequency.

Note: The carrier frequency can only be set in "Arbitrary Carrier Frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency`
on page 316

Gain
Sets the gain of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer` on page 317

Phase
Sets the starting phase of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe` on page 317

Delay
Sets the starting delay of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay` on page 316

File
Accesses the standard "File Select" function for selecting the input file with the I/Q signal to be modulated onto the carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE` on page 316

Info
Indicates the sample rate, number of I/Q value pairs (number of samples), and the resulting signal period of the selected I/Q input file.

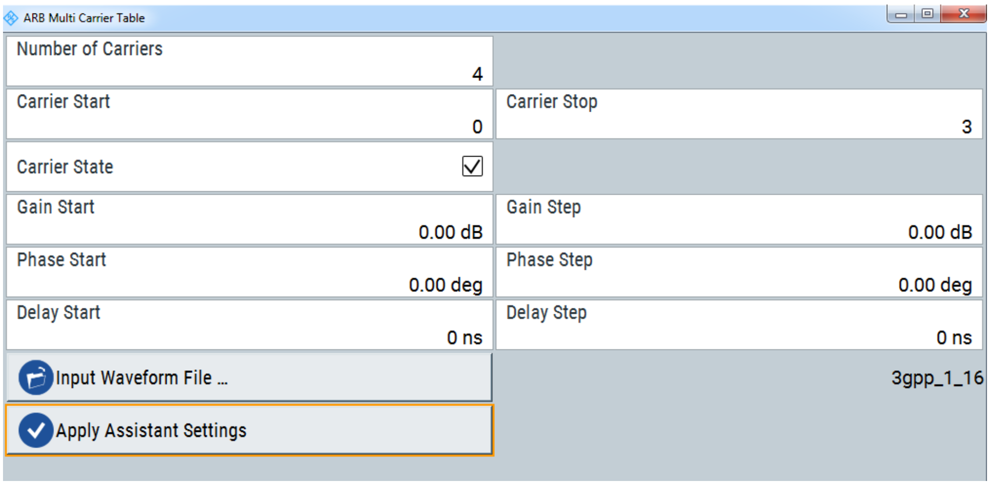
Remote command:
n.a.

!!!
Indicates an occurred conflict by 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 315

3.6.3.3 Carrier table assistant

1. To access the dialog, select "Baseband > multi carrier".
2. Select "Carrier Table > Carrier Table Assistant"



The "Carrier Table Assistant" dialog enables you to configure a selectable subset of carriers. Using the assistant, you can quickly set up a multi carrier scenario within a specified carrier range.

Settings:

Number of Carriers
Sets the number of carriers for the multi carrier waveform. By default the multi carrier table lists 1 carrier. A maximum of 512 carriers can be configured and activated.

Tip: You can find and modify the number of carriers in both, the "General" tab as well as in the dialogs "Carrier Table" and "Carrier Table Assistant".

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

See also Chapter 3.6.2.1, "Defining the carrier frequency", on page 109.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 314

Carrier State
Activates the carriers within the range "Carrier Start" to "Carrier Stop".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe` on page 324

Carrier Start/Stop
Defines the start or stop index of the carrier range that applies for the assistant settings.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 324
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 324

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 324

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

The resulting carrier gain in the carrier table equals:

Gain = "Gain Start" + n*"Gain Step"

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

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP`
on page 323

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 323

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

The resulting phase in the carrier table equals:

Phase = "Phase Start" + n"Phase Step"*

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

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP
on page 323

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 321

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

The resulting delay in the carrier table equals:

Delay = "Delay Start" + n"Delay Step"*,

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

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP
on page 321

Input Waveform File
Accesses the standard "File Select" function for selecting the input file with the I/Q signal to be modulated onto all carriers of the selected carrier range.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE on page 322

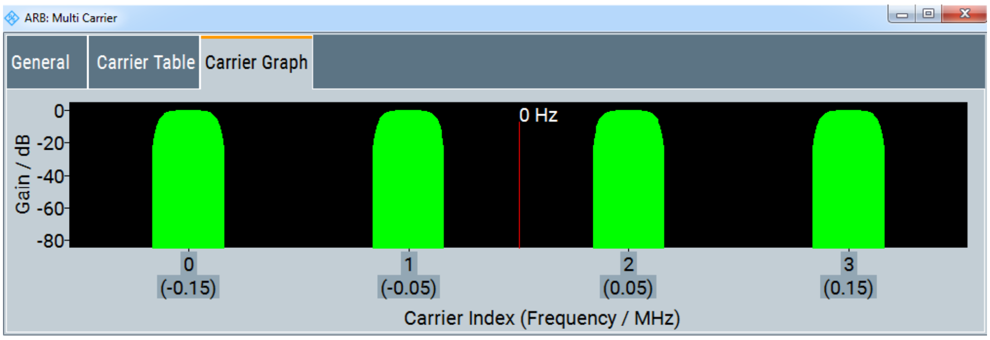
Apply Assistant Settings
Transfers the assistant settings to the carrier table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute
on page 322

3.6.3.4 Carrier graph

1. To access the dialog, select "Baseband > multi carrier".

2. Select "Carrier Graph"



The carrier graph is a graphical representation of the current multi carrier configuration in the frequency domain.
The height of the bars corresponds to the selected gain of each individual carrier.
The bandwidth of the carrier signals is indicated by the width of the bars.

3.6.4 How to use the multi carrier function

This section provides step-by-step instructions on how to configure and use the multi carrier settings.

To create a multi carrier waveform file (general workflow)

Perform the following general steps:

1. To configure the general settings, select "Baseband > multi carrier > General".
2. To configure the carrier table select "Carrier Table"
3. To enter the file name of the multi carrier waveform, select "General > Output File"
4. To save or load a multi carrier waveform, select "State > On".

To generate a multi carrier signal for standard transmitter tests

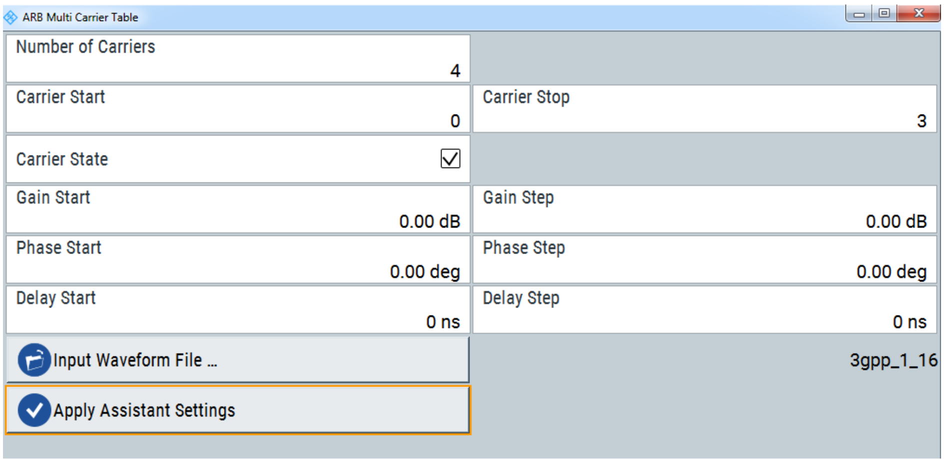
High power amplifiers of multi carrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance.

To set up a standard transmitter test, proceed as follows:

1. Select "Baseband > 3GPP FDD".
2. Adjust the following parameters:
   a) Select "3GPP FDD > Basestations > Test Setups/Models"
   b) Select "3GPP FDD: Downlink/Test Model > Test_Model_1_16channels".
   c) Confirm with "Select".
3. To enable signal generation, select "3GPP FDD > General > On".
4. To create a 3GPP waveform file, perform the following:
   a) Select "Generate Waveform".

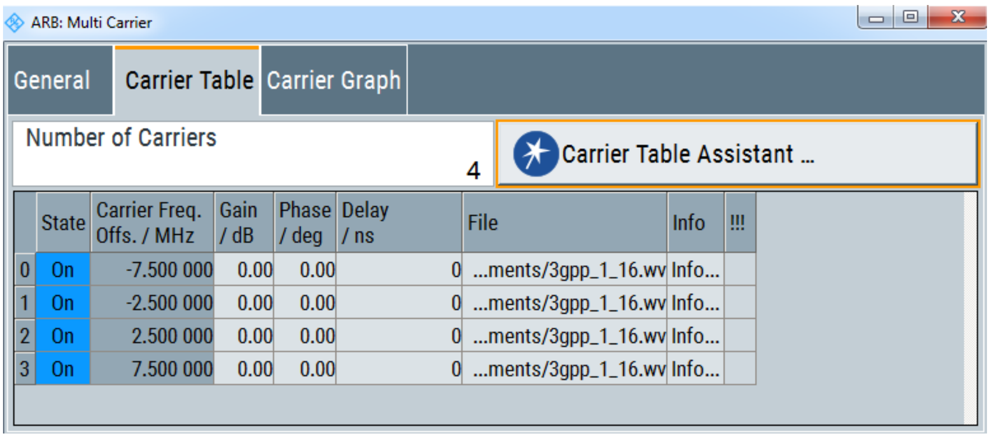
b) In the destination folder, enter the "File Name" for the waveform file, for example `3gpp_1_16`.
c) Confirm with "Save"

5. To set up a multi carrier scenario with 4 carriers and a carrier spacing of 5 MHz, select "Baseband > multi carrier".
6. Adjust the following parameters:
   a) In the "General" tab, select "Number of Carriers = 4" and "Carrier Spacing = 5 MHz".
   b) Select "Carrier Table > Carrier Table Assistant".
   c) Select "Carrier Start = 0".
   d) Select "Carrier Stop = 3".
   e) To load the generated waveform file to all 4 carriers, select "Input Waveform File".
   f) Navigate to the generated waveform file `3gpp_1_16`.
   g) Confirm with "Select".
   h) Select "Carrier State > On".

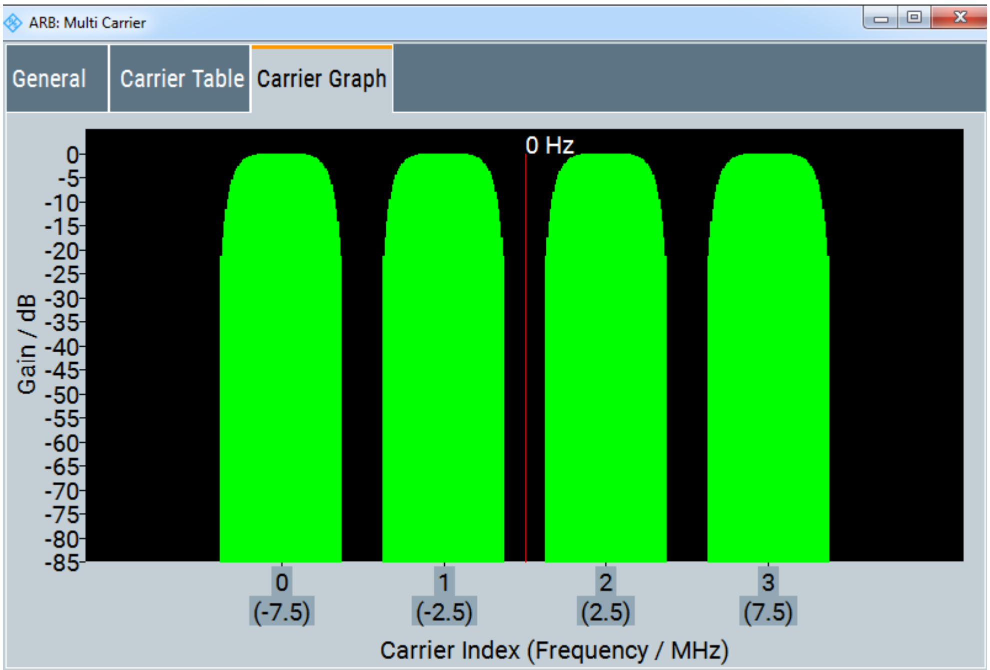


   i) Select "Apply Assistant Settings".
   j) Close the dialog.

The "ARB: multi carrier > Carrier Table" dialog confirms the configuration.



7. Select "Carrier Graph" to visualize the configuration.



8. To store the multi carrier waveform, select "General > Output File".
9. Enter the name for the file, for example `4x5MHz_3gpp_1_16`.
10. To save or load a multi carrier waveform, select "State > On").
11. To transmit the waveform to an ARB generator, proceed as described in Chapter 7.2, "How to transmit waveform data to instruments or files", on page 202.

3.6.5 References

Table 3-12: Multi carrier default values

Parameter	Value
Number of Carriers	1
Carrier Spacing	0 MHz
Crest Factor Mode	Off
Signal Period Mode	Longest file wins

3.7 Generating multi segment waveform files

Modern chip technologies implement several communication standards within one chip and rise spatial verification and test requirements. To fulfill the requirements of these test systems and to enable rapid alternation between different waveforms with differing test signals, R&S WinIQSIM2 provides the functionality to create multi segment waveform files.

This section introduces the concept of multi segment waveform files, including the setting parameters and some typical configuration examples.

3.7.1 Required options

R&S WinIQSIM2 offers all included digital standards for the creation of waveform files. However, the used instrument must be fitted with the associated R&S WinIQSIM2 options for the generation of the signal from the waveform file.

3.7.2 About multi segment waveforms

A multi segment waveform is a signal composed of several different waveforms, called segments. Each segment contains a fully independent waveform that can be generated with its own specific markers and clock settings. You can also implement blank segments, i.e. segments containing a zero signal.

The Figure 3-8 shows the principle of building a multi segment waveform.

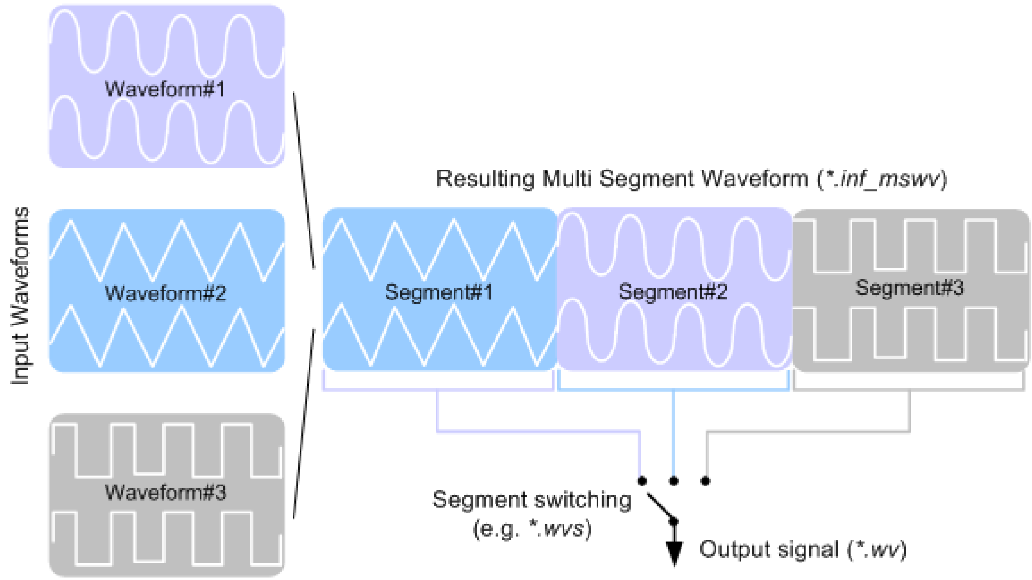


Figure 3-8: ARB Multi Segment Waveform concept

Typical applications for the multi segment mode are described in section Chapter 3.7.4, "How to create and work with multi segment waveform files", on page 134.

3.7.2.1 Multi segment waveforms processing

A multi-segment waveform file is configured and stored with R&S WinIQSIM2. If connected, you can directly transmit the waveform file to a signal generator that plays the file and generates the signal, triggered by the functions "State" button. An instrument loads the entire multi segment waveform into the memory, and thus allows you to alternate between the individual waveforms without delay by loading. Moreover, in most instruments you can define the output order of the segments, and the segment intended to be output at any given moment. See the manual of the used generator to get more information on the processing of waveform files.

3.7.2.2 File concept

To provide flexible configuration, building a composed multi segment waveform file involves different stages; by completing of each of them, R&S WinIQSIM2 creates and stores a dedicated file. The following files are used:

- **Configuration list:** is a dedicated file with details on how a multi segment waveform is made up from different waveforms, the level and the clock rate settings, and the file name. The file extension is `*.inf_mswv`.
  You can create any number of configurations as a basis for defining further multi segment waveforms.
- **Output file:** is the created output multi segment waveform file. R&S WinIQSIM2 stores it under a user definable name; as with the standard waveforms, the used file extension is `*.wv`. R&S WinIQSIM2 appends additional information to the header of the composed waveform file, e.g. user comments.

3.7.2.3 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.

To be optimally flexible for those tasks, you can define additional marker signals with R&S WinIQSIM2:

- Segment markers
  Since multi segment waveforms act as stand alone waveforms that can also contain marker signals. You can either include this marker signals in the processing of the composed multi segment waveform signal, or exclude.
- Additional segment restart and sequence restart markers
  Additional marker signals can be defined to restart the multi segment sequence or to restart each of the multiple segments. A marker signal over-writes markers that are defined in the individual waveforms. The same happens to markers that are assigned to the same output connector of an instrument.

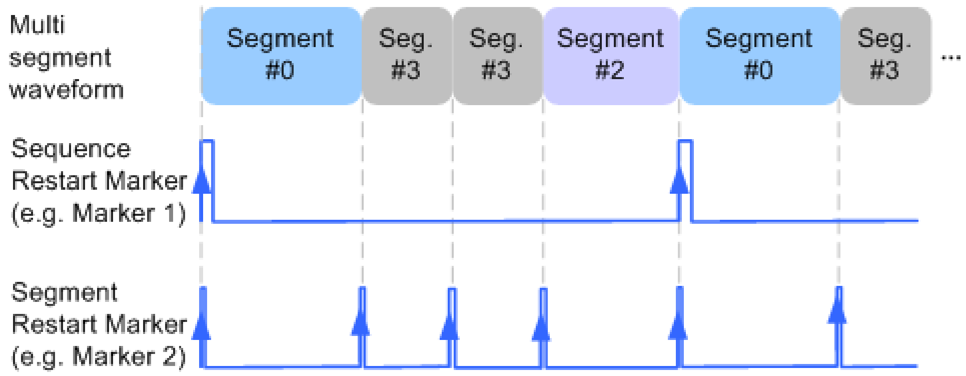


Figure 3-9: Example of marker signals

The segment start is defined by the rising edge of the marker. It applies for switching between two segments and segment replay.

3.7.3 Multi segment settings

► To access the multi segment settings, select "Baseband > Multi Segment".

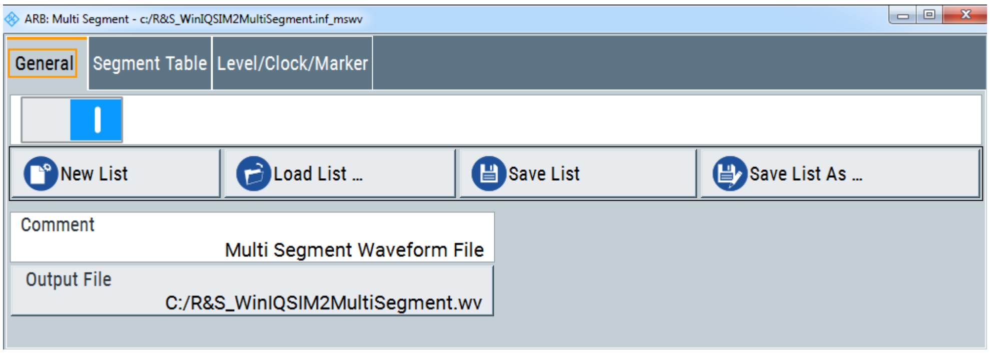
The "ARB: Multi Segment" dialog enables direct assignment of waveforms to the multiple segments, adjusting the clock, level, and marker settings of the composed waveform, and selecting the output file.
For description on the provided settings, refer to Chapter 3.7.3.1, "Settings for the handling of multi segment and output files", on page 127, Chapter 3.7.3.2, "Segment table settings", on page 129 and Chapter 3.7.3.3, "Level / clock / marker settings", on page 131.

The remote commands required to define these settings are described in Chapter 11.8, "SOURce:BB:ARB:WSEG subsystem", on page 328.

3.7.3.1 Settings for the handling of multi segment and output files

To access the general settings:

1. Select "Baseband > Multi Segment".



The "General" tab comprises standard functions for file handling, like selecting and loading of files, determining the output file name.
The provided settings depend on the current waveform. The "Sequencing List" function, for instance, requires that the current "Sequence Table" contains more than one segment.

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 define the file name for the multi segment waveform file.

Settings:

State

Activates multi segment waveform generation.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:STATe on page 337

New List

Accesses the standard "Create Multi Segment Waveform List" function to enter the name of the new file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 334

Load List

Accesses the standard "File Select" function to select the configuration file to be edited.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?` on page 329
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect` on page 334

Save List/Save List As...
Saves the current entries of the Segment table settings in a configuration list (file), including the level mode, clock mode, segment marker mode and output file name settings.

See also Chapter 3.7.2.2, "File concept", on page 126.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe` on page 333

Comment
Adds a comment to the composed multi segment file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent` on page 330

Output file
Accesses the standard "File Select" dialog function and requests a file name.

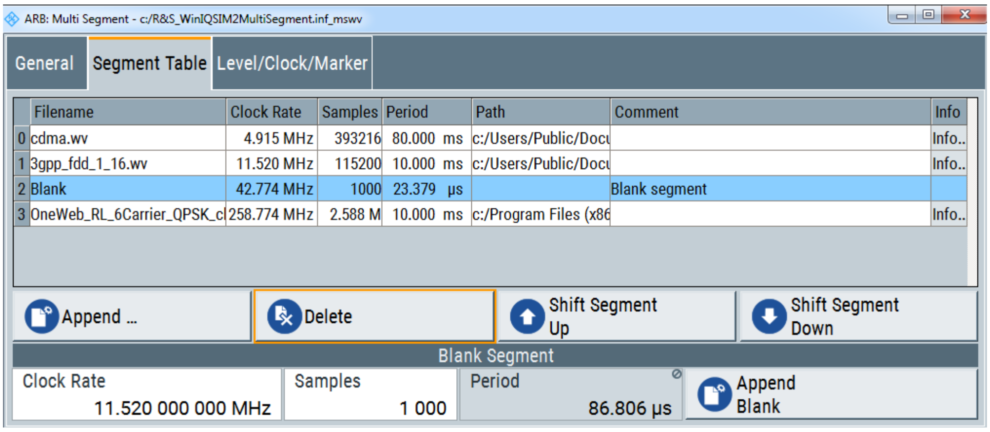
The output file name is required for the internal storage of the multi segment waveform, triggered by the "Save List" function.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe` on page 333

3.7.3.2 Segment table settings

1. To access the multi segment table settings, select "Baseband > Multi Segment".
2. In the "ARB: Multi Segment > General" tab, select an existing list.
3. Select "Segment Table".
4. Select "Append" to add *existing* waveform segments.
5. Select "Append Blank" to add a blank segment.

6. Configure the "Blank Segment Settings" as required.



This section contains the parameters required to create and configure settings of the multi segment waveform file.

Multi Segment Table, Append/Delete/Shift Seg.

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.

Table 3-13: GUI elements in the multi segment table

Function	Description
"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 for output in the mode "Next Segment" or "Next Segment Seamless".
"Waveform"	Indication of the waveform file name of the segment.
"Clock Rate"	Indication of the clock rate of the selected waveform.
"Samples"	Indication of the number of samples in the segment.
"Period"	Indication of the segment duration.
"Path"	Indication of the location of the waveform file used for the corresponding segment.
"Comment"	Indication of the possible comment contained in the waveform.
"Info"	Opens a dialog with detailed information about the currently selected waveform.

"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:CATalog?` on page 333
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend` on page 333

"Delete" Removes the selected entry from the table. The waveform file itself is however not deleted.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete` on page 331

"Shift Seg.# Up/Down"
Rearranges the segments, i.e. moves the selected segment up and down.

Blank Segment
Comprises the settings of a blank segment. A blank segment is a zero signal with defined clock rate and number of samples.

"Clock Rate" Selects the clock rate of the blank segment.

"Samples" Selects the number of samples for the blank segment.

"Period" Displays the resulting period for the blank segment.

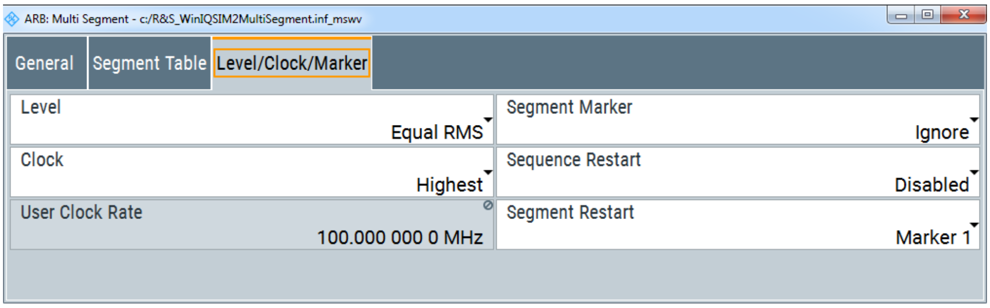
"Append Blank" Adds the blank segment to the multi segment file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend`
on page 329

3.7.3.3 Level / clock / marker settings

1. To access these settings, select "Baseband > Multi Segment".
2. In the "ARB: Multi Segment > General" dialog, select an existing list.
3. Select "Segment Table".
4. Configure the segments.

5. Select "Level/Marker/Clock".



The "Level/Marker/Clock" tab provides the parameters required to adjust the level, marker and clock settings for the selected multi segment waveform file.

Settings:

Level

Determines the signal level mode to be used for generating the multi segment signal.

"Unchanged" When generating the signal, the level meets the values defined in the individual segment files.

"Equal RMS" The signal is generated with the same RMS level value for all segments.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]`
on page 331

Clock

Determines the clock rate mode to be used for generating the multi segment signal.

"Unchanged" Uses the clock rate that is defined in the corresponding waveform file of each segment.

"Highest" Uses the highest available clock rate for all segments.

Note: Trade-off between fast switch over and computing time. This mode provides short switch over times between segments.
However, the computing time increases because the individual segments have to be resampled.

"User" Uses the clock rate defined by the parameter "User Clock" for all segments.
This mode is a trade-off between fast switch over and computing time, too.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE
on page 330

User Clock Rate
Determines a user-specific clock rate for all segments of the multi segment waveform.

This value applies to "Clock Mode > User".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk on page 329

Segment Marker
Determines the marker signal mode to be used for generating the multi segment waveform signal, see also Chapter 3.7.2.3, "Impact of the marker settings", on page 126.

"Ignore" The marker information in the individual segment waveform files is not considered.

"Take Over" Uses the marker information of the individual segment waveform files.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE
on page 332

Sequence Restart
Activates the generation of an additional sequence restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Chapter 3.7.2.3, "Impact of the marker settings", on page 126.

"Disable" No additional marker is generated.

"Marker 1, 2, 3"
Generates a restart marker signal at the beginning of the first segment of the complete multi segment sequence.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment
on page 332

Segment Restart
Activates the generation of an additional segment restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Chapter 3.7.2.3, "Impact of the marker settings", on page 126.

"Disable" No additional marker is generated.

"Marker 1, 2, 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. It applies for switching between two segments and segment replay.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment
on page 331

3.7.4 How to create and work with multi segment waveform files

This section provides step-by-step instructions on how to configure and use the multi segment settings. The basic workflow in Figure 3-10 shows the essential stages of multi segment waveform configuration, together with the corresponding user interface dialogs and if applicable, the corresponding file extensions.

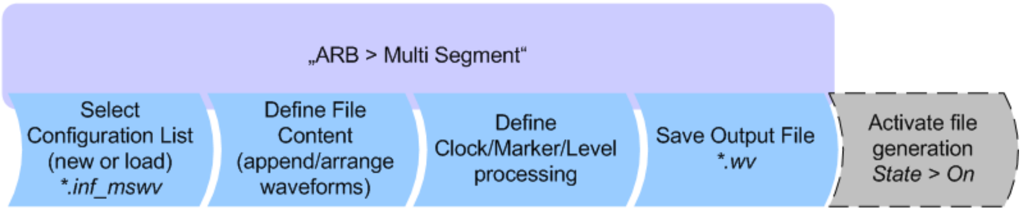


Figure 3-10: Basic workflow for generation of multi segment waveforms

To generate a multi segment waveform file (basic workflow)

1. Select "Baseband > Multisegment".
2. In the "General" tab, select "New List" to create an empty list.
3. Use the "ARB: Multi Segment > Segment Table > Append" function to add two or more waveform files.
4. In the "Level/Clock/Marker" tab, adjust the "Level", "Clock" and "Segment Marker" settings.
5. In the "General" tab, select "Output File".
6. Enter a file name.
7. Confirm with "Save".
8. Select "Save List" to store the configuration in the file.
9. Select "State > On".

To add additional marker signals

To add marker signals at the beginning of each segment and at the beginning of the sequence, additional marker signals are enabled and inserted into the multi segment waveform.

1. In the "Multi Segment > Level/Clock/Marker" dialog, select "Segment Marker = Ignore"
2. Enable "Level/Clock/Marker > Sequence Restart = Marker 1"

3. Enable "Level/Clock/Marker > Segment Restart = Marker 2"

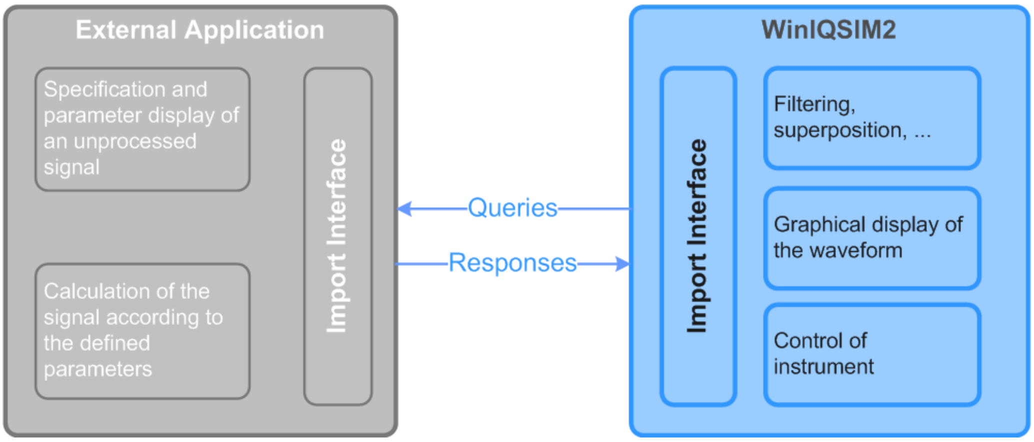
   An additional restart marker signal is generated at the beginning of each segment and the beginning of the waveform. These restart markers *overwrite* the existing Marker 1 and Marker 2 trace signals defined in the waveforms of the individual segments.

3.8 Import IQ data

The import function allows you to load externally created I/Q samples via a server connection into R&S WinIQSIM2.

Created on a user-specific system, you can transfer unprocessed external signals directly to R&S WinIQSIM2. Once imported, R&S WinIQSIM2 provides all processing stages like filtering, graphics display or adding noise, and even directly transmitting the waveform signal to a connected instrument.

R&S WinIQSIM2 and the user-specific application communicate over LAN and the TCP/IP network protocol, provided the TCP/IP driver is installed on the corresponding computers. Using this link, programs can always communicate even if they run on different PCs and different operating systems. For information on the LAN interface and the structure of the associated IP address, see Chapter 10.1.1, "LAN interface", on page 233.



The external application acts as a server for the data. In the following description, it is referred to as *import server*. For communication R&S WinIQSIM2 sends queries to the server, and receives the corresponding replies.

The applications exchange the following information:

- Server identity
- Parameter status
- Sequence length
- Waveform

3.8.1 About the import interface

This section explains the programming of the import interface using the example of the development environment *National Instruments LabWindows CVI xxxx Full Development System*. In principle, other development environments use similar TCP/IP commands, therefore see the manuals of the respective development systems for details.

Network communication using TCP/IP consists of a server and one or more several clients. The server provides the data and transfers it on request or spontaneously to the client. The client receives the incoming data.

Thus, when importing waveform files, R&S WinIQSIM2 acts as client and the external application as server. Client and server exchange the user data in ASCII format, and the messages as binary blocks.

3.8.1.1 Server name, port number and items

To build a link to the server, the client must know the name of the server (e.g. 12.34.56.78). In addition, both participants need access to a common channel, the TCP/IP port.

The default port address is 1000, but you can select any other value.

Note that certain ports are pre-allocated, such as 80 for browsers. Assign therefore only a freely available port address.

Table 3-14: TCP/IP items from client to server

Item	Meaning
`GetServerID`	ID query
`GetNewState`	Query if new data are available
`GetSequenceLength`	Query of sequence length
`GetSymbolRate`	Query of symbol/reference point rate in Hz
`GetSymbol`	Query of the symbols/reference points

3.8.1.2 Format of query commands of the import client

Query commands are sent with `ClientTCPWrite (gHandle, request, strlen(request), 1000)`; the last parameter timeout is given in ms.

3.8.1.3 Format of reply commands (Messages) of the import server

Replies are sent with `ServerTCPWrite ()`.

R&S WinIQSIM2 must receive the reply within 10 seconds, otherwise the timeout takes effect.

The calculation and the transmission of the signal typically require a certain time. Therefore, it is important that the calculation is performed in advance, and not triggered by renewed requests. R&S WinIQSIM2 queries regularly for data with the command `GetSymbols`, and the server provides the calculated signal from a buffer.

To distinguish between replies to different queries, a header is placed in front of the data section of the reply:

```
typedef enum { SYMBOLRATE, SEQUENCE_LENGTH, SYMBOLS, NEWSTATE, SERVER_ID }
SERVER_MESSAGE_HEADER_TYPE;
typedef struct
{
SERVER_MESSAGE_HEADER_TYPE type;
float data;
}
SERVER_MESSAGE_TYPE;
SERVER_MESSAGE_TYPE Reply;
Reply.type = SEQUENCE_LENGTH;
Reply.data = (float)SequenceLength;
ServerTCPWrite (gHandle, (void *)&Reply, sizeof(Reply), 1000);
```

`SERVER_ID`, `NEWSTATE` and `SYMBOLRATE` are handled the same way as the sequence length.

The format above cannot be used if the symbol value is to be sent to R&S WinIQSIM2 because the message is longer than the size of element data in structure `SERVER_MESSAGE_TYPE`.

A free memory block must be filled then with data as follows:

```
Pos 1 : SYMBOLS (enum, = 2)
Pos 2 : I(0)
Pos 3 : Q(0)
Pos 4 : I(1)
Pos 5 : Q(1)
....
Pos 2*N : I(-1)
Pos 2*N+1 : Q(-1)
```

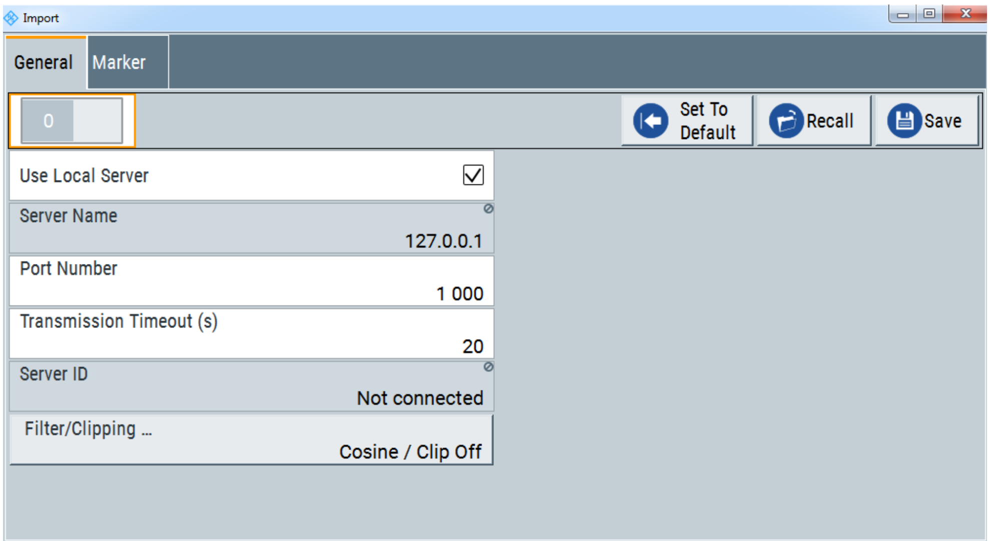
A pointer on this block is then transferred to the function `ServerTCPWrite()`.

Alternatively to transmitting the waveform in one block, the samples can be divided into several blocks. In the latter case, only the first block is sent with a header, the following blocks are without header.

3.8.2 Import settings

Access:

► Select "Baseband > Import...".



The "Import" dialog contains the parameters for configuring the TCP/IP connection to the server, and provides access to the filter, clipping and marker settings.

The remote commands required to define these settings are described in Chapter 11.10, "SOURce:BB:IMPort subsystem", on page 366.

State

Activates the import of IQ data.

Remote command:
`[:SOURce<hw>]:BB:IMPort:STATe` on page 370

Set to Default

Sets all relevant parameters to default, see Table 3-15

Remote command:
`[:SOURce<hw>]:BB:IMPort:PRESet` on page 366

Save/Recall
Accesses the "Save/Recall" dialog, i.e. the standard function for storing and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory are user-definable; the file extension is however predefined (`*.import`).

See also Chapter 8, "File and data management", on page 205.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SETTing:CATalog?` on page 368
`[:SOURce<hw>]:BB:IMPort:SETTing:LOAD` on page 369
`[:SOURce<hw>]:BB:IMPort:SETTing:STORe` on page 369
`[:SOURce<hw>]:BB:IMPort:SETTing:DELete` on page 368

Use Local Server
Determines the computer on which R&S WinIQSIM2 is running as the server from which the IQ data streams are downloaded. If activated, the field for entering a remote host is filled with the entry "127.0.0.1" automatically and is read-only.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SERVer:LOCal[:STATe]` on page 367

Server Name
Sets the name (IP address) of the connected server.

This parameter is editable when "Use Local Server" is unchecked. Otherwise, "127.0.0.1" is used.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SERVer:NAME` on page 367

Port Number
Defines the port number for the server connection.

See also Chapter 3.8.1.1, "Server name, port number and items", on page 136.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SERVer:PORT` on page 367

Transmission Timeout (s)
Sets the wait time for aborting the data transfer in a server timeout.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SERVer:TTOut` on page 368

Server ID
Indicates the connected import server.

If no import server is connected, "not connected" is displayed.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SERVer:ID?` on page 367

Filter/Clipping
Accesses the dialog for configuring the baseband filter and clipping, see Chapter 3.8.3, "Filter / clipping settings", on page 140.

The current filter and the clipping state are displayed next to the button.

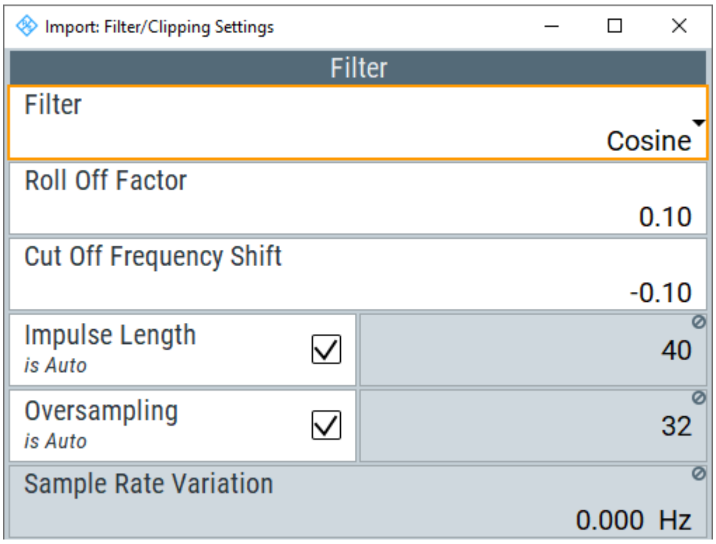
3.8.3 Filter / clipping settings

Access:

► Select "Import > Filter/Clipping".

The dialog comprises the settings, necessary to configure the baseband filter, sample rate variation and clipping.

3.8.3.1 Filter settings



The "Filter" section in the dialog contains the parameters necessary for configuring the baseband filter.

The remote commands required to define these settings are described in Chapter 11.10, "SOURce:BB:IMPort subsystem", on page 366.

Settings

Filter
Selects the baseband filter.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:TYPE` on page 373

Roll Off Factor or BxT
Sets the rolloff factor or bandwidth time product ("B*T") for the filter type that supports this parameter.

For supporting predefined filters, this parameter can have a different default value for each of the predefined filters.

For more information, see "Impact of the filter parameters" on page 59.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:COSine` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:RCOSine` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:PGAuss` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:GAUSs` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:SPHase` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:APCO25` on page 373

Cut Off Frequency Shift
Sets the value for the cut-off frequency shift.

The cut-off frequency of the filter can be adjusted to meet spectrum mask requirements. This parameter applies to "Cosine" and "EUTRA/LTE" filters.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:COSine:COFS` on page 373

Cut Off Frequency Factor
Sets the value for the cutoff frequency factor. The cutoff frequency of the filter can be adjusted to reach spectrum mask requirements.

This parameter applies to "Lowpass" and "EUTRA/LTE" filters.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:LPASs` on page 373
`[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:LPASSEVM` on page 373

Sample Rate Variation
Displays the sample rate of the imported signal.

If you change the sampling rate in the external application, R&S WinIQSIM2 updates the parameter immediately, even if you have not recalculated the signal.

A variation of this parameter only affects the ARB clock rate; all other signal parameters remain unchanged.

Remote command:
`[:SOURce<hw>]:BB:IMPort:SRATe:VARiation?` on page 369

Impulse Length
Displays the number of filter tabs.

If enabled, the most sensible parameter values are selected. The value depends on the coherence check.

Disable it to set the values manually.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:ILENgth:AUTO` on page 372
`[:SOURce<hw>]:BB:IMPort:FILTer:ILENgth` on page 372

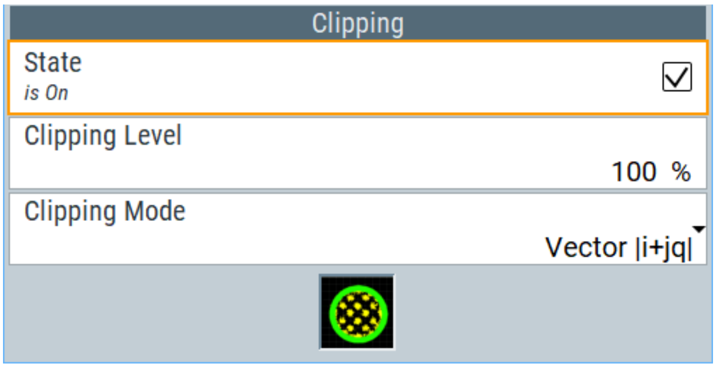
Oversampling
Sets the upsampling factor.

If enabled, the most sensible parameter values are selected. The value depends on the coherence check.

Disable it to change the value manually.

Remote command:
`[:SOURce<hw>]:BB:IMPort:FILTer:OSAMpling:AUTO` on page 372
`[:SOURce<hw>]:BB:IMPort:FILTer:OSAMpling` on page 372

3.8.3.2 Clipping settings



The "Clipping" section in the dialog contains the parameters necessary for configuring clipping.

The remote commands required to define these settings are described in Chapter 11.10, "SOURce:BB:IMPort subsystem", on page 366.

Settings:

Clipping State
Switches baseband clipping on and off.

Baseband clipping is a simple and effective way of reducing the crest factor of the signal. Since clipping is done before to filtering, the procedure does not influence the spectrum. The EVM however increases.

Remote command:
[:SOURce<hw>]:BB:IMPort:CLIPping:STATe on page 371

Clipping Level
Sets the limit for clipping.

This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

Remote command:
[:SOURce<hw>]:BB:IMPort:CLIPping:LEVel on page 370

Clipping Mode
Selects the clipping method. The dialog displays a graphical illustration on how this two methods work.

- "Vector | i + jq |"
  The limit is related to the amplitude | i + q |. The I and Q components are mapped together, the angle is retained.
- "Scalar | i | , | q |"
  The limit is related to the absolute maximum of all the I and Q values | i | + | q |. The I and Q components are mapped separately, the angle changes.

Remote command:
[:SOURce<hw>]:BB:IMPort:CLIPping:MODE on page 371

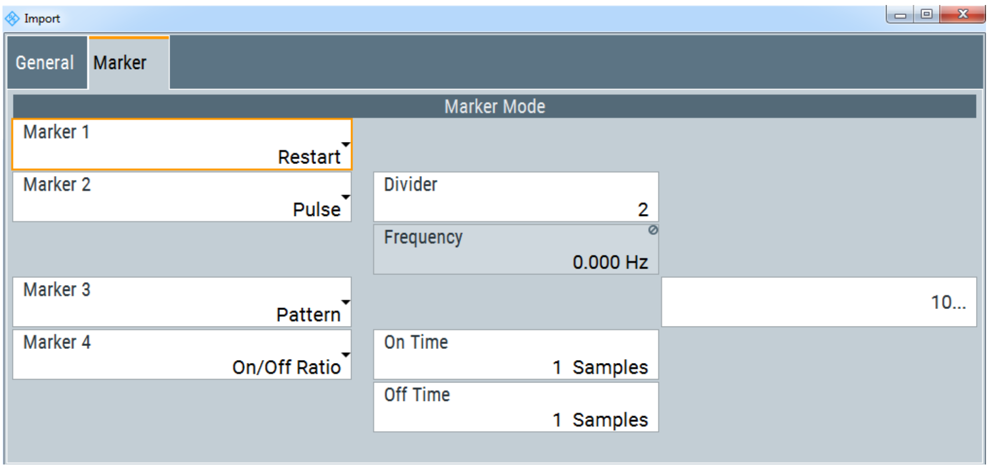
3.8.4 Marker settings

This dialog provides access to the settings necessary to select and configure a marker output signal, like the marker mode.

For information on how these settings affect the signal, refer to Chapter 3.3.1.2, "Marker signals", on page 55.

Access:

► Select "Import > Marker...".



The dialog contains the parameters required for configuring marker output signals. The remote commands required to define these settings are described in Chapter 11.10, "SOURce:BB:IMPort subsystem", on page 366.

Settings:

Marker 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 four. The marker configuration changes with the selected marker mode.

All regular marker signals are described in "Marker modes" on page 56.

Remote command:
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:MODE` on page 374
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 375
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 376
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PATTern` on page 375
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:OFFTime` on page 375
`[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:ONTime` on page 375

3.8.5 How to import an external unprocessed signal

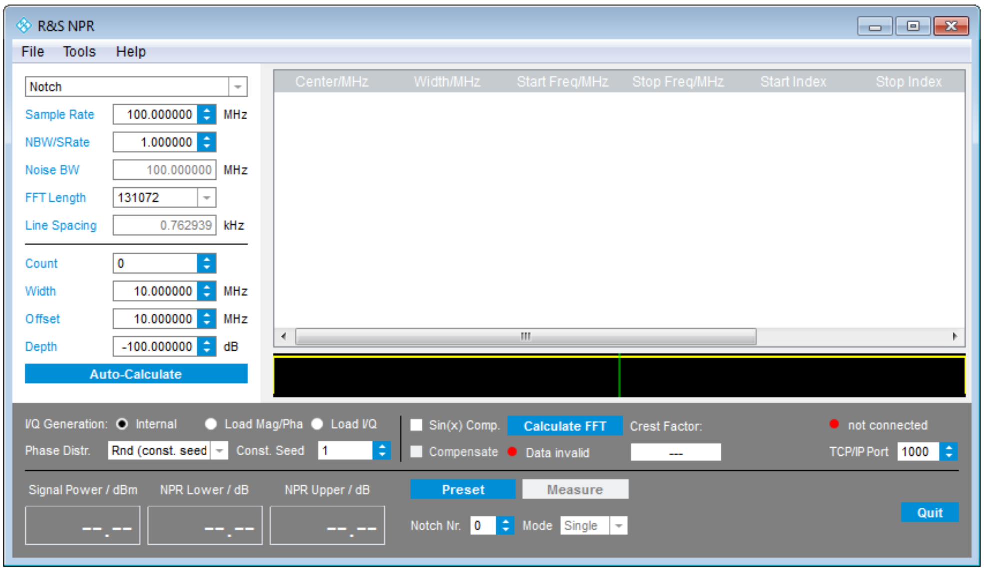
This section gives an example on how to import an externally generated signal to R&S WinIQSIM2. Using *R&S NPR Noise Power Ratio Signal Generation and Measurement*, an add-on tool for R&S WinIQSIM2 to generate noise power ratio signals, we create a stimulus signal for import to R&S WinIQSIM2. In the example, both applications are started on the same computer.

To install the R&S NPR application, refer to the application note 1MA29: NPR - Noise Power Ratio Signal Generation and Measurement, available on the Internet.

To establish the client to server connection

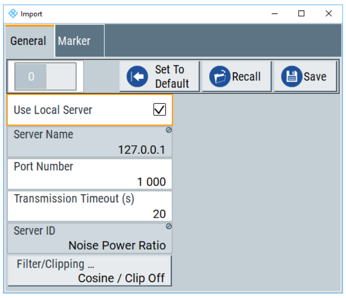
It is assumed that you have installed both, R&S WinIQSIM2 and the R&S NPR application on your computer.

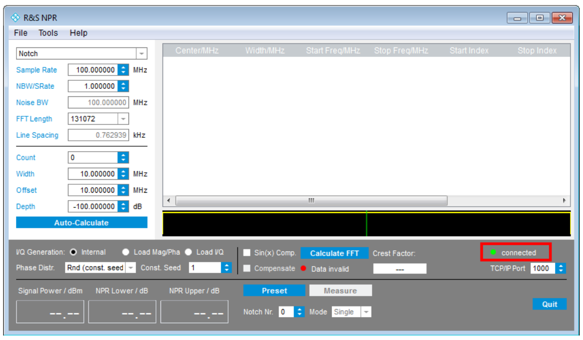
1. Start R&S WinIQSIM2.
2. To start R&S NPR, select "Windows > All Programs > R&S Noise Power Ratio".



3. In R&S WinIQSIM2, select "File > New" to start from an initial state.
4. Select "Baseband > Import".
5. Check "Use Local Server".

   R&S WinIQSIM2 assigns the address of the local host automatically and displays it under "Server Name".
   The connection to the server is established immediately and R&S WinIQSIM2 displays the designation of R&S NPR under "Server ID".
   In R&S NPR, the "Connected" LED also indicates that the connection between the two applications is established.



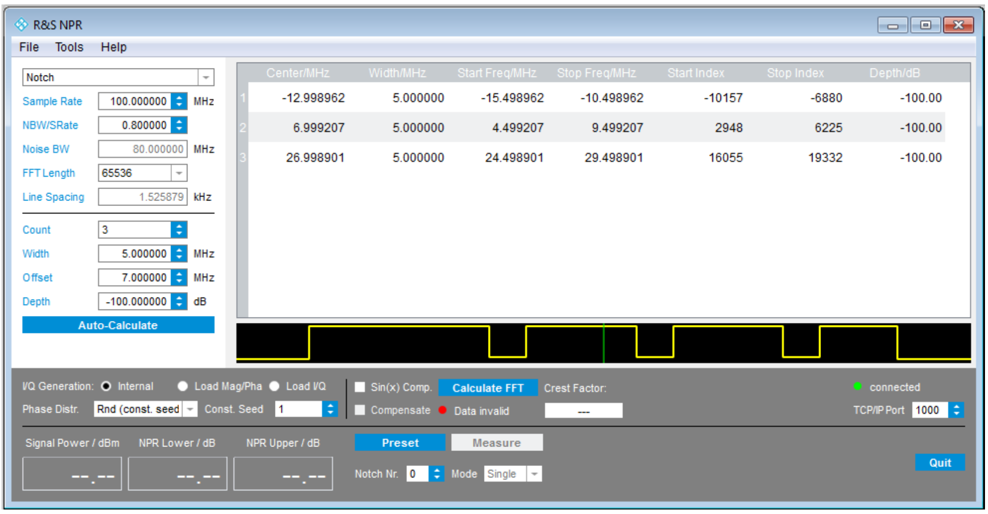


To configure a custom signal in NPR

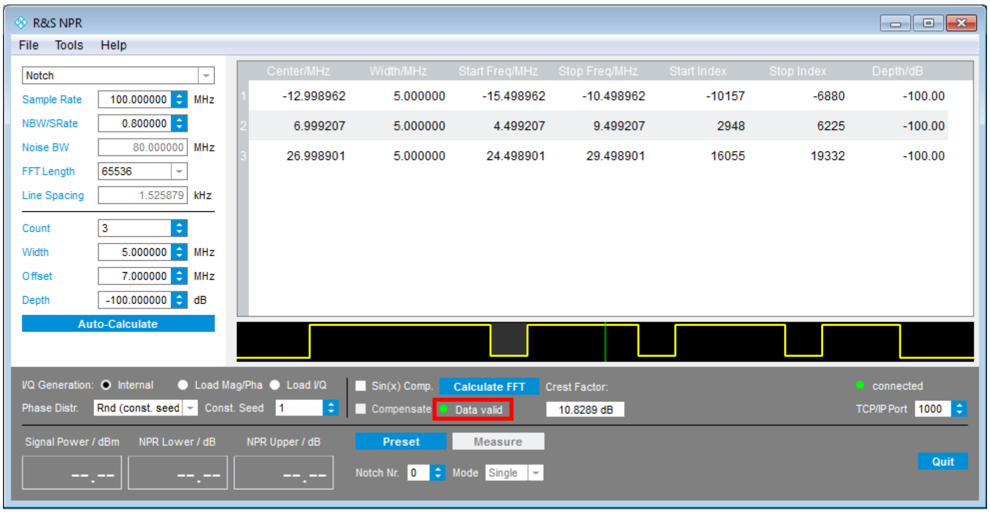
The R&S NPR application provides all parameters required for configuring a noise ratio stimulus signal.

1. Configure the signal, e.g. ...
   a) Set "Sample rate = 100 MHz", and "NBW/SRate = 0.8".
   b) Select "FFT Length = 65536".
   c) Set "Notch Count =3", "Notch width = 5 MHz", "Notch Offset = 7 MHz" and "Notch Depth = -100 dB".

2. Select "AutoCalc Notches" to update the signal parameters, displayed in the upper panel on the right.



3. Select "Calculate FFT" to prepare the IQ data for transmission to R&S WinIQSIM2.

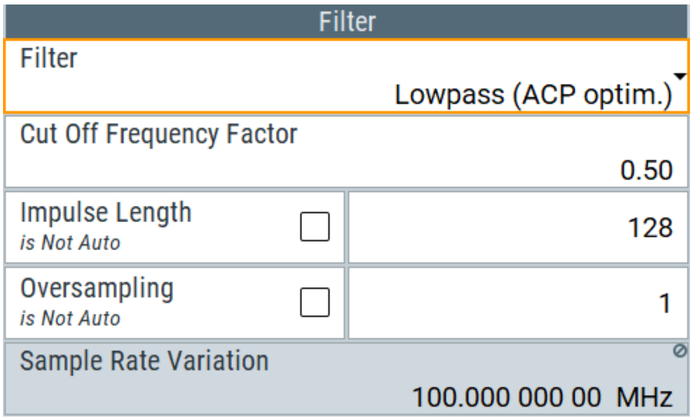


The "Data Valid" LED indicates that the data is ready for transfer.

To process the signal in R&S WinIQSIM2 and validate it graphically

1. In the "Import" dialog of R&S WinIQSIM2, select "Filter/Clipping", to configure the filter, e.g. a lowpass:
   a) In the "Filter" tab, select "Filter > Lowpass (ACP optim.)".
   b) Uncheck "Impulse Length > Auto".
   c) Enter "Impulse Length = 128".
   d) Uncheck "Oversampling > Auto".
   e) Enter "Oversampling = 1".

   The settings are applied.



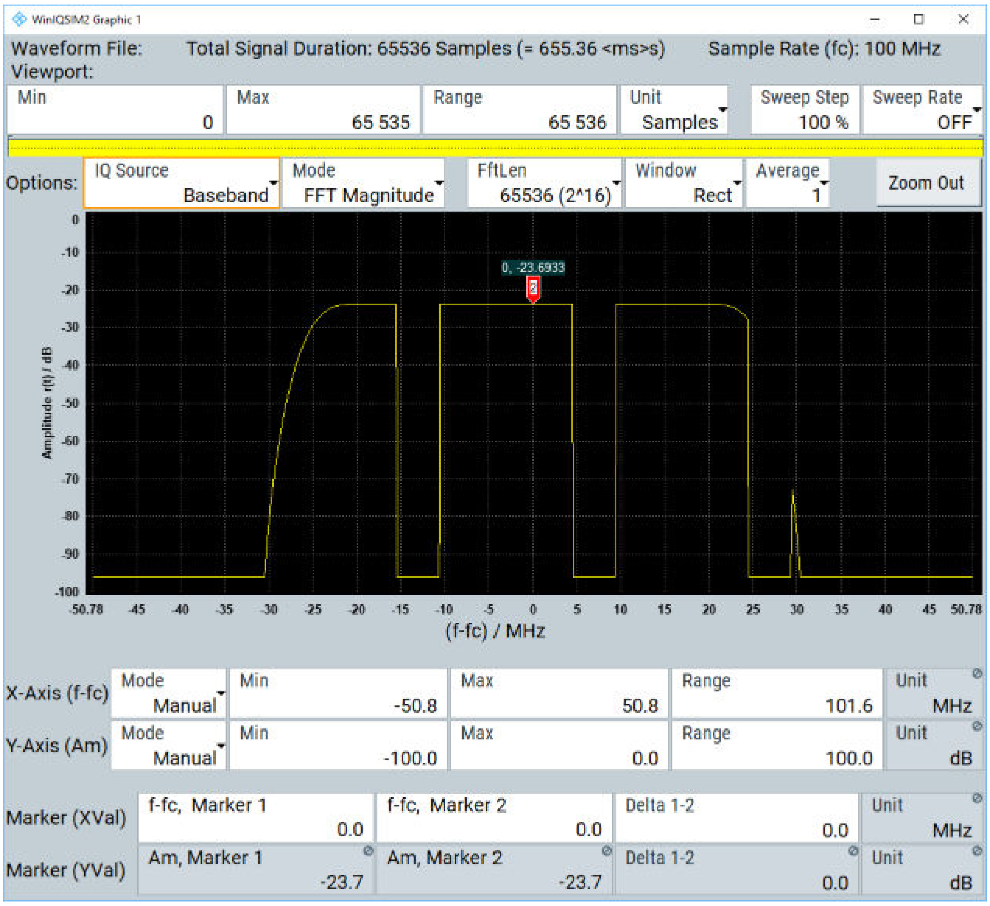
2. Close the dialog.
3. In the "Import" dialog of R&S WinIQSIM2, select "State > On" to enable data transfer.

   The IQ signal data is transmitted immediately.

To verify the signal in R&S WinIQSIM2 graphically

1. In R&S WinIQSIM2 application window, select "Graphics > Graphic 1 > Graphic1 (Complete)".
2. Configure the graphical display:
   a) Select "IQ Source > Baseband".
   b) Set "Mode > FFT Magnitude", FFT window function "Win > Rect", and FFT average mode "Avg. > 1".

c) Select segment length "Len > 65536 (2^16)".



The graph displays the power spectrum of the imported I/Q signal calculated by FFT (Fast Fourier Transform).

Now you can further process the waveform, like e.g.:

- Verify the signal directly in the graph using markers and the zoom function, see "To use markers to analyze the signal" on page 28, or Chapter 5.2.3, "Scaling and marker", on page 174.
- Superimpose the signal with additional noise, see Chapter 2.3.4, "Adding noise to the waveform signal", on page 24, or Chapter 4.1, "About the AWGN generator", on page 150.
- Store the resulting waveform in a file, see Chapter 2.3.7, "Transmitting the waveform to a file", on page 33, or Chapter 8.7, "Transferring a file to an instrument", on page 220.
- Directly transmit the waveform to an ARB instrument and activate signal generation, see Chapter 2.3.6, "Transmitting the waveform to the R&S SMW", on page 32, and Chapter 7, "Transferring data", on page 200.

3.8.6 References

Table 3-15: Import default settings

Parameter	Value
Use Local Server	On
Server Name	localhost
Port Number	1000
Transmission Timeout (s)	20
Filter	Cosine
Roll off factor (cosine filter)	0.10
Impulse Length	Auto
Oversampling	Auto
Clipping State	On

4 Adding noise to the signal

This section introduces the concept of the AWGN generator (Additive White Gaussian Noise). It describes the settings for generation of noise, sine wave interferer and adding noise to the generated signal.

4.1 About the AWGN generator

R&S WinIQSIM2 allows you to superimpose the generated signal with noise. The 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.

Multi carrier and multi segment signals cannot be superimposed with a noise signal.

This noise signal superimposes the (interference-free) useful signal ("Additive Noise" mode).

Typical applications for signals superimposed with noise, are bit or block error measurements, depending on the set S / N or C / N ratio, or measurements of mobile base stations.

Generation of the AWGN signal

The generated Gaussian noise achieves ideal statistical characteristics:

- I and Q paths are decorrelated from each other.
- Small probabilities are achieved due to the crest factor of 18 dB.
- The period of the noise signal depends on the selected system bandwidth.

AWGN modes

The AWGN generator generates signals in one of the following different modes:

- **"Additive Noise":** the generated noise signal superimposes the interference-free useful signal
  An additive white noise is required for measurements of mobile radio base stations.
- **"Noise Only":** a pure noise signal is generated and modulated on the carrier; the connection to the baseband is interrupted.

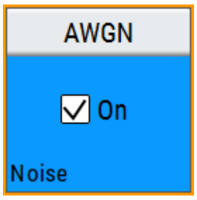


Figure 4-1: Representation of an "AWGN > Mode > Noise Only" in the block diagram

- **"CW Interferer mode":** a sinusoidal signal with an adjustable frequency offset and carrier-to-interferer (C/I) power ratio is added to the baseband signal by a counter instead of a shift register.

Signal and noise parameters

The Figure 4-2 illustrates the relation between the signal and noise parameters.

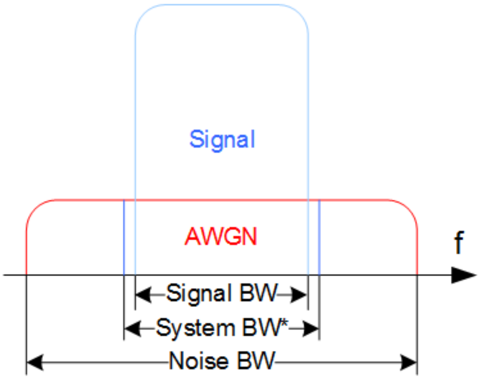


Figure 4-2: Graphical representation of the relation between system bandwidth and noise bandwidth (minimum Noise/System BW = 2)

System BW* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and can therefore be a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but by the target's signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*.

To achieve flat noise within the selected system bandwidth, the **noise bandwidth** must 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"

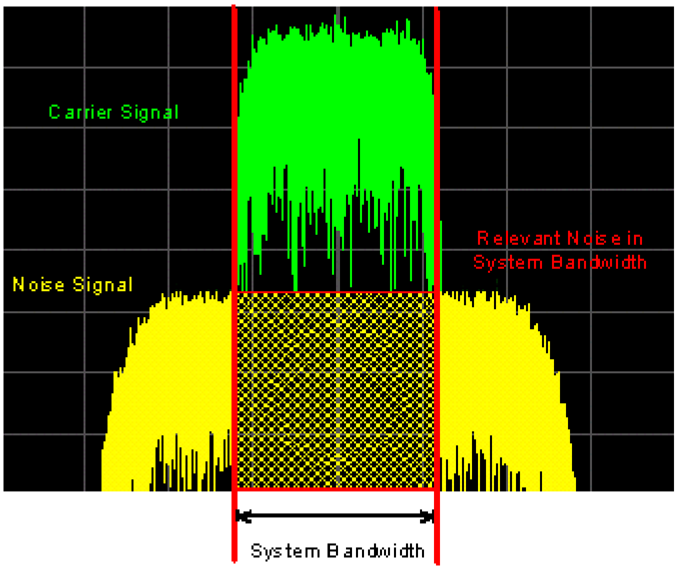
The achievable noise bandwidth must not exceed the sampling rate of the baseband.

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.

Measured noise power can exceed the displayed value

Noise also occurs outside the set system bandwidth. The total measurable noise power (see figure below) usually exceeds the displayed value of the "Noise Power".

For 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**.

The noise power of a digitally modulated signal is characterized by the parameter **E_b/N_0** indicating the ratio of bit energy to noise power density. The correlation to the SNR is as follows:

C/N or S/N = $(E_b/N_0)*(f_{bit}/B_{sys})$, where B_{sys} is the system bandwidth.

Bit Rate f_{bit} = *"Symbol Rate" * Modulation Value*

Where is the bit rate value retrieved from?

The parameter "AWGN > 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 Dig Mod", the bit rate is determined by the selected standard.
  (see parameter "Custom Dig Mod > General" > ""Symbol Rate" on page 65").
- For signals generated in accordance to a digital standard, the bit rate is often a stand-alone 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.

Application fields

Typically, the noise generator is required for the following tests:

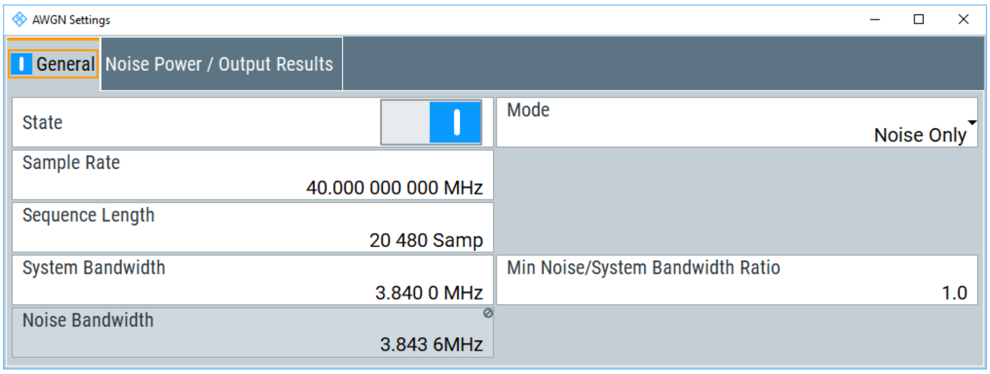
- In receiver sensibility tests with predefined SNR of the receiver, see Chapter 4.3, "How to configure the noise generator for receiver tests", on page 159.
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

4.2 AWGN settings

The "AWGN" block provides settings of the additional white Gaussian noise (AWGN) generator.

Access:

1. Select "Block Diagram > AWGN".



   The dialog contains the parameters for configuration of noise and CW interfering signals.

2. To activate the AWGN generator, perform one of the following:
   a) In the AWGN Settings dialog, set "State > On".
   b) In the block diagram, select "AWGN > On".

The remote commands required to define these settings are described in Chapter 11.6, "SOURce:AWGN subsystem", on page 306.

4.2.1 General settings

Access:

► Select "Block Diagram > AWGN".

Settings:

State

Activates 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 313

Mode

Selects the mode for generating the interfering signal.

"Additive Noise"
: The AWGN noise signal with selectable system bandwidth is added to the baseband signal.

"Noise Only"
: The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted.

"CW Interferer"
: A sine with a defined frequency offset is added to the baseband signal. The calculation of E_b/N_0 ratio is omitted.

Remote command:
`[:SOURce<hw>]:AWGN:MODE` on page 309

Sample Rate

Sets the sample rate of the AWGN signal in "Noise Only" mode.

The sample rate depends on the selected instrument. If you select a different device, the value range of the sampling rate changes accordingly. In addition, the maximum sample rate must not exceed the maximum clock frequency of the instrument.

Remote command:
`[:SOURce<hw>]:AWGN:SRATe` on page 312

Sequence Length

Sets the sequence length of the "Noise Only" signal in samples.

This parameter depends on the selected instrument. The value range changes accordingly, if you select a different instrument.

Remote command:
`[:SOURce<hw>]:AWGN:SLENgth` on page 312

System Bandwidth
Sets the RF bandwidth for the corresponding carrier/noise ratio of "Additive Noise" and "Noise Only" signals.

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 4-2, and "Measured noise power can exceed the displayed value" on page 152.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth` on page 306

Min. Noise/System Bandwidth Ratio
Sets the ratio of minimum noise bandwidth to system bandwidth of "Additive Noise" and "Noise Only" signals. Using this parameter, you can configure the minimum real noise bandwidth, as required by some standards.

R&S WinIQSIM2 automatically adjusts the value range corresponding to the selected instrument. The maximum value of "Min. Noise/System Bandwidth Ratio" is derived from the maximum sample clock of the instrument, according to:

Noise Bandwidth = System BW x Minimum Noise/System BW Ratio

The parameter Noise Bandwidth displays the resulting noise bandwidth. It must not exceed the maximum sampling rate of the instrument.

The calculation of level from the selected C/N or S/N ratio in relation to system bandwidth is not affected.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:RATio` on page 307

Target CW Frequency Offset
Sets the frequency offset of the sine wave for "CW Interferer" signals.

The range is limited to *± (Symbol Rate + Sample rate) /4*.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:TARGet` on page 309

Resulting CW Frequency Offset
Indicates the resulting frequency offset of the sine wave in "CW Interferer" mode.

The resulting "CW Frequency Offset" is the correction of the desired value based on generating an integer multiple of periods out of the output sequence length.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:RESult?` on page 308

Noise Bandwidth
Indicates the real noise bandwidth of the "Additive Noise" and "Noise Only" signals.

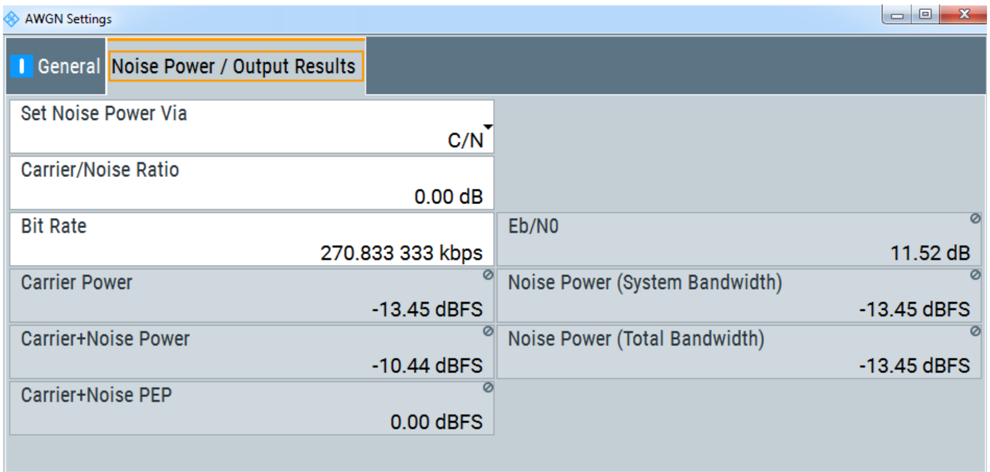
See also Figure 4-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:NOISe?` on page 307

4.2.2 Noise power/output results settings

Access:

► Select "AWGN > Noise Power / Output Results".



The dialog provides setings for noise power configuration. The settings vary according to the selected Mode.

Settings:

Set Noise Power Via

Selects the mode for setting the noise power of an "Additive Noise" signal.

The following correlation applies:

"C/N or S/N"= ("E_b/N_0")(f_{bit}/B_{sys})*, where:

- "C/N or S/N" is the carrier/noise ratio
- "E_b/N_0" is the ratio of bit energy to noise power density
- *"Bit Rate"f_{bit}= "Symbol Rate" x Modulation Value*
- B_{sys} is the system bandwidth.

See also Chapter 4.1, "About the AWGN generator", on page 150.

Remote command:

`[:SOURce<hw>]:AWGN:POWer:MODE` on page 310

Bit Rate
Indicates the bit rate used for converting C/N or S/N to E_b/N_0 in "Additive Noise" mode.

For input, set > C/N, or S/N. In "E_b/N_0" mode, the parameter is only displayed.

Tip: For digitally modulated signals, select the bit rate before or after channel coding, as required.

See also "Signal and noise parameters" on page 151.

Remote command:
`[:SOURce<hw>]:AWGN:BRATe` on page 306

Carrier/Noise Ratio, Carrier/Interferer Ratio
Sets the ratio of the carrier signal to the respective AWGN signal:
- "Carrier/Noise Ratio" in "Additive Noise" mode
- "Signal/Noise Ratio" in "CW Interferer" mode

- The power of the noise signal is derived from the entered C/N or S/N value and displayed with the parameter Noise Power (System Bandwidth) / Interferer 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 modified there.
- The power of the output signal is displayed under Carrier + Noise Power, Carrier + Interferer Power.

Remote command:
`[:SOURce<hw>]:AWGN:CNRatio` on page 308

E_b/N_0
Specifies the value for the ratio of bit energy to noise power density in "Additive Noise" mode.

For input, set > Eb/N0. In "C/N, S/N" mode, the parameter is only displayed.

- The power of the noise signal is derived from the selected E_b/N_0 and displayed with the parameter Noise Power (System Bandwidth) / Interferer Power in the units of the useful signal.
- The power of the useful signal is displayed with the parameter Carrier Power"".
- The power of the output signal is displayed under Carrier + Noise Power, Carrier + Interferer Power.

Remote command:
`[:SOURce<hw>]:AWGN:ENRatio` on page 308

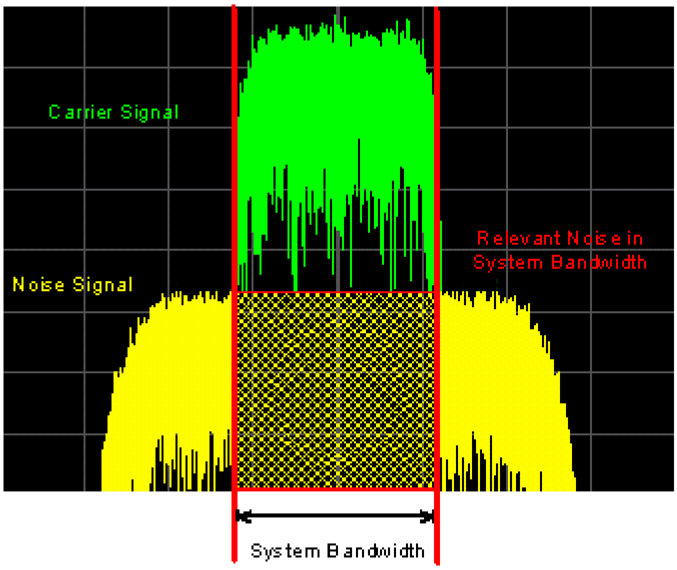
Carrier Power
Displays the power of the useful signal in "Additive Noise" or "CW Interferer" mode.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:CARRier` on page 310

Noise Power (System Bandwidth) / Interferer Power
Displays the power of the noise signal in the system bandwidth.

Note:
Noise also occurs outside the set system bandwidth. The total measurable noise power (see figure below) usually exceeds the displayed value of the "Noise Power".

For correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.



Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe on page 310

Noise Power (Total Bandwidth)
Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? on page 311

Carrier + Noise Power, Carrier + Interferer Power
Displays the power of the noise/interferer signal plus useful signal in "Additive Noise" and "CW Interferer" mode.

Remote command:
[:SOURce<hw>]:AWGN:POWer:SUM? on page 311

Carrier+Noise PEP, Carrier + Interferer PEP
Displays the peak envelope power (PEP) of the signal comprised of noise signal plus useful signal in "Additive Noise" and "CW Interferer" mode.

This parameter is set to 0 dBFS whereas all other display power values show the values relative to the PEP after noise generation.

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 312

4.3 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 R&S WinIQSIM2 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"

Settings in the used signal generator:

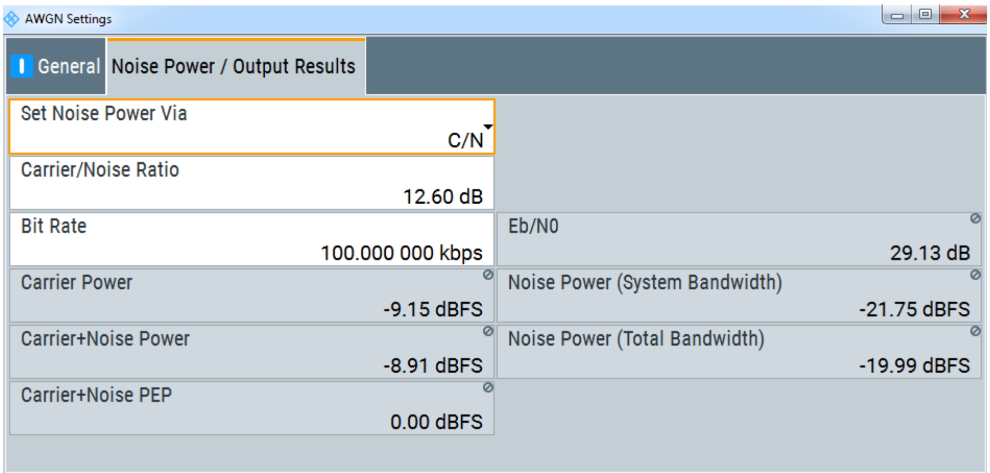
- "Status bar > Frequency = 1.95 GHz" and "Level = -69.9 dBm"
- "RF State > On"

To configure the AWGN for receiver sensibility tests with predefined SNR of the receiver

We assume that an AWGN interfering signal with the following characteristics is required:

Average power = -21.75 dBm/BW and C/N = 12.6 dB.

1. Select "AWGN".
2. Set the following parameters:
   - "Mode > Additive Noise"
   - "System Bandwidth > 4.5 MHz"
     The unit of the interfering 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 4-2.
   - "Min Noise/System Bandwidth Ratio = 1.5"
3. Select "Noise Power/Output Results".
4. Set the following parameters:
   - "Set Noise Power Via > C/N"
   - "Carrier/Noise Ratio > 12.6 dB"



The dialog confirms the required interfering signal's average power: "Noise Power (System Bandwidth) = -21.75 dBm". If you add this value to the level of the generator (-69.9 dBm), the resulting interfering power is 82.5 dBm, as required for testing.

5. Select "AWGN > General > State > On".

   R&S WinIQSIM2 generates the noise signal, and adds it to the baseband signal. Now you can store the waveform, or directly transfer it to a connected instrument, see Chapter 7, "Transferring data", on page 200.

To generate a CW interfering signal

In 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 in the signal generator; the LTE signal at 1.96 GHz and the CW signal 10 MHz below it.

To configure the signal:

1. To enable the required LTE signal, select "EUTRA/LTE > General Uplink Setting > Channel Bandwidth = 5 MHz" and "EUTRA/LTE > State = On".
2. 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".
3. Enable the required interfering signal:
   a) Select "AWGN > General > Mode > CW Interferer".
   b) Select "Target CW Frequency Offset = 10 MHz".
   c) In the "Interferer Power/ Output Results" tab, select "Carrier/Noise Ratio = 12.6 dB".
   d) In the "General" tab, select "State > On".

   R&S WinIQSIM2 generates the noise signal, and adds it to the baseband signal. Now you can store the waveform, or directly transfer it to a connected instrument, see Chapter 7, "Transferring data", on page 200.

5 Displaying simulated waveforms graphically

The built-in graphical signal display function of R&S WinIQSIM2 visualizes a generated signal in various graphical views. Shown graphically, you can quickly check signal characteristics or evaluate the signal in detail.

5.1 About the graphical signal display

R&S WinIQSIM2 displays a signal either as I/Q, amplitude/phase, vector, eye, or constellation diagram, but also the power spectrum of the signal or the statistical evaluation of the signal power, see Diagram modes. General display functions, like zooming or the use of markers, assist you in the in-depth evaluation of certain measuring points, see Display functions.

5.1.1 Diagram modes

This section focuses on graphical signal displays, their content and application. See Table 5-1 for an overview of the signal characteristics you can monitor.

Table 5-1: Graphics modes overview

Graphics modes	Domain	Measurement is known from this instrument
i(t)/q(t) diagram	Time	Oscilloscope (standard mode)
r(t)/φ(t) 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

5.1.1.1 i(t)/q(t) diagram

The diagram displays the in-phase component "i(t)" and quadrature component "q(t)" of the signal over time.

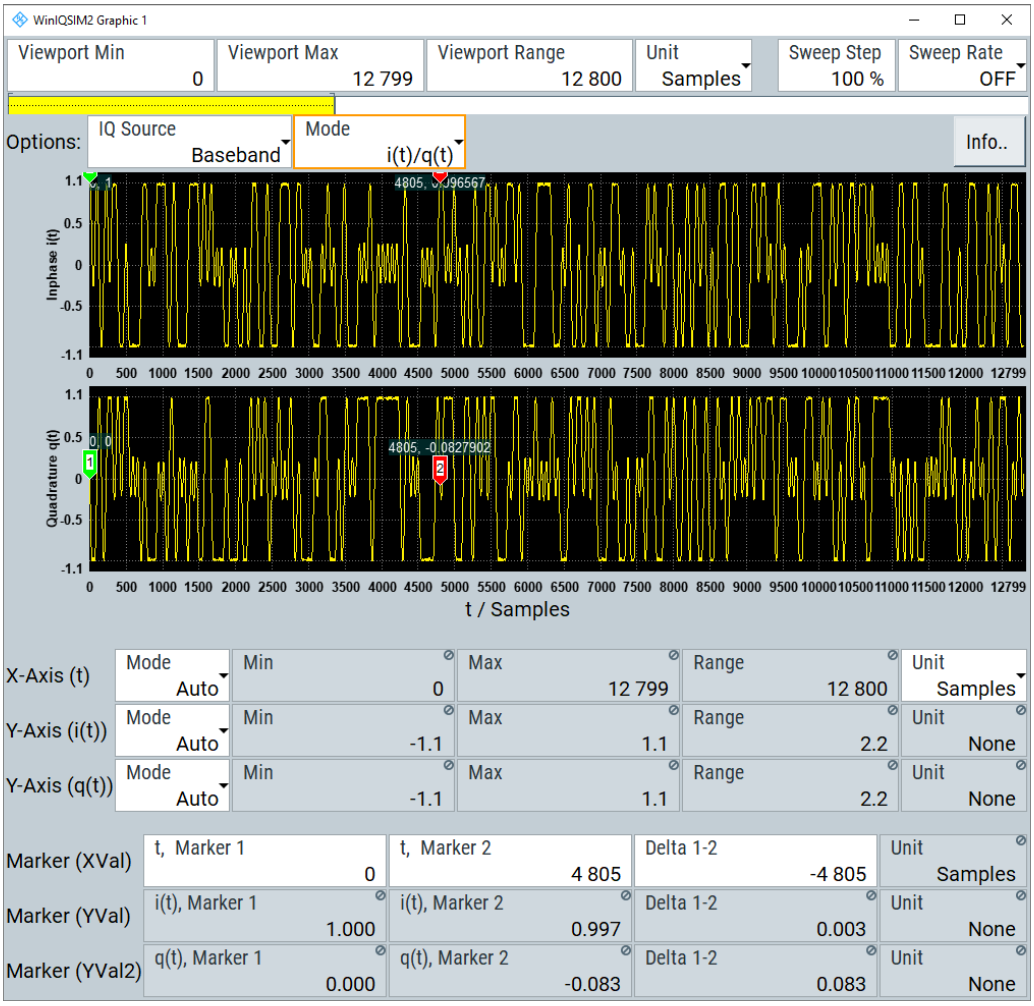


Figure 5-1: I/Q diagram of a GSM/EDGE signal with markers

In-phase (t), quadrature q[t])	= graphical signal display in two separate coordinate systems with identical X and Y axes
X-axis	= time represented as number of symbols, chips or samples depending on the signal
Y-axes	= amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To analyze time slot signals, for example, with added noise from the AWGN in the time domain. This mode shows the signal like an oscilloscope.

5.1.1.2 r(t)/ϕ(t) diagram

The diagram displays the amplitude "r(t)" and phase "ϕ(t)" of the waveform over time.

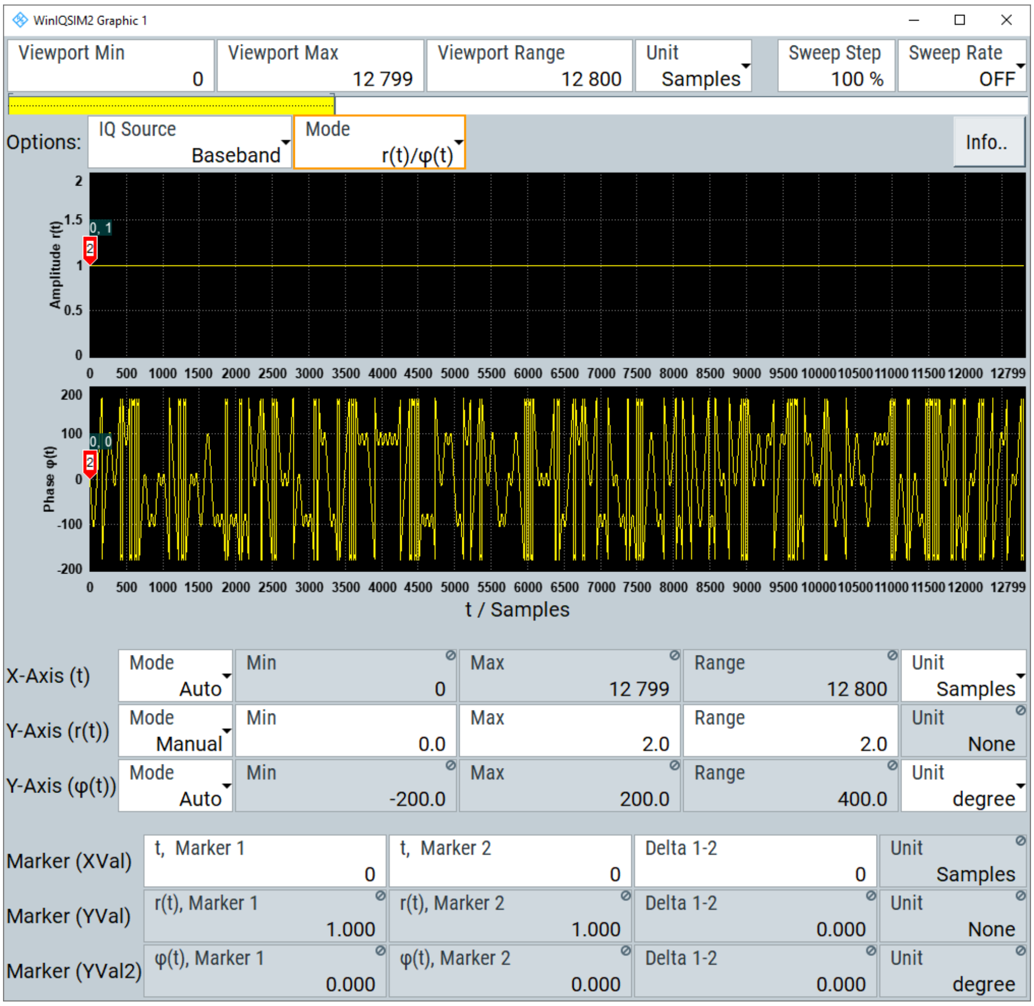


Figure 5-2: r(t)/ϕ(t) diagram with markers

"Amplitude r(t)", "Phase ϕ(t)"	= graphical signal display in two separate coordinate systems with identical X axes and varying Y axes
X-Axis (t)	= time represented as number of symbols, chips or samples depending on the signal
Amplitude r(t)	= absolute amplitude value, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1
Phase ϕ(t)	= phase, scaled in rad or degree; where minimum scaled phase = -180 °, maximum scaled amplitude = +180 °

Application: To analyze the amplitude or phase modulated signals in the time domain.

5.1.1.3 Vector diagram

The vector diagram displays the Q component over the I component. All points in the complex domain are connected by lines.

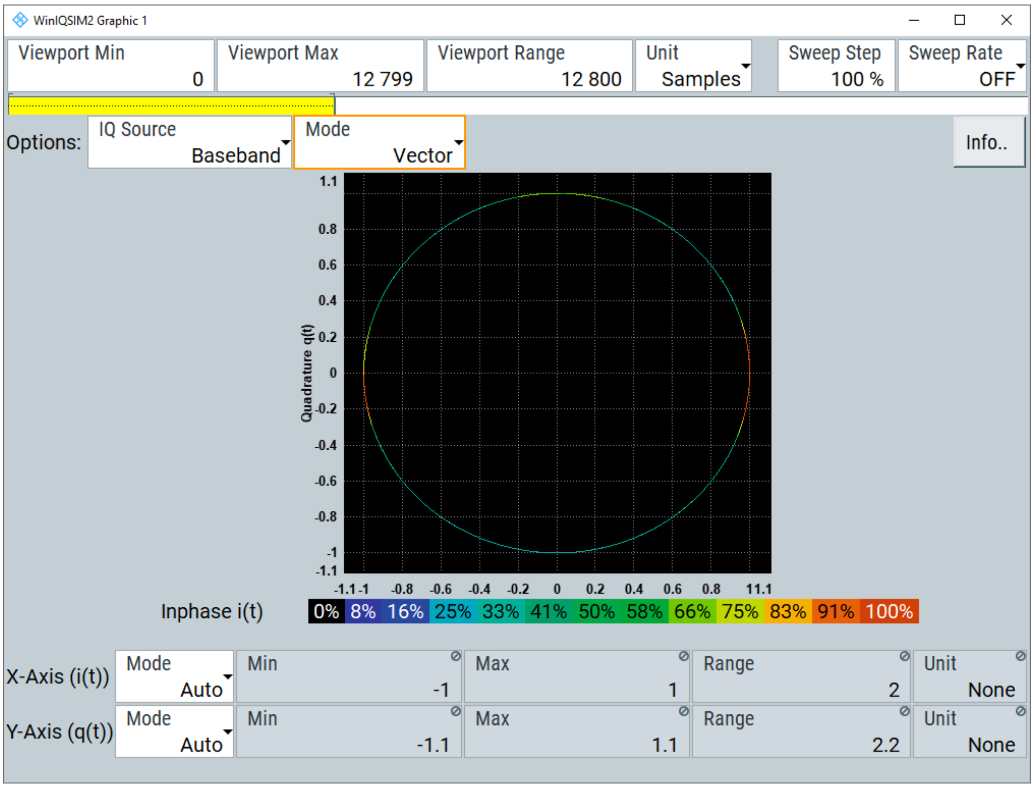


Figure 5-3: Vector diagram

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).

5.1.1.4 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.

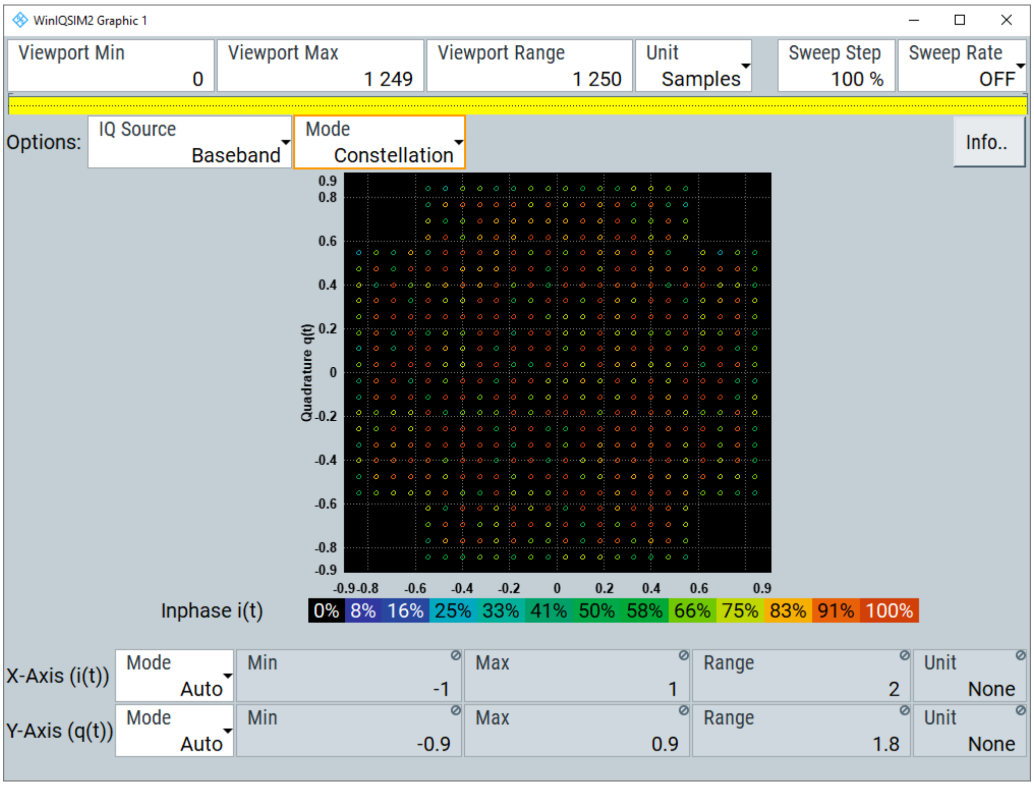


Figure 5-4: Constellation diagram of a user standard 512QAM signal

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.

5.1.1.5 Power spectrum

The power spectrum displays the signal spectrum which is calculated from the I/Q signal by Fast Fourier Transform (FFT). The power density over frequency is displayed.

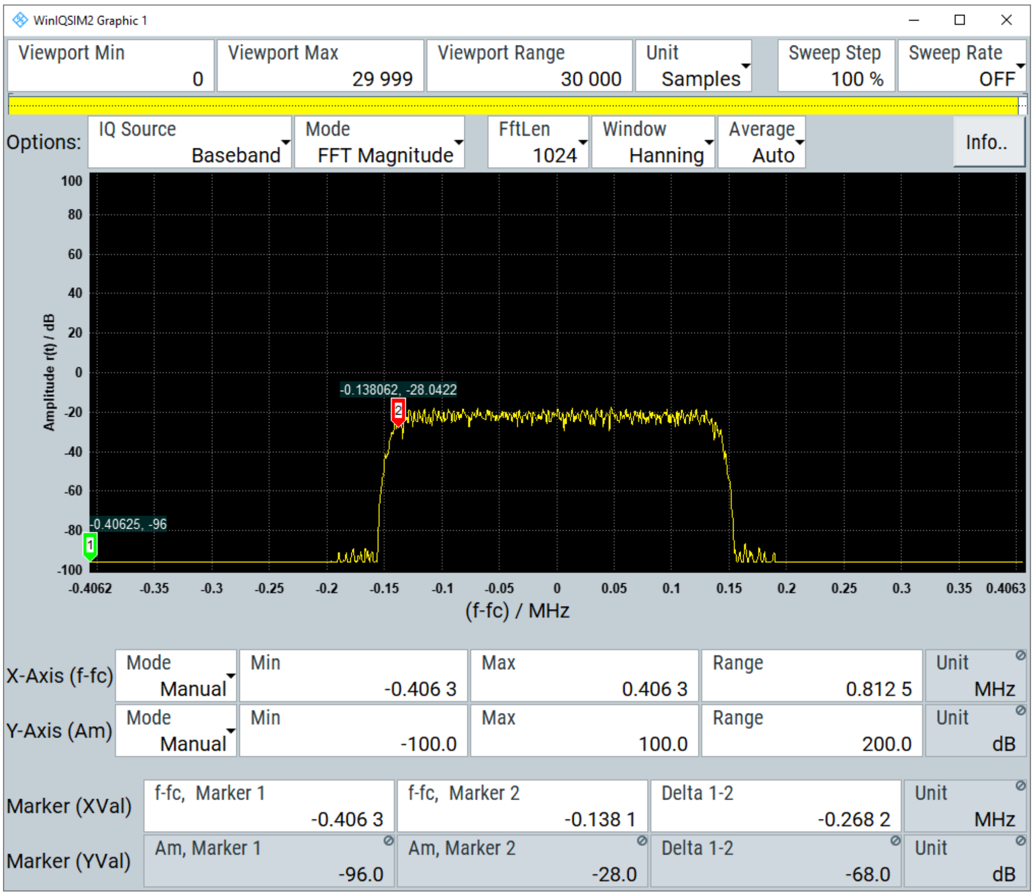


Figure 5-5: Power spectrum diagram: Example with two signals

"FftLen" = indicates the number of samples used for calculating the Fast Fourier Transform (FFT)
"Window" = indicates the window FFT function
"Average" = indicates the number of subspectra used for averaging
X-axis = frequency plotted symmetrically (- sampling rate/2 to +sampling rate/2)
Y-axis = power density

5.1.1.6 Eye diagram

The eye diagram displays synchronized and superimposed sections of either the in-phase or the quadrature components of the signal.

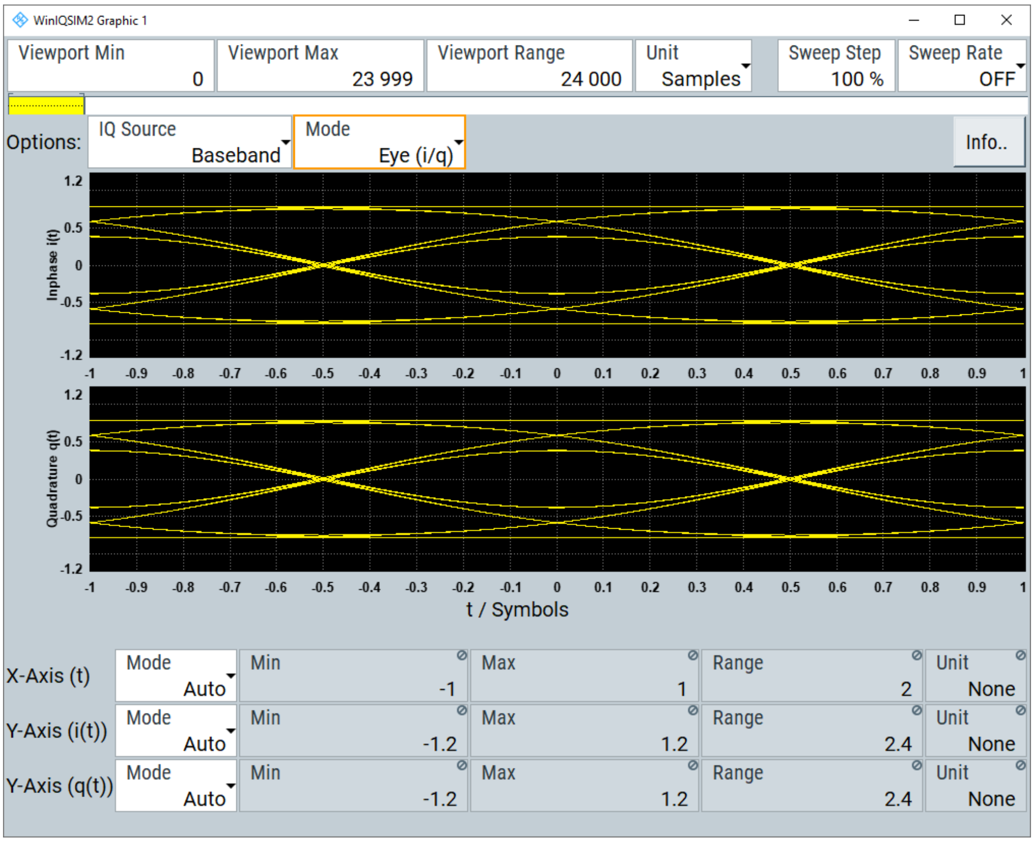


Figure 5-6: Eye diagram of a user standard QPSK signal

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 two symbols:

- The one-symbol "eye opening" in the center of the display.
- 1/2-symbols to the left and right of the center eye for capturing time transitions.

Several 100 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).

5.1.1.7 CCDF display

The complementary cumulative distribution function (CCDF) displays the probability the waveform signal exceeds the average power.

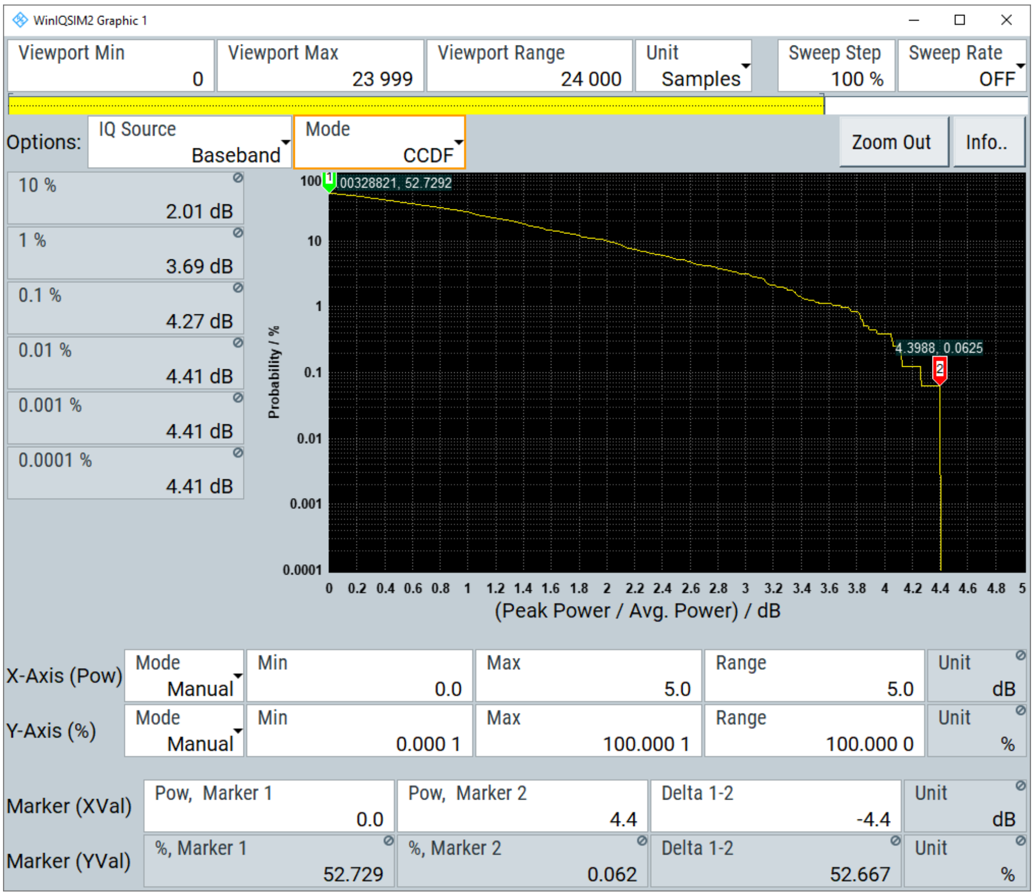


Figure 5-7: CCDF diagram of a 3GPP signal

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
Probability table	= probability values in percent

5.1.2 Display functions

The graphical display provides general display functions known from other measurement instruments. It enables you to focus on a certain area of the diagram or to use markers for precise evaluation. You can find out how to optimize the display for your monitoring task.

Zooming

You can zoom into the diagram to visualize the measurement in more detail. Using the mouse pointer or by value entries you can define the area to be zoomed.

Zooming is merely a visual tool, it does not change the number of samples used for the calculation. Increase the number of samples before zooming, as otherwise the function has no real effect.

A zoom replaces the current diagram by a new diagram which displays an enlarged extract of the diagram. Repeat zooming until the required details are visible.

Using markers

Markers are tools for numerical readout of measured data in diagrams. They help you to analyze the displayed signal characteristics by determining particular values in the diagram. Thus you can extract numeric values from a graphical display in both the time and the frequency domain. For example, you can measure the frequency distance between two peaks of a signal.

See also "To set markers with the mouse" on page 183.

You can use two markers (and) for your measurements. With the mouse pointer or on the basis value entries, you can determine the marker positions and the distance between "Marker 1" and "Marker 2". Directly above the icons, you can see the corresponding values of the marker in the diagram.

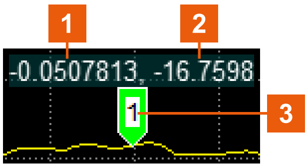


Figure 5-8: Marker number and position

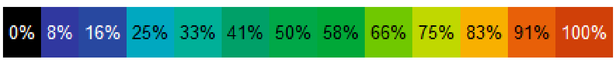
1 = marker position on the x-axis
2 = marker position on the y-axis
3 = marker number

If a marker is outside the range of the "Viewport", and thus not visible, you can shift it into the indicated area. Type a value within the displayed scale in the entry field of the corresponding marker.

Color maps

The vector, constellation and power spectrum diagrams assign colors to the graphs to visualize how often the signal components have achieved certain values. The color represents the number of occurrences in %, related to the maximum value.

The legend below the diagram explains the distribution the colors represent.



5.2 Graphical signal display settings

This section focuses on the configuration and the graphical representation of a waveform.

If you have activated a graphical representation, R&S WinIQSIM2 provides the graphic as:

- Graphics icon
- Preview in the block diagram
- Full-size graphs in the configuration dialog

To show the small graphics preview in the block diagram, perform one of the following:

1. In the menu bar, select "Graphics > Graphic 1 > Graphic 1 (Preview Only)"
2. In the "Toolbar", select a graphic icon .

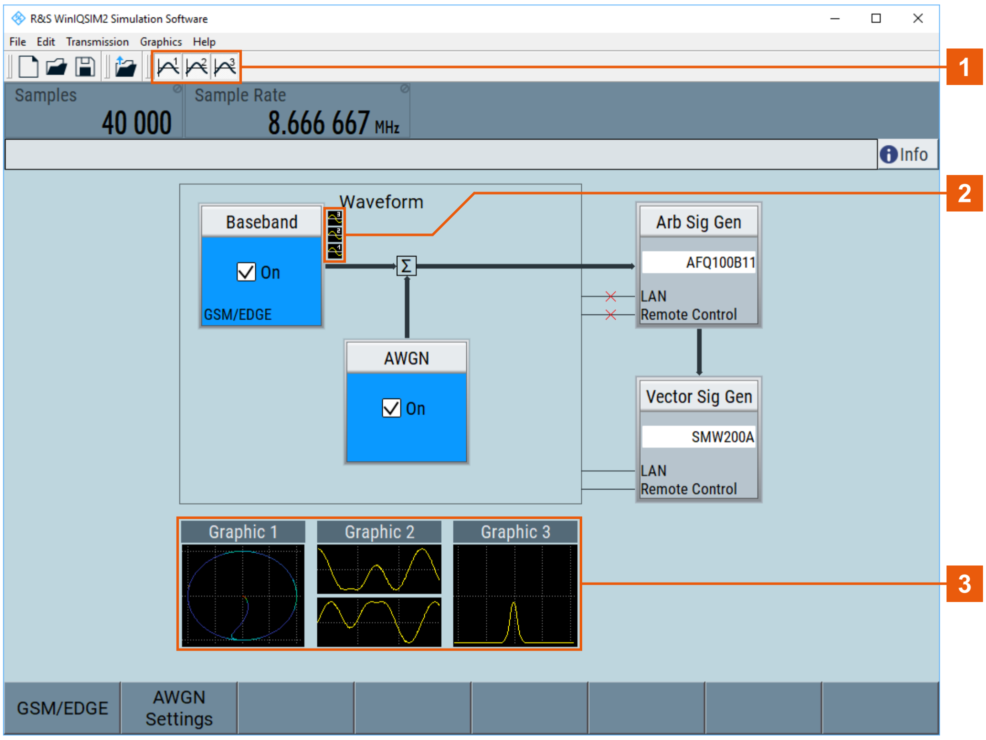


Figure 5-9: R&S WinIQSIM2 bock diagram with active graphics

1 = Toolbar graphics icons
2 = Block diagram graphics icons
3 = Graphics preview

R&S WinIQSIM2 displays the selected graphic as small graphic block diagram.

To access the graphic signal display settings, perform one of the following:

1. In the menu bar, select "Graphics > Graphic 1 > Graphic 1 (Complete)"

2. In the block diagram, double-click the small graphics preview.

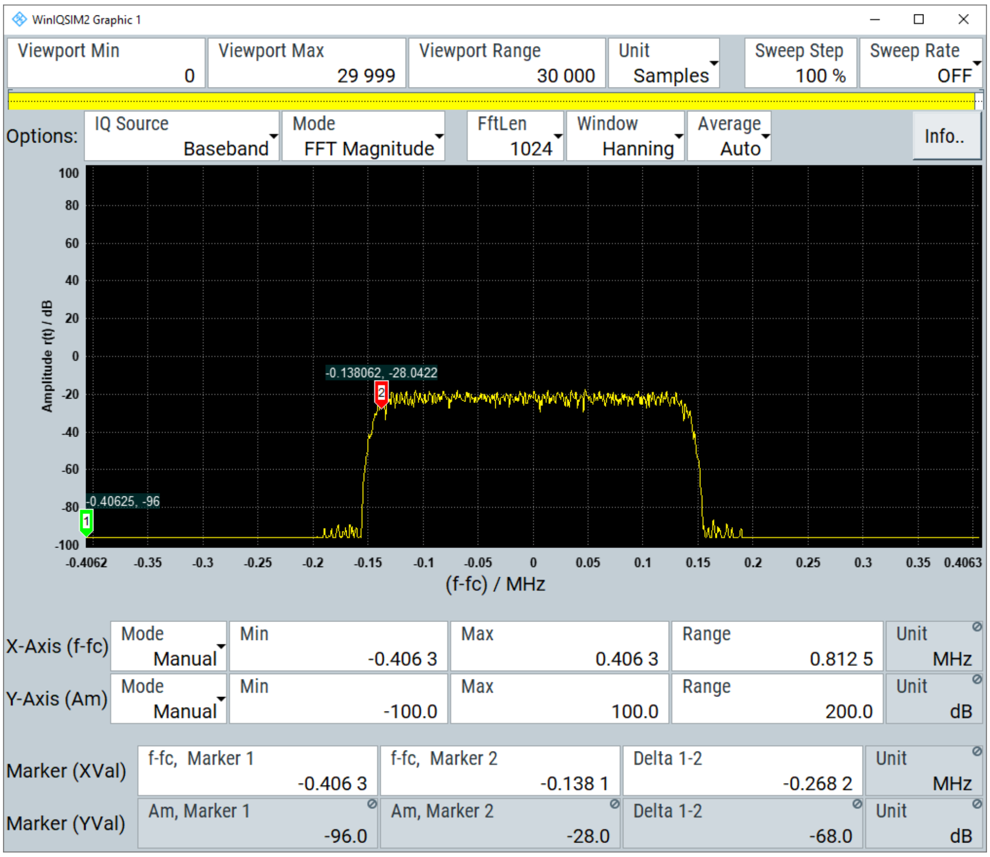


Figure 5-10: Graphics configuration dialog

The dialog contains all parameters required for graphical representation of the waveform:

- Viewport
- Options
- Scaling and marker.

The remote commands required to define these settings are described in Chapter 11, "Remote control commands", on page 257.

5.2.1 Viewport

The viewport indicates the currently displayed range of the waveform.

The yellow bar indicates the displayed part, and the white bar represents the total length of the waveform. The display is dynamic, and you can control it either manually or automatically.

To control the viewport, you have the various options:

- Manually by defining "Min" and "Max" or "Min"or "Max" and "Range"
- Manually with the mouse by dragging the yellow bar

- Using an automatic time control by defining the sweep step size and time

"Mode"	"Viewport"	Yellow bar	White bar
"i(t)/q(t)" "r(t)/φ(t)"	Range, within the scaling of the X-axis is shifted in the display.	Currently displayed range.	Total signal
"FTT"	Maximum observed range.	Used range for FTT	Total signal
"Vector" "Constellation" "Eye (i/q)" "CCDF"	Observed scope	Irrelevant	Total signal

In addition, the viewport section includes the selection of the graphics mode, and the possibility to display the signal with noise specified under AWGN (see Chapter 4.2, "AWGN settings", on page 153.

Depending on the selected graphic mode, you can set additional parameters like filter, segment length.

Viewport
Note: There is no limitation to the length of the waveforms. Long waveform streams are divided in packets of a displayable size and are then displayed packet-wise.

Sets the operating range to display the waveform.

"Min"	Start value of the operating range.
"Max"	End value of the operating range.
"Range"	Operating range, the calculated delta between "Min" and "Max". **Tip:** If you define two of the three values, the third value is calculated automatically.
"Unit"	Unit of the operating range. Select between samples, milliseconds and microseconds. If you change the unit, the settings are adjusted automatically.
"Sweep Step"	Step size of the sweep in per cent.
"Sweep Rate"	Sweep steps per second.

5.2.2 Options

This section comprises settings to configure the graphical representation of the I/Q signal. Also, the section displays information on the generated waveform such as total signal duration and sample rate.

IQ Source

Selects the signal for the graphical display.

The graphics allow you to view the baseband signal and the additive noise separately, and the resulting superimposed signal.

Mode

Selects the graphics mode.

"i(t)/q(t)" Displays the currently active waveform over time in two graphs: the top one shows the in-phase component i(t), the bottom one the quadrature samples q(t).

"r(t)/ϕ(t)" Displays the waveform over time in two graphs: the top one shows the amplitude, the bottom one the phase.

"Vector" Depicts the samples in the complex plane, that means the transitions are shown as vectors.

"Constellation" Depicts all samples in a two-dimensional diagram in the complex plane, sampled at the symbol rate.

"FFT Magnitude"
Displays the power spectrum (magnitude over frequency) derived from a Fast Fourier Transform of the waveform.

"Eye (i/q)" Displays the repetitively superposed I and Q samples. The symbol transitions are sampled at the symbol rate.

"CCDF" Depicts the probability the waveform takes on a value higher than the maximum output power.

FftLen

Selects the number of samples of the Fast Fourier Transform.

Window

Selects the FFT window function.

Windowing supports you in FFT analysis to minimize the discontinuities in the measured signal interval. It reduces the effect of spectral leakage, and the frequency resolution increases.

Various window functions are provided for the FFT analysis of waveform signals. Each of these functions has certain characteristics with specific advantages and also trade-offs. Therefore consider these properties carefully, to find the optimal FFT function for your signal.

"Rect (Rectangular)"
Suitable for separate two tone signals with almost equal amplitudes and a small frequency distance.
Resolution: high (frequency), low (amplitude)

"Hanning"	Used for frequency response measurements, sine waves, periodic signals and narrow-band noise. Resolution: high (frequency), low (amplitude)
"Blackman"	Mainly for signals with single frequencies to detect harmonics. Suitable for signals provided for accurate single-tone measurements. Resolution: low (frequency), high (amplitude)
"Welch"	Fast estimation of the power spectrum at different frequencies. Reduces noise in the estimated power spectrum, but also the frequency resolution. Resolution: low (frequency), high (amplitude)
"Flat Top"	Suitable for signals that are used for accurate single-tone measurements. Resolution: low (frequency), high (amplitude)

Average
Selects the number of waveforms used for average calculation.

Info ..
Opens a dialog to display waveform information such as total signal duration and sample rate.

Total Signal Duration ← Info ..
Displays the signal duration in seconds of the available samples within the generated waveform file.

Remote command:
`:GENerate:WAVeform:DURation?` on page 297

Sample Rate (fc) ← Info ..
Displays the sample rate in [Hz]. It is calculated as follows:

Sampling rate = number of symbols * oversampling factor.

Remote command:
`:GENerate:WAVeform:SAMPles?` on page 298
`:GENerate:WAVeform:SRATe?` on page 298

Oversampling Factor ← Info ..
Displays the baseband oversampling factor.

This parameter is determined by the content of the generated waveform file. To adjust the oversampling rate, set the corresponding parameters defined within the standards.

Remote command:
`:GENerate:WAVeform:OSAMpling?` on page 297

5.2.3 Scaling and marker

In this section, you can configure the graphics display and determine the marker positions manually.

The settings for configuring the x-axis and y-axis are the same. You can select the manual mode, which enables manual defining of the scope (min, max, range values) and the unit for the respective parameter.

Mode

Selects the mode for setting the axis scaling.

"Auto" Activates automatic scaling.
R&S WinIQSIM2 scales the axis automatically, according to the parameters of the waveform.
The value range is indicated as read only, but you can still determine the unit. Automatic scaling assumes the values of the viewport for the x-axis, and calculates the scaling for the y-axis based on the maximum and minimum values of the samples.

"Manual" Activates manual scaling.
You can define the area that is to be zoomed with "Min" and "Max", or "Range" in combination with "Min" or "Max". The third value is calculated automatically. The unit can be set as well.

Remote command:
n.a.

Scale X-Axis/Y-Axis

Sets the scaling and the units for the x-axis and the y-axis.

Note: The scaling values can never be higher or lower than the scaling values set under "Viewport" on page 172.

"Min" Start value of the operating range.

"Max" End value of the operating range.

"Range" Operating range, the calculated delta between "Min" and "Max".
Tip: If you define two of the three values, the third value is calculated automatically.

"Unit" Unit of the operating range.
If you change the unit, the settings are adjusted automatically.

Marker 1 / 2, Delta 1-2, Units

Determines the marker position on the x-axis, and shows the corresponding y-value, and the distance between the two markers. See also "Using markers" on page 169.

Zoom Out

Resets a previous zoom, see also "Zooming" on page 168.

Note: The "Zoom Out" button always returns to the initial display size.

5.3 How to verify the generated signal with the graphics display

This section shows how to use the various graphic modes to visualize the signal characteristics of the generated waveform. It also explains how to evaluate the effect of standard settings like added noise. The examples use a simple custom digital modulated signal.

Generating a simple WCDMA-3GPP (QPSK 45° offset) waveform

► In the custom digital modulation dialog, enable a predefined WCDMA-3GPP signal (see "To generate a digitally modulated signal" on page 81).

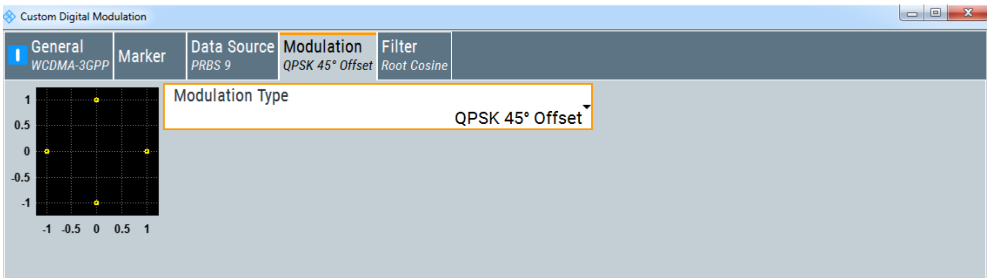
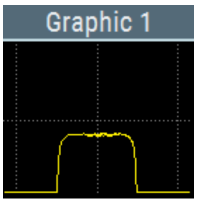


Figure 5-11: Used modulation type

To display the constellation diagram of the WCDMA-3GPP waveform graphically

1. To activate the graphical signal display, perform one of the following:
   a) In the menu bar, select "Graphics > Graphic 1 > Graphic 1 (Preview only)"

      R&S WinIQSIM2 indicates the graphics preview in the block diagram. To access the graphics settings, select the small graphics preview.
   b) In the menu bar, select "Graphics > Graphic 1 (Complete)"

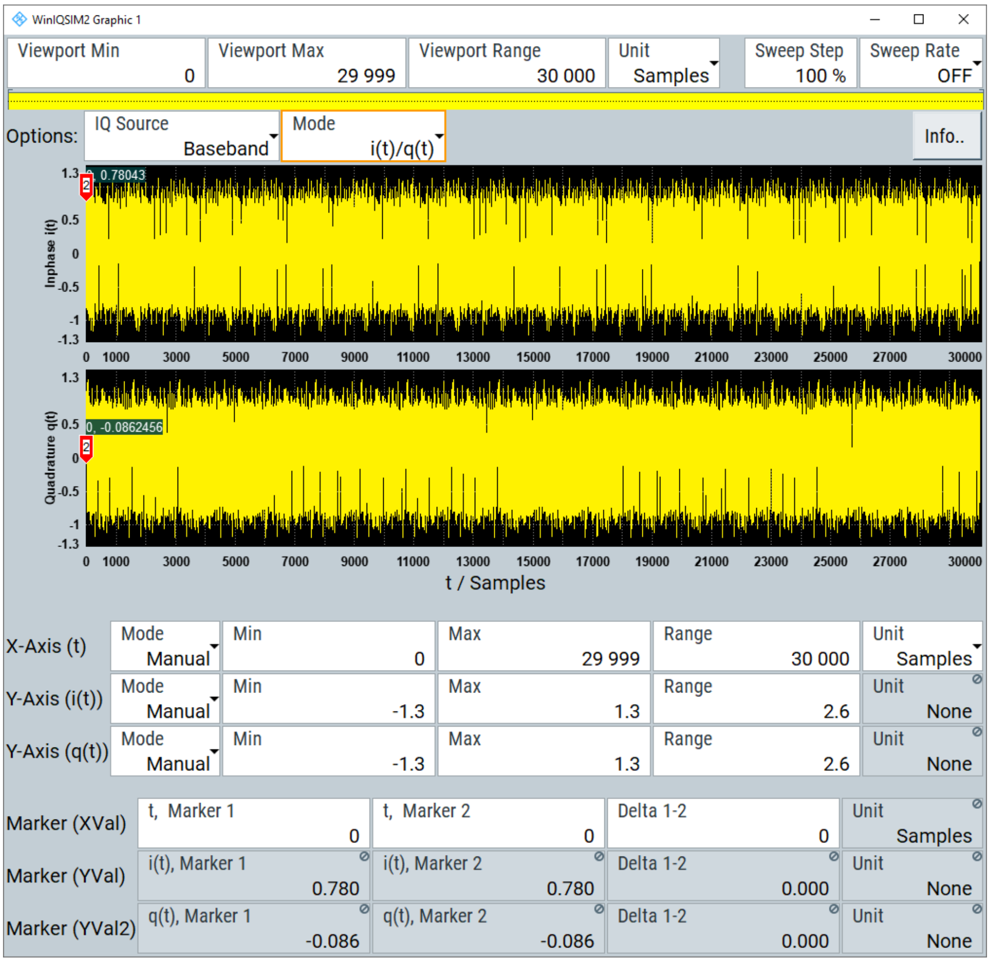


Figure 5-12: Graphic dialog with WCDMA-3GPP signal, I(t)/q(t) mode

The "Graphics Configuration" dialog contains the parameters, required to configure the graphical display, and shows the waveform graphically.

2. Select "IQ Source > Baseband".
3. Select "Mode > Constellation".

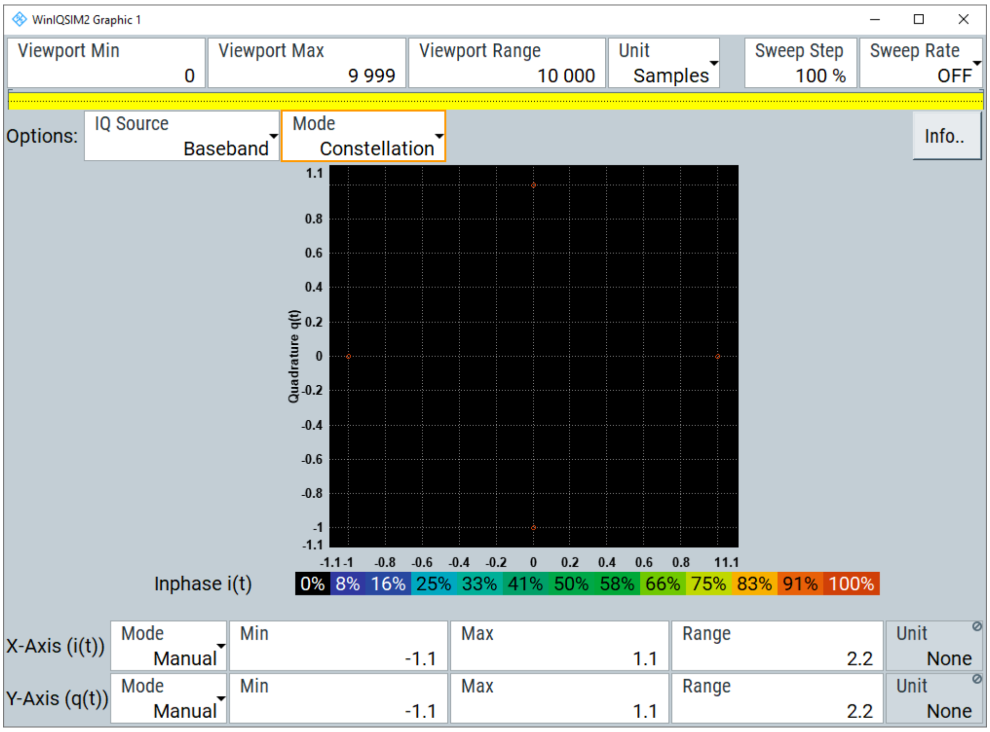


Figure 5-13: Constellation diagram of a WCDMA-3GPP (QPSK 45° offset) waveform

The displayed constellation diagram confirms the used modulation type, see Figure 5-11.

To display the WCDMA-3GPP waveform in the vector diagram

1. Select "IQ Source > Baseband".
2. Select "Mode > Vector".

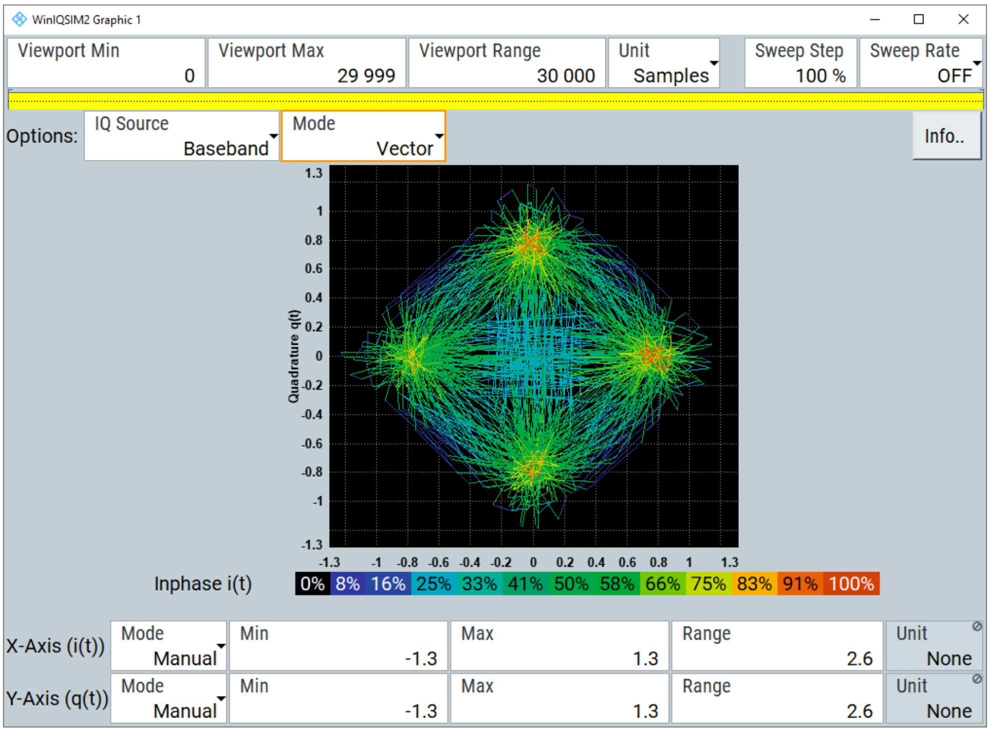
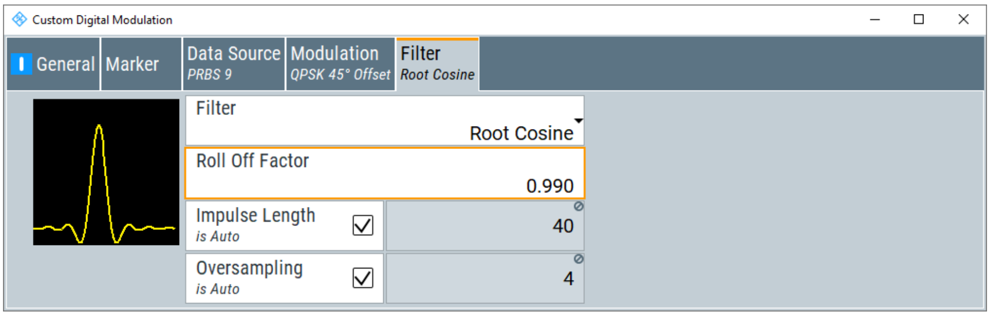
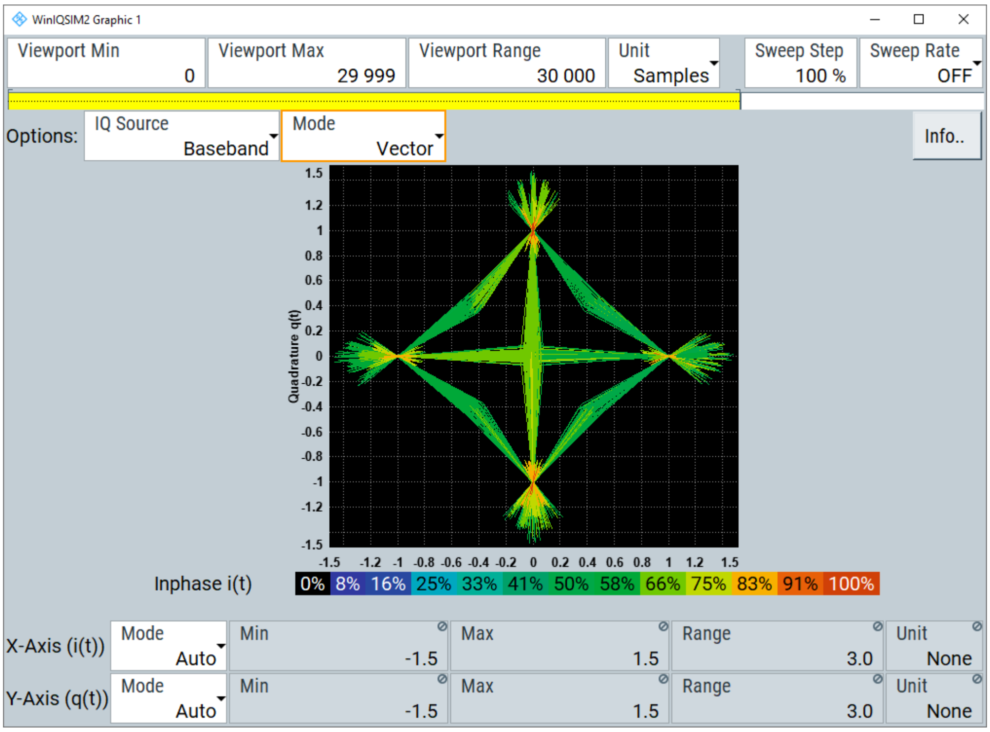


Figure 5-14: Vector diagram of the WCDMA-3GPP (QPSK 45° offset) waveform

To visualize the effect of filter parameters on the generated waveform

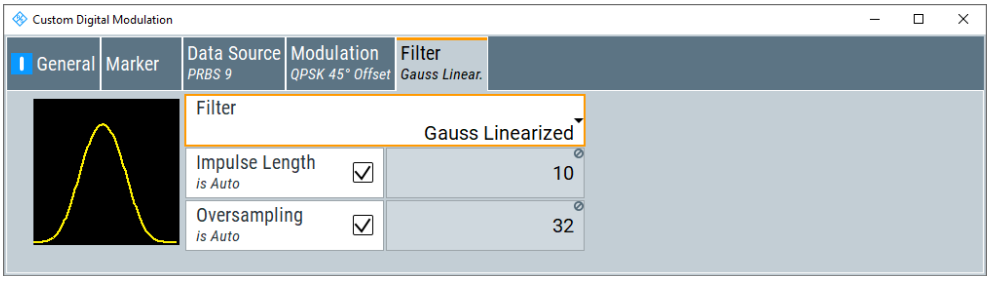
1. Select "Baseband > Custom Digital Mod... > Filter > Roll Off Factor = 0.99"

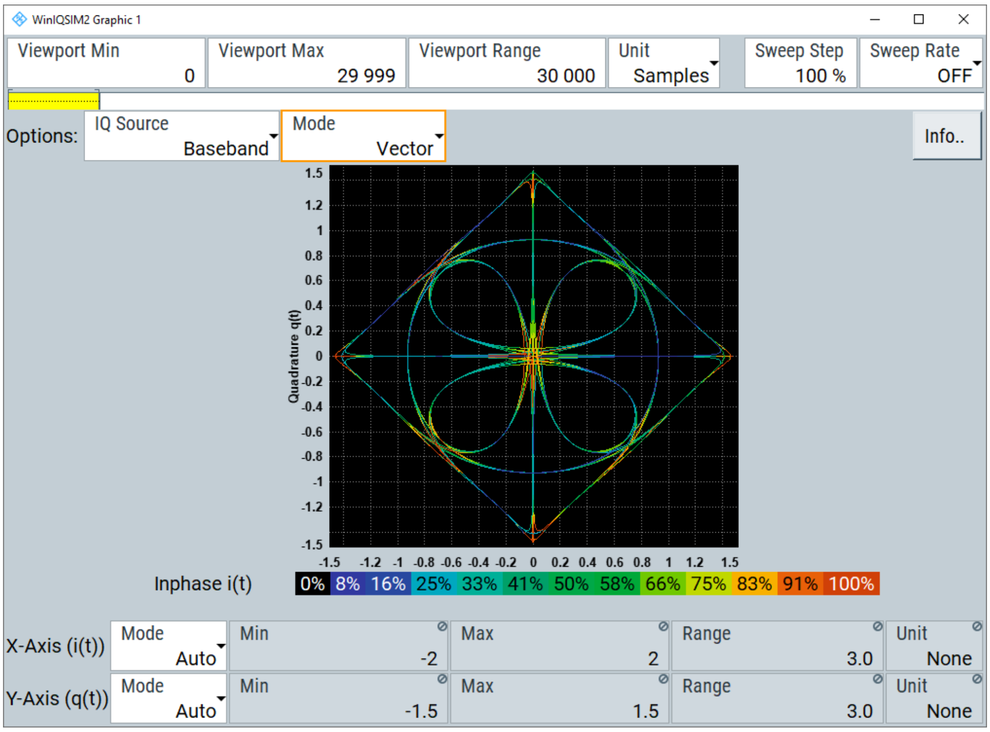




The vector diagram changes according to the modified filter parameter.

2. Select "Baseband > Custom Digital Mod... > Filter > GAUSS linearized"

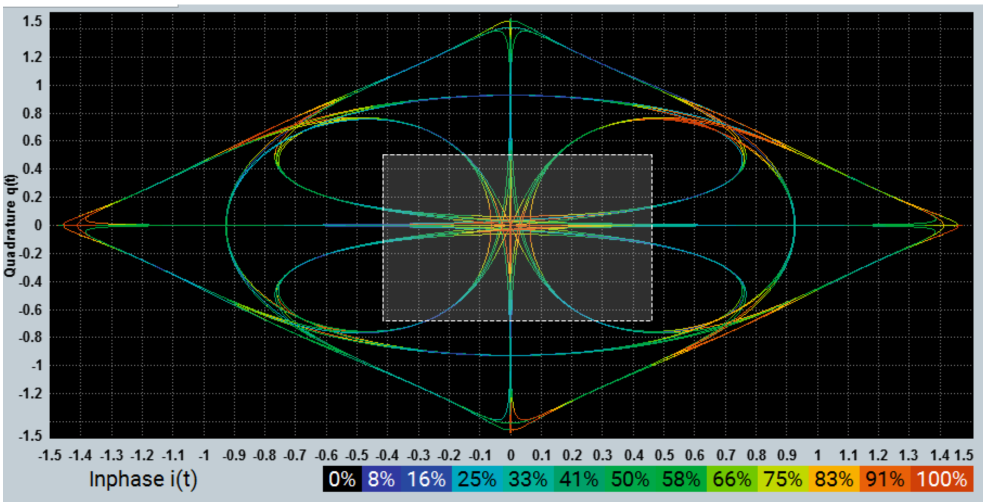




To zoom in a diagram with the mouse

To zoom a displayed part of a waveform directly in the graph, perform the following:

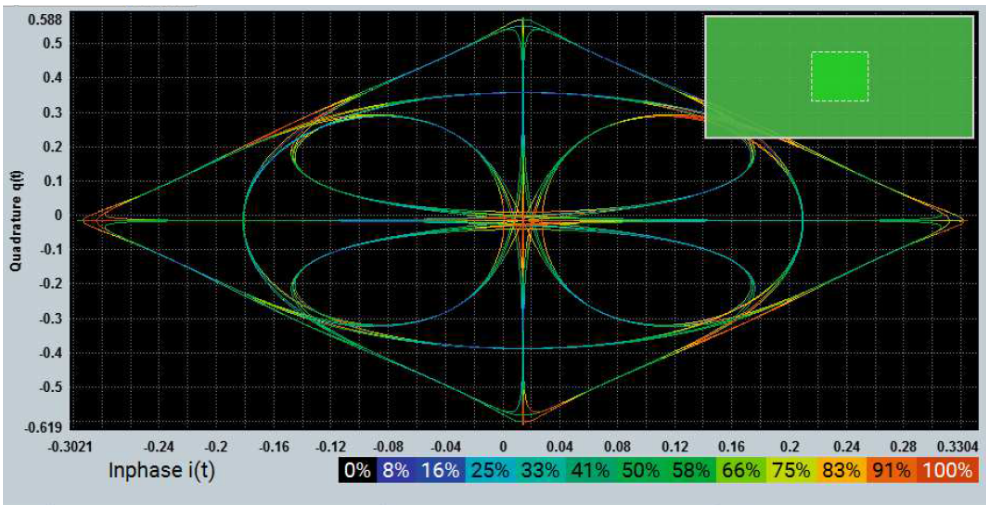
1. Left-click the upper left corner of the graph area you want to zoom.
2. Drag the zoom rectangle.



   A dotted rectangular frame shows the marked area.

3. Click into the frame to confirm the selection.

   The display expands and shows the selected area. A green frame with a miniaturized rectangle embedded appears, indicating the zoomed area.



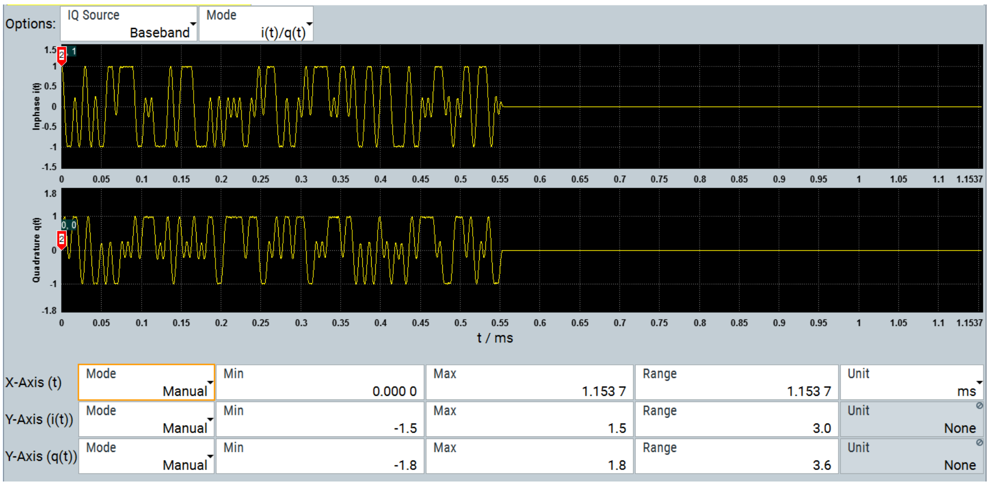
Now you can move the zoomed area in the overview-window by dragging with the mouse.
To return to original size, right-click and select "Unzoom" in the context-sensitive menu.

To zoom in a diagram by adjusting the axes

To expand the entire graph, you can also adjust the scaling of the axes. The method for adjusting the axis scale is the same for both the X and Y axis. Therefore, the function is explained only once.

Perform the following:

1. Select "Mode > Manual".
2. Set the "Min" and "Max" values to determine the zoom area.



R&S WinIQSIM2 adjusts the "Range" accordingly. Alternatively, you can determine "Min" and "Range" with an automatically calculated "Max" value.

Tip: The scaling range is limited by the scaling values of the "Viewport".

3. If necessary, set the "Unit".

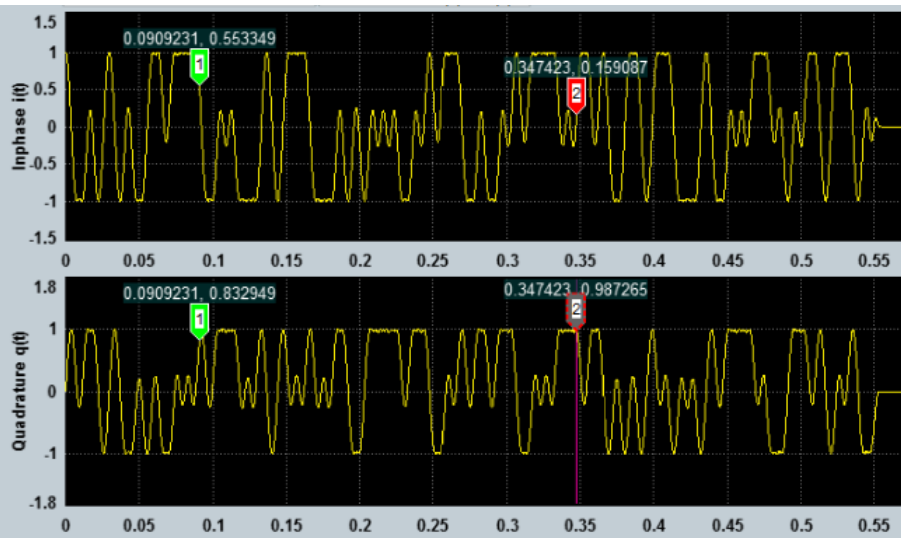
R&S WinIQSIM2 converts the values automatically.

For reverse operation, set "Mode > Auto".

To set markers with the mouse

To place a marker directly in the graph, perform the following:

1. Left-click the first marker symbol.
2. Drag and drop the marker to the target position.



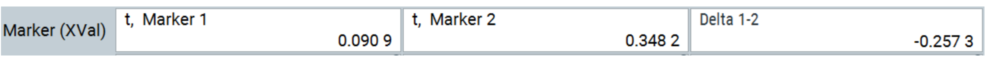
3. Left-click the second marker and repeat step 1 to 2.

   Now you can analyze the displayed waveform.

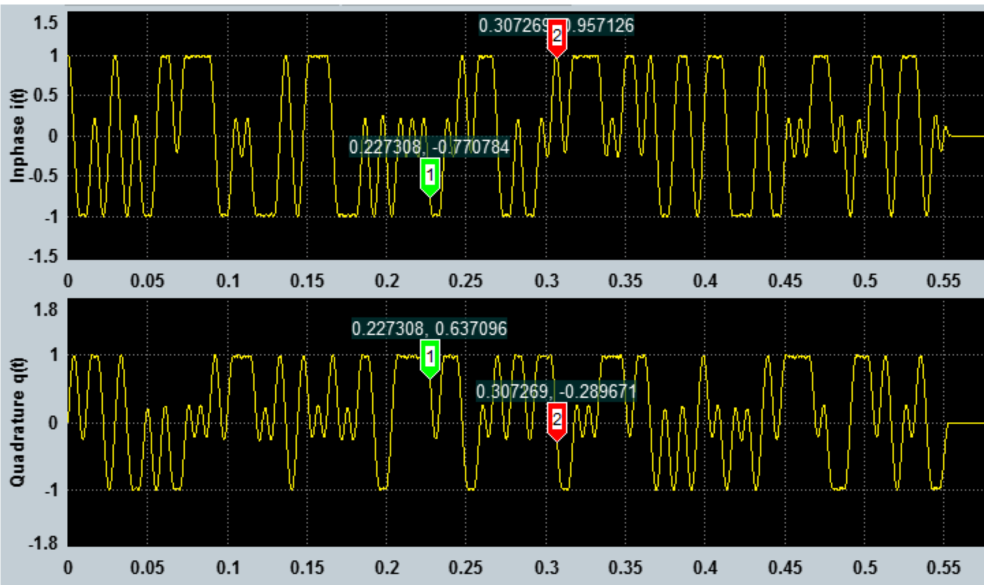
Setting markers by entering the position

To place a marker precisely in the graph, perform the following:

► Enter the X-axis positions for the "t, Marker 1" and "t, Marker 2".

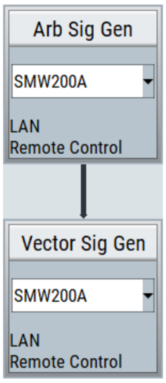


The marker moves to the defined position, giving the Y-axis values in the "I(t)" and "q(t)" fields. The values are not editable. In the "Delta: 0 - X" group box, the difference (delta) between the X-axis value and Y-axis value of the marker position is displayed.



Alternatively, you can determine "Delta: 1 - 2" value with an automatically adjusted "Marker 2" position. "Marker 1" remains fixed.
Now you can analyze the waveform.

6 Setting up instruments



Configure the connection to an instrument and the transmission of waveform data to this instrument or waveform playback at the instrument via the signal generator blocks:

At the "Arb Sig Gen" block, configure instruments that have an ARB. At the "Vector Sig Gen" block, configure instruments that have an I/Q modulator and generate a vector-modulated RF signal.

Both blocks open dialogs for configuring the instrument, the connection between the instrument and R&S WinIQSIM2 and remote operation. When connected, R&S WinIQSIM2 can send the generated waveform signal directly to a R&S WinIQSIM2 instrument, and even enable signal generation on the instrument remotely.

Remote control with R&S WinIQSIM2

If you remotely control a connected instrument with R&S WinIQSIM2 and also with another remote control software, for example, an R&S SGT controlled by the R&S SGMA-GUI software, note the following:

- If you connect the instrument via USB, you cannot use the same PC for both remote applications.
- If you connect the instrument via LAN, you can use the same PC via different SCPI socket ports for remote control with both remote applications.

Required instrument equipment

For processing R&S WinIQSIM2 waveform files at an instrument, make sure that the following applies:

- R&S WinIQSIM2 supports the instrument.
  For supported Rohde & Schwarz instruments, see Chapter 1.3, "Supported Rohde & Schwarz instruments", on page 12.
- The instrument has an ARB and is equipped with suitable options. These options can be a digital standard option, the multicarrier signal generation option or the AWGN option.
  For information on the required options, refer to the specifications document of the instrument. The digital standard options are described in the user manuals of these standards.
- For correct playback of the waveform file at the instrument, make sure that the file properties match with the equipment of the instrument. For example, the storage space, the parameter value ranges, the ARB sample rate and the ARB memory of the instrument.

Online and offline signal calculation

You can transmit waveforms directly to a connected instrument. R&S WinIQSIM2 calculates the waveform signal online and transmits the waveform data to the instrument. Also, you can generate the waveform signal offline and save it to a waveform file. For example, to transmit the waveform later to a connected instrument or to load the waveform file from an external storage device to the ARB of the instrument.

The following sections provide information on instrument settings and step-by-step instructions to configure and control these instruments.

6.1 Configuring and connecting to an instrument

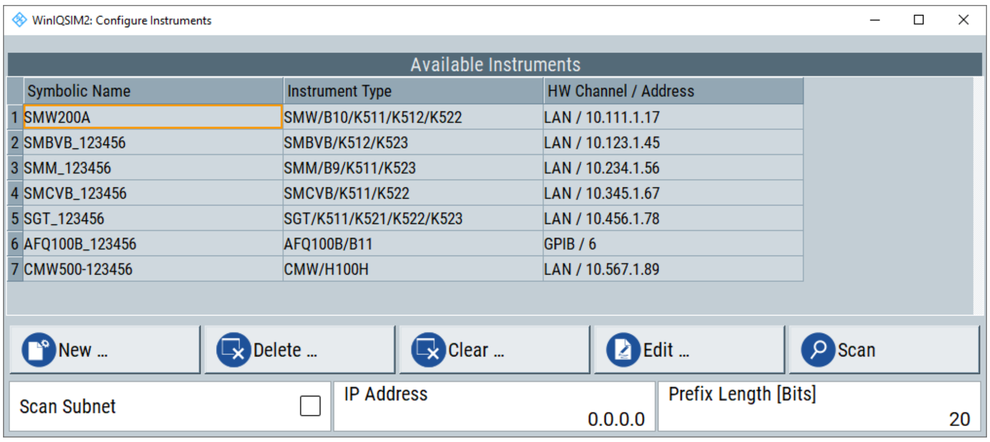
The following step-by-step instructions explain how to detect instruments in the network and configure the associated settings in R&S WinIQSIM2. They cover the following topics:

- "To scan the network for connected instruments" on page 186
- "To add an instrument manually" on page 187
- "To configure the instrument" on page 187
- "To understand the instrument configuration" on page 189
- "To remove instruments" on page 190

To scan the network for connected instruments

1. In the block diagram, select "Arb Sig Gen"/"Vector Sig Gen" > "Instruments ...".
2. Select "Scan" to search for connected instruments.

   R&S WinIQSIM2 searches for available instruments. This process can take some time.



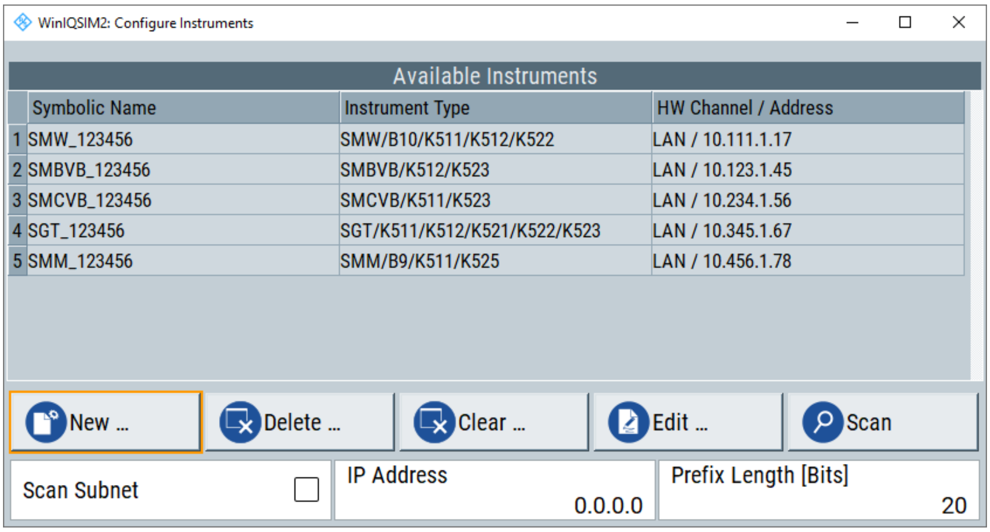
   When finished, R&S WinIQSIM2 displays all instruments found in your network domain and instruments connected via the GPIB or USB interfaces.
   In addition, R&S WinIQSIM2 retrieves information about the connection to the instrument automatically.

3. To check the network parameters, select the corresponding instrument in the list.
4. Select "Edit".

   The "Configure Instruments" dialog opens, and you can look at the settings of the selected instrument, or modify the configuration. For details, see Chapter 6.4, "Configure instruments settings", on page 194. For an example of how to set the parameters, see "To understand the instrument configuration" on page 189.

To add an instrument manually

1. In the menu bar of R&S WinIQSIM2, select "File > New" to start the software from an initial state.
2. In the block diagram, select "Arb Sig Gen/Vector Sig Gen > Instruments...".



   R&S WinIQSIM2 shows the list of all previously assigned entries, even if the instruments are currently not connected.

3. Select "New" to create an instrument entry.

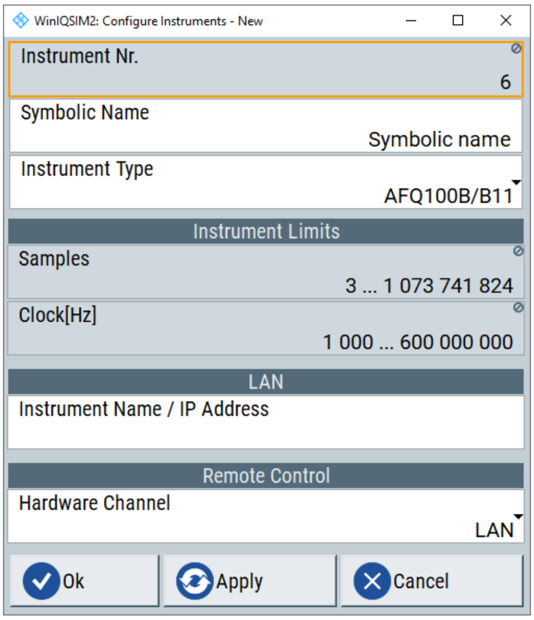
   The "Configure Instruments" dialog opens where you can configure the parameters of the dummy instrument, see "To understand the instrument configuration" on page 189.
   For details on the provided settings, see Chapter 6.4, "Configure instruments settings", on page 194.

To configure the instrument

This example shows the steps to be taken for configuring an instrument manually. We assume an R&S SMW equipped with extended ARB and bandwidth options is connected via USB.

Note: If you have selected a connected instrument, no further configuration is required.

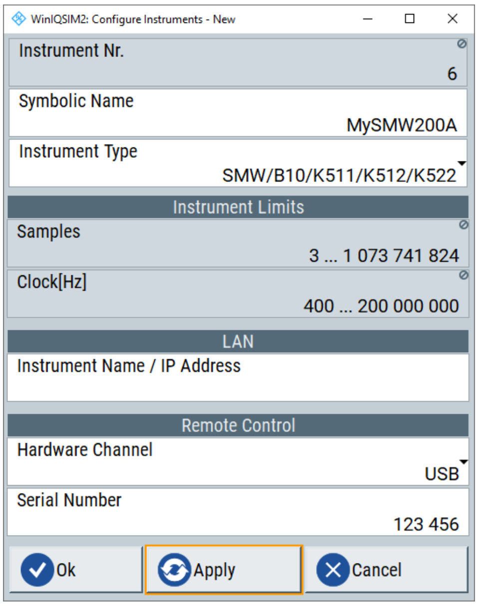
1. Select "Arb Sig Gen"/"Vector Sig Gen" > "Instruments ..." > "New" or "Edit".



First, the dialog box shows any default entries.

2. Enter "Symbolic Name" > "MySMW200A".
3. Select "Instrument Type", e.g., "SMW/B10/K511/K512/K522".

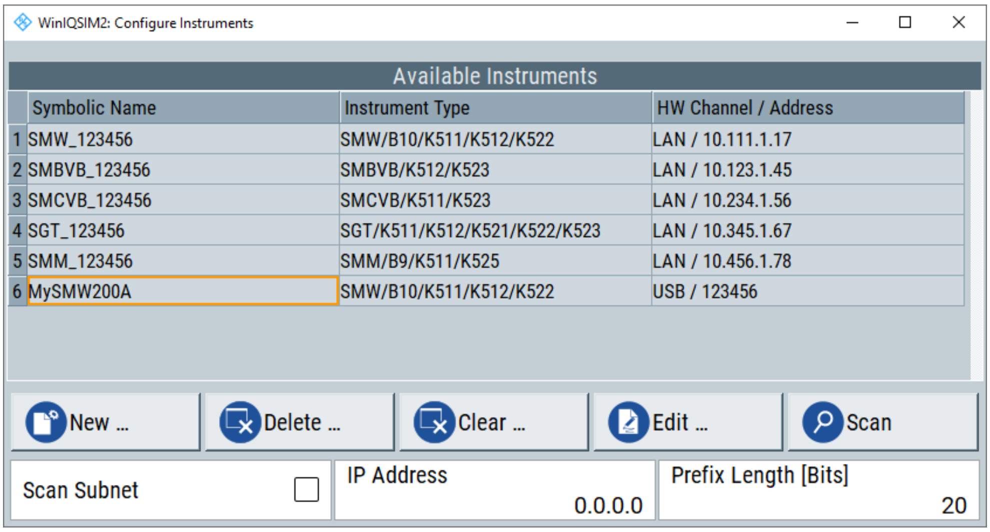
   According to the instrument and its options, R&S WinIQSIM2 indicates the relevant sample parameters of the instrument in the "Instrument Limits" section. See also "To understand the instrument configuration" on page 189.
4. Select "Hardware Channel" > "USB".
5. Confirm with "Apply".



R&S WinIQSIM2 assigns your settings.

6. To close the dialog, select "Ok".

   You can see the new instrument "MySMW200A" added to the list.



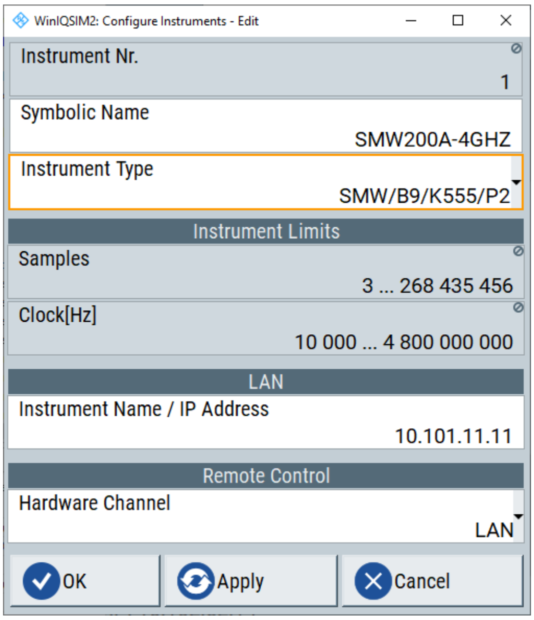
To understand the instrument configuration

This example shows how to interpret an instrument configuration for an R&S SMW. The R&S SMW is equipped with a wideband baseband generator and option R&S SMW-K555 for bandwidth extension to 4 GHz.

1. To open the instrument settings, see "To configure the instrument" on page 187.
2. Configure your R&S SMW:
   a) Enter the "Symbolic Name", e.g., "SMW200A-4GHZ".
   b) Select "Instrument Type" > "SMW/B9/K555/P2".
   The software assumes an R&S SMW configured with the following options:

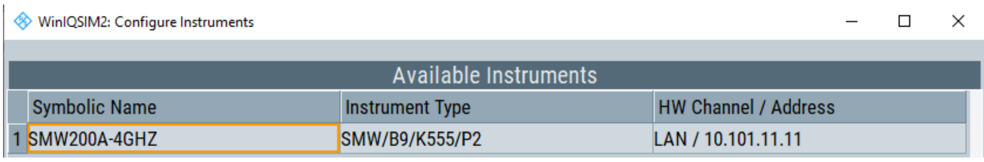
Option/equipment	Designation
R&S SMW-B9	Wideband baseband generator
R&S SMW-K555	Bandwidth extension including the baseband extension options: R&S SMW-K525 and R&S SMW-K527
P2	Two RF ports

3. Check the updated characteristics in the "Instrument Limits" panel.
   The software displays instrument limits for the number of samples ("Samples") and the clock rate ("Clock[Hz]"). The upper limit of the clock rate is 4.8 GHz.



4. Configure the hardware channel and instrument address as needed.
   See "To add an instrument manually" on page 187.
5. Confirm with "Apply".
6. To close the dialog, select "OK".

   You can see the new instrument "SMW200A-4GHZ" added to the list.



To remove instruments

1. To open the instrument settings, see "To configure the instrument" on page 187.
2. To delete an instrument from the list, proceed as follows:
   a) Select the instrument.
   b) Select "Delete".
3. To clear all instruments from the list, select "Clear".

   R&S WinIQSIM2 removes the selected entry from the list of available instruments.

6.2 Configuring remote operation modes

The following step-by-step instructions provide information to control and operate an instrument remotely with R&S WinIQSIM2. The instructions assume that you established a control connection between R&S WinIQSIM2 and an R&S SMW. They cover the following topics:

- "To control an ARB signal generator remotely" on page 191

To establish the control connection, see Chapter 6.1, "Configuring and connecting to an instrument", on page 186.

To control an ARB signal generator remotely

1. Select "Arb Sig Gen" > Remote Control (SCPI)

   The dialog "Remote Control Arb <instrument>" opens. It provides general settings to configure the baseband signal and the clock rate and to load a waveform file at the connected instrument.

2. For instruments with more than one signal path, set the "Path". For example, for an R&S SMW, set "Path A".

R&S WinIQSIM2 provides the option to control the instrument remotely for several basic parameters that are relevant for the signal generation. These parameters vary depending on the selected instrument or generator type that is "ARB" or "Vector".

The "Remote Control" dialog displays the parameters relevant for exchanging and activating waveforms from R&S WinIQSIM2, and you can modify these settings via remote control.

When the connection is active, both the R&S WinIQSIM2 and the instrument synchronize modified settings immediately, regardless of where you perform the changes.

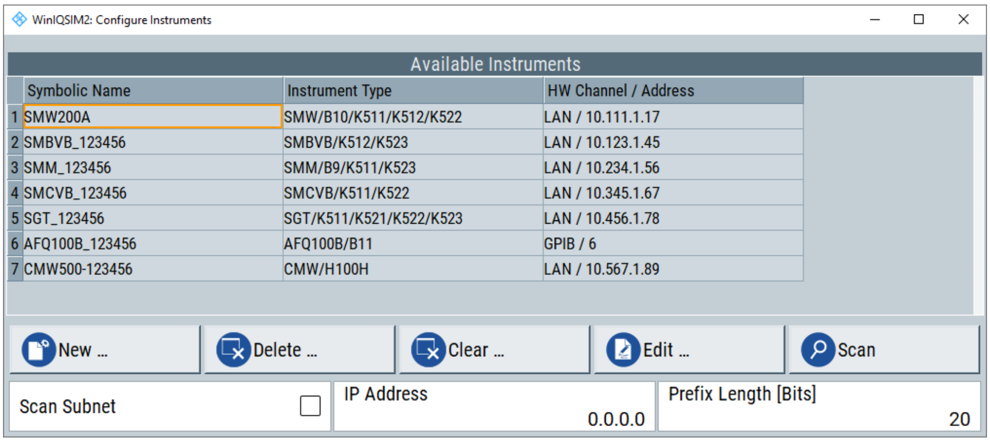
6.3 Available instruments settings

Access:

► Select one of the following:

a) In the block diagram, select "ARB Sig Gen" > "Instruments".
b) In the block diagram, select "Vector Sig Gen" > "Instruments".

c) In the menu bar, select "Transmission" > "Instruments".



The dialog lists available instruments for selection and provides access to the parameters for configuring a selected instrument. The list provides information on the symbolic name of instruments, instrument type, hardware connection and address.
See also Chapter 6.4, "Configure instruments settings", on page 194. The remote commands required to define these settings are described in Chapter 11.5, "Transmission commands", on page 295.

To access the instrument directly

► To access an instrument directly, you have two options:
- Scan the network, or USB or GPIB interfaces and search for connected instruments: "To scan for instruments" on page 19.
- Specify an instrument manually. It can be a dummy or an existing instrument that a scan did not detect: "To add an instrument manually" on page 187.

You can also browse the network for instruments, or remove an entry from the list. With "New", you can create a dummy instrument.

The list of instruments shows all previous entries. When you start a network search (scan), or add a new instrument, R&S WinIQSIM2 maintains the list. It adds any newly detected instruments to the next free list entry (instrument number).

Settings:

Available Instruments
Displays a list of all instrument entries with information on the user-definable symbolic name, the instrument type, the hardware connection and address.

Remote command:
`:INSTruments:NAME` on page 299
`:INSTruments:TYPE` on page 302

New/Edit
Accesses the corresponding "Configure Instrument - Edit" or "Configure Instrument - New" dialogs. Since the provided parameters are similar, these dialogs are described only once, see Configure instruments settings.

Delete
Removes an instrument from the list.

Clear
Removes all instruments from the list.

Remote command:
`:INSTruments:CLEar` on page 298

Scan
Searches for instruments in the network or instruments connected to the USB or GPIB interfaces.

When completed, available instruments are listed in the table.

Remote command:
`:INSTruments:SCAN` on page 299
`:INSTruments:NAME` on page 299

Scan Subnet
Enables scanning of the subnet.

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

Remote command:
`:INSTruments:SCAN:SNET[:STATe]` on page 300

IP Address
Sets the IP address with the subnet.

Remote command:
`:INSTruments:SCAN:SNET:IPADdress` on page 300

Prefix Length
Sets the prefix length in bits.

Remote command:
`:INSTruments:SCAN:SNET:PLENgth` on page 300

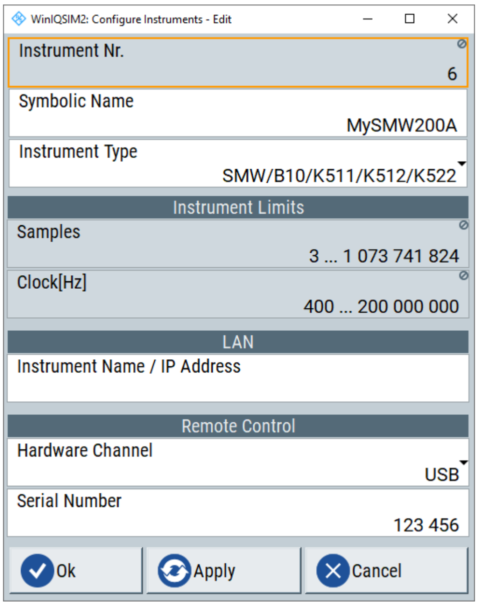
6.4 Configure instruments settings

To communicate with a connected instrument of the network or via other interfaces, it must be clearly identifiable. Therefore, each connection requires unique address information.

The "Configure Instruments - Edit/New" dialogs cover the same parameters, therefore the following description applies to both modes.

Access:

1. Select "Arb Sig Gen"/"Vector Sig Gen" > "Instruments...".
2. Choose between the following:
   a) To define a new instrument, select "New".
   b) To change an existing instrument configuration, select an instrument from the list of available instruments
   c) Select "Edit".



Both the "Configure Instruments" > "New"/"Edit" dialogs provides settings to configure the instrument and the network connection. Also, they show the value ranges of the characteristic signal parameters of the currently selected instrument.

The remote commands required to define these settings are described in Chapter 11.5, "Transmission commands", on page 295.

Instrument Nr.
Displays the line number of the instrument entry in the list of available instruments, see Available instruments settings.

Symbolic Name
Determines an alias name for the selected instrument.

Remote command:
`:INSTruments:NAME` on page 299

Instrument Type
Selects a type from the instrument family according to the features of the selected instrument.

Remote command:
`:INSTruments:TYPE` on page 302

Instrument Limits
Displays the samples and clock value ranges of the selected instrument.

Instrument Name / IP Address
Determines the instrument IP address or instrument name in the LAN.

Note: In a LAN that uses a DNS server (Domain Name System server), each PC or instrument connected to the LAN can be accessed. Access is provided via an unambiguous instrument name (hostname) instead of the IP address.
Basically the default instrument name follows the syntax `<instrument>-<serial number>`, e.g. `SMW200A-100000` according to the conventions of Rohde & Schwarz.

If you do not know the serial number or the serial number is not accessible, use the hostname of the instrument. On the instrument, select "System Config > Remote Access > Network > Hostname".

Check the settings in the instrument setup or the user documentation to obtain the required information on the instrument name.

Remote command:
`:INSTruments:REMote:NAME` on page 299

Hardware Channel
Selects the remote connection.

Each of the available channels requires a unique address information for identification. Therefore, the displayed parameters vary accordingly.

"LAN" Configures the connection in the LAN.
For communication in the LAN, the IP address or the instrument name is required, see Instrument Name / IP Address.

"USB" Configures the connection via the USB interface. The USB resource string requires that you enter the "Serial Number".
"Tip:" you find the 6-digit serial number on the rear panel of the instrument.

Example:

100012

"GPIB" Configures the connection via the interface GPIB (IEC 625/IEEE 488). GPIB provides channel addresses from 0 to 30.

Example:

28

"HiSLIP" Configures the connection via the LAN interface using the HiSLIP protocol.

Remote command:
`:INSTruments:REMote:CHANnel` on page 299

Apply, Ok
Applies the settings. "Ok" confirms the settings and closes the dialog.

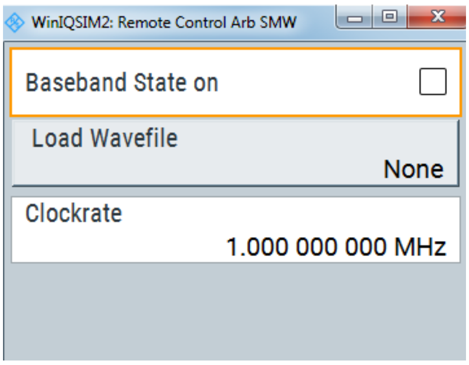
Cancel
Discards the modifications and closes the dialog.

6.5 Remote control (SCPI) ARB settings

Access:

► In the block diagram, select "Arb Sig Gen" > "Remote Control (SCPI)".

Table 6-1: Remote Control ARB <instr>, examples



R&S SMW200A R&S AFQ100B

The dialog contains the parameters required for the ARB configuration of the appropriate instrument. Depending on the accessed instrument, the parameters in the dialog vary.

Path
Selects the signal path to be controlled.

Applies to instruments with more than one signal path.

Baseband State on
Activates the baseband signal.

Load Wavefile
Opens the instruments directory, where waveform files are saved. When a waveform file is selected, the instrument loads it into the ARB. On the right of the button, R&S WinIQSIM2 displays the loaded file.

Wideband Mode
Displays the current setting of the wideband mode, when you are working with an R&S AFQ100B.

Active Output
Sets the active output of the instrument to "Analog out" or "Digital out", provided the instrument is equipped accordingly.

Output Type
Selects output type options for analog signal output of an R&S AFQ100B.

"Balanced" Provides symmetrical signals at the inverting and non-inverting outputs.

"Unbalanced" The inverted and non-inverted signals at the outputs are not symmetrical.

"No options for digital output type"
There are no options for the digital output.

Amplitude
Sets the amplitude of an R&S AFQ100B. The value depends on the settings of the "Active Output" and "Output Type". The analog output amplitudes are given in volt, the digital output amplitudes in a value related to full-scale (FS).

Clockrate
Sets the clock rate of the instrument.

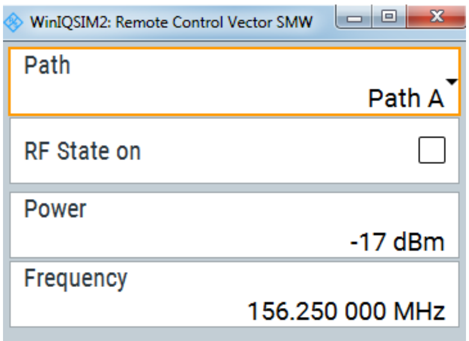
Option Key
Defines the option key for authentication of an R&S AFQ100.

6.6 Remote control (SCPI) vector settings

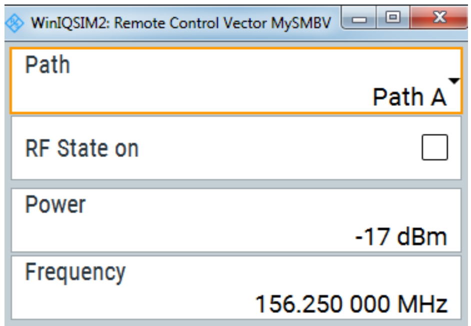
Access:

► In the block diagram, select "Vector Sig Gen" > "Remote Control (SCPI)".

Table 6-2: Remote Control Vector <instr>, examples



R&S SMW



R&S SMBVB

The dialog contains the parameters required for the configuration of the appropriate vector signal generator. Depending on the instrument, the parameters in the dialog vary.

Path
Selects the signal path to be controlled.

Applies to instruments with more than one signal path.

RF State on
Activates the RF signal.

Power
Sets the RF power.

Frequency
Sets the RF frequency.

6.7 Remote desktop

Remote desktop is a windows application R&S WinIQSIM2 supports to access and control a connected instrument via any browser, e.g. Windows Internet Explorer or Mozilla Firefox.

While the instrument is in operation, the browser displays the instruments' screen. It is possible to access the settings of the instrument, files, and network resources.

To access the instrument via a remote desktop, perform the following steps:

Prerequisites

It is assumed that the instrument is connected to the LAN and configured in R&S WinIQSIM2. In addition, you need the security password of the instrument, and the remote desktop control must be enabled in the instrument (see the user manual of the instrument).

1. In the "ARB Sig Gen or Vector Sig Gen" block, select an instrument.
2. Select "ARB Sig Gen or Vector Sig Gen > Remote Desktop".

   The "VNC Authentication" dialog prompts you to enter the instruments' security password.
3. Enter the password.
4. Confirm by pressing the "Enter" key.

   When the connection is established, you have access to the instrument and you can perform settings directly from your computer.

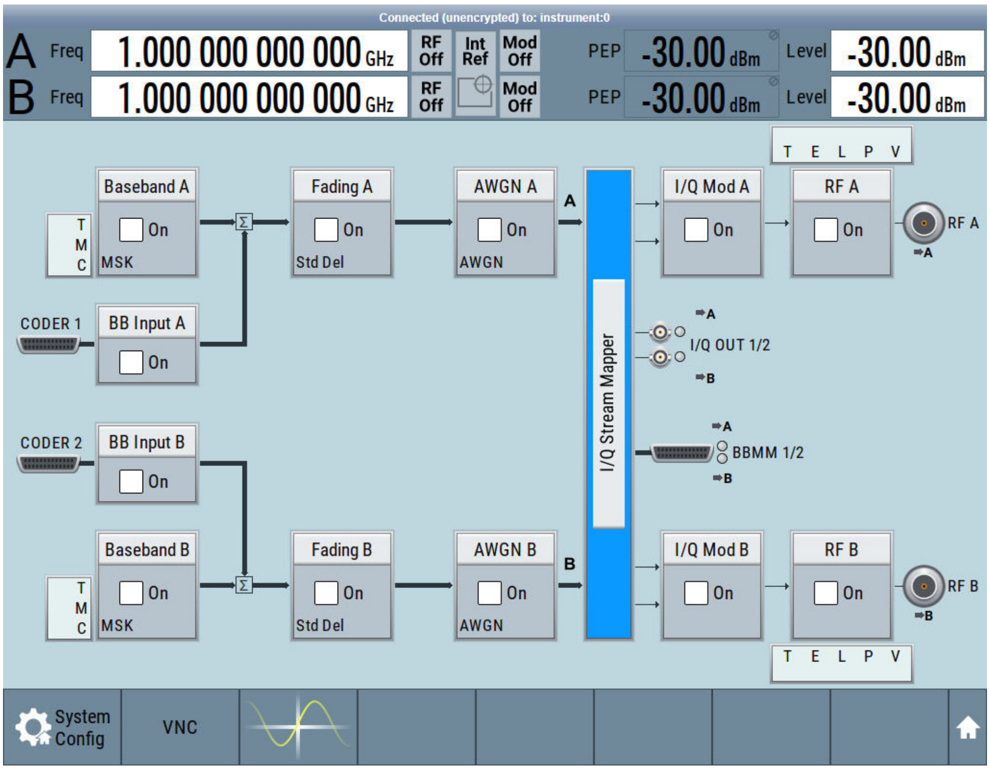


Figure 6-1: Remote desktop access to the R&S SMW

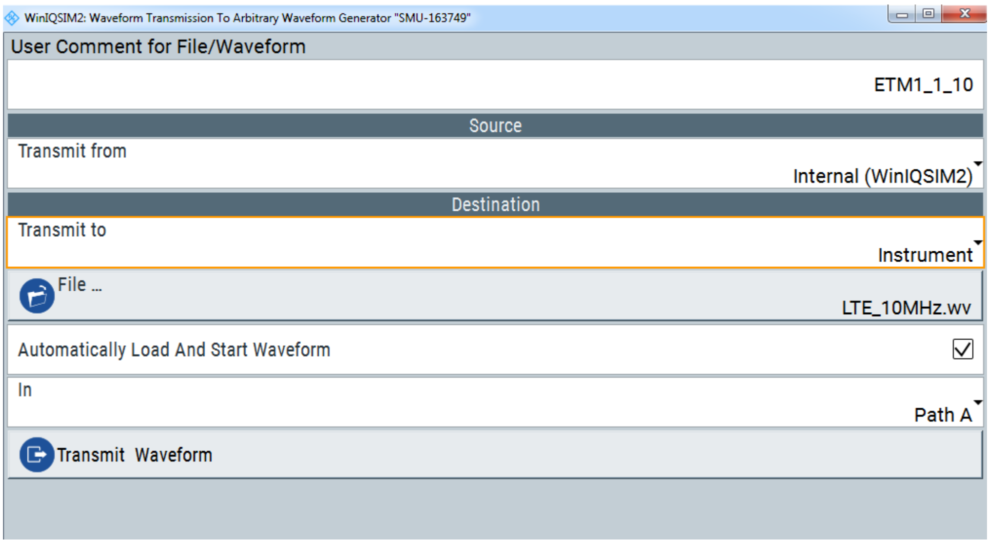
7 Transferring data

In addition to saving a waveform signal in a file, you can download it directly to an instrument connected via LAN, GPIB or USB. R&S WinIQSIM2 provides a transfer dialog with the necessary setting parameters.

7.1 Waveform transmission settings

To configure the data transmission, perform the following steps:

1. Configure the baseband signal that you want generate with the ARB of an instrument.
2. In the menu bar of R&S WinIQSIM2, select "Transmission > Transmit"



The "Waveform Transmission To Arbitrary Signal Generator" dialog contains the parameters required for configuring data transmission or saving.

User Comment for File/Waveform
Enables you to specify a brief remark to the waveform (optionally), e.g. information for identifying the file.

The destination instrument displays the comment in the "Load Waveform" dialog. For example, the R&S SMW200A shows the main characteristics of the waveform file in a tooltip, including the user comment.

Remote command:
:TRANsmit:COMMent on page 304

Transmit from
Selects the data source.

"Internal (WinIQSIM2)"
Uses last generated internal waveform file.

"File" Uses a previously stored file.
To select the file, you can access the browser with the displayed File button.

Remote command:
:TRANsmit:SOURce on page 305

File
Accesses the standard browser for selecting a previously stored waveform file.

Remote command:
:TRANsmit:SOURce:LFILe on page 305

Transmit to
Selects the recipient of the waveform file.

"Instrument"
Transmits the waveform file directly to the instrument.
The instrument receives the file and stores it in its user directory. If you have enabled "Automatically Load and Start Waveform", the instrument loads the waveform file directly in the ARB and starts signal generation.

"File" Stores the waveform into a file on the computer.
To determine the location and file, use the File button.

Remote command:
:TRANsmit:DESTination on page 304

File
Accesses the standard browser for storing the waveform file. You can select the directory and assign a file name. The file extension is predefined (`*.wv`).

Remote command:
Saving a file on the instrument: :TRANsmit:DESTination:IFILe on page 304
Saving locally on the hard disc: :TRANsmit:DESTination:LFILe on page 305

Automatically Load And Start Waveform
Enables the following automatic process sequence when you execute Transmit Waveform:

The generator stores the file on its internal hard disk, loads it into the ARB and starts replaying the signal. The resulting signal is immediately available for the I/Q output.

When disabled, Transmit Waveform transmits the waveform file and stores it on the hard disk of the instrument.

Remote command:
:TRANsmit:AUTO[:STATe] on page 304

In
Selects the signal path of the instruments for the signal generation.

Remote command:
`:TRANsmit:AUTO:PATH` on page 303

ARB
Requires connected R&S BTC instruments, since these instruments have several ARB generators in a path.

Selects the arbitrary waveform generator.

Remote command:
`:TRANsmit:AUTO:ARB` on page 303

Transmit Waveform
Executes the waveform transfer according to the configured source and destination media.

Remote command:
`:TRANsmit:STATe` on page 305

7.2 How to transmit waveform data to instruments or files

The step-by-step instructions in this section deal with the following:

- "To configure the connection and to generate the waveform file" on page 202
- "To transfer the generated waveform signal to the instrument via the network" on page 203
- "To transfer the generated waveform signal to the instrument via USB" on page 203
- "To store the generated waveform signal in a file" on page 204
- "To load a waveform file" on page 204
- "To copy a previously created waveform file" on page 204
- How to transfer waveform data created by R&S WinIQSIM2 to a connected instrument

Using the example of an R&S SMW200A connected in the LAN, we assume that you have already performed the following steps:

- The R&S SMW200A is connected in the LAN and turned on
- R&S WinIQSIM2 is installed on a remote controller also connected in the network.
- R&S WinIQSIM2 is running, reset to an initial state.

This section does not describe any settings for the R&S SMW200A but focuses only the task-related settings. For information on configuration and working with the R&S SMW200A, refer to the user manual of the instrument.

To configure the connection and to generate the waveform file

This instruction leads through the required steps before the data transfer.

1. Perform the steps in "To scan the network for connected instruments" on page 186, to establish the connection to the R&S SMW200A in the LAN.

2. Verify the instrument settings, according to "To understand the instrument configuration" on page 189.
3. In the block diagram of R&S WinIQSIM2, select "Vector Sig Gen > SMW200A".
4. To generate the waveform signal with the required settings:
   a) Follow the example under Chapter 2.3.3, "Generating a waveform signal", on page 22
   b) If you want to add an interference signal to the waveform, see Chapter 2.3.4, "Adding noise to the waveform signal", on page 24.

To transfer the generated waveform signal to the instrument via the network

At this point, we refer to "To transmit the generated waveform to the R&S SMW" on page 32 for an example to transmitting the created waveform data to the R&S SMW200A.

► See "To transmit the generated waveform to the R&S SMW" on page 32.

To transfer the generated waveform signal to the instrument via USB

Alternatively to the file transfer possibility via LAN, GPIB or USB connection, you can use a USB storage device for direct file transfer to the instrument.

It is recommended that you transfer files with user data, e.g. waveform files, data lists, application settings to the instrument. Avoid loading and playing them from a connected USB storage device.

To transfer a file with user data via USB and store it on an instrument, perform the following:

1. Connect a USB storage device, e.g. a USB memory stick to a USB interfaces of the PC.

   The PC recognizes the connected USB storage device automatically and assigns a directory drive.
2. Configure the waveform, e..g. a 3GPP FDD signal.
3. Store the waveform in a file, as described in "To store the generated waveform signal in a file" on page 204 by selecting the target directory on the USB drive letter.
4. Verify the security settings of the destination instrument.
   If disabled:
   a) Enable the file transfer via USB on the instrument.
   b) Enable the write permission to the storage media of the instrument.

   Refer to the user manual of the instrument for information on how to get the access.
5. Connect the USB memory device to a USB interface of the instrument.
6. On the instruments front panel, press the [Save/Recall] key.
7. Select "File Manager".

8. In the directory tree, navigate to the USB drive.
9. Select the required file.
10. Select "Copy".
11. In the directory tree, navigate to the internal user directory.
12. Select "Paste".

    The file with user data is transferred to the instrument.

To store the generated waveform signal in a file

► To store the waveform, see "To save the generated waveform file" on page 33.

To load a waveform file

1. In the menu bar, select "Transmission > Transmit".
2. Select "Source > Transmit from > File".
3. Open the browser dialog with the "File" button.
4. Select the required file.
5. Confirm with "Open".

To copy a previously created waveform file

If you want to duplicate for example an existing waveform, you can save a copy with a different name.

1. In the tool bar, select to open the "Waveform Transmission" dialog.
2. Select "Source > Transmit from > File".
3. Open the browser dialog with the "File" button.
4. Select the required file.
5. Confirm with "Open".
6. Select "Destination > Transmit to > File".
7. Open the browser dialog with the "File" button.
8. Open the browser dialog with "Destination > File".
9. Select the destination directory.
10. Enter the new file name.
11. Confirm with "Save".

    R&S WinIQSIM2 stores the same waveform data in the new file.

8 File and data management

R&S WinIQSIM2 uses files to save all application data. You can store and load application settings, as well as import and export user data.

The save and recall function for managing of the application settings is available via the "File" menu. Dedicated save/recall functions are available in the settings dialogs of the digital standards or accessible whenever user files are used.

This section focuses on the functions provided for managing of user data files and covers the topics listed below.

For information on the related remote control commands, refer to Chapter 11.4, "MMEMory subsystem", on page 284.

8.1 About the file system

Depending on the contained information, two file groups are distinguished: program and user files.

R&S WinIQSIM2 stores the program files in a predefined destination directory, as described in "To download the software" on page 16. These files and the system directory are not to be modified.

Therefore, this section focuses on files with user data.

This section is an overview of the file system of R&S WinIQSIM2 and covers the following topics:

- "Types of user data" on page 205
- "File storage Location" on page 206
- "File handling" on page 206
- "File naming conventions" on page 207
- "File extensions" on page 207
- "File Contents" on page 207

Types of user data

The **user data** includes saved settings of the application, data for the different digital standards and import data, and the waveform files generated for transmission.

Also, you can save the settings in the form of command sequences, e.g. in SCPI or other languages.

The user data can be roughly divided into the following data types:

- *Settings*, e.g. the frame setting of the GSM/EDGE standard or the current application settings, can be stored and reloaded later.
  See Chapter 8.2, "Storing and recalling application settings", on page 207
- Externally or internally generated *lists*, e.g. user correction lists, or data lists can be loaded in the instrument.
  See Chapter 8.5, "Loading, importing and exporting lists", on page 217 and Chapter 8.3, "Accessing files with user data", on page 213
- Externally or internally generated *complex modulation and control data* can be loaded.
  See Chapter 8.3, "Accessing files with user data", on page 213
- Externally generated *waveforms* can be imported.
  See Chapter 3.8, "Import IQ data", on page 135

File storage Location

R&S WinIQSIM2 stores user files on an arbitrarily selectable directory, or on an external storage medium, like a memory stick.

Application data storage Location

R&S WinIQSIM2 stores application data in the default application data directory `%APPDATA%\Rohde-Schwarz\winiqsim2`. In manual control, you can access and change the storage directory via "File > Setup > Temporary Files > Browse".

In remote control, you can query the directory with the command `:SYSTem:MMEMory:PATH:USER?`. To change the current directory, use the command `:MMEMory:CDIRectory`.

File handling

To access files and the file system or to use the general file management functions such as copying and moving data, use the standard browser functions (see Chapter 8.6, "Using the file manager", on page 217).

To transfer files from and to the instruments or to import files, use one of the following alternatives:

- Connect a memory stick to one of the USB interfaces.
  The computer recognizes a connected memory stick and assigns a drive letter automatically.
- Establish a connection to a LAN.
  You can also exchange files with devices / computers that have shared directories on the network for SMB access

  Connected to a LAN you can exchange files via two standard transfer protocols from a remote client:
  – FTP (file transfer protocol)
  – File sharing according to SAMBA/SMB (server message block) protocol.

See the user manual of the destination instrument, to obtain information on the supported file transfer protocols.

File naming conventions

To enable files to be used in different file systems, consider the following file naming conventions:

- The *filename* can be of any length and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters.
- All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the filename).
- Avoid using special characters.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

File extensions

R&S WinIQSIM2 distinguishes the files according to their extensions; each type of file is assigned a specific file content and hence a specific file extension. The extension is usually of no consequence to the user since access to the files occurs in the individual dialogs where only the relevant type of file is available. For example, files with frame settings can only be saved and loaded in the "GSM/EDGE" dialog.

See Chapter A, "Extensions for user files", on page 406 for an overview of the supported file extensions.

File Contents

In general, a settings file contains user-specific settings of a session, e.g. baseband settings, instrument settings, graphic display settings, etc.

To maintain the file size and to accelerate the loading and processing times, only the settings which differ from their respective default values are stored. Considered is also configuration data for the operating elements and lists with user data, e.g. dialog positions and a data lists. However, if a list data is part of the settings, a reference to this list is stored, not the list itself.

This approach makes sure that the created files contain only relevant information. During the recall process, R&S WinIQSIM2 interprets only the relevant settings; all non-referenced parameters are set to the associated preset values. Error messages indicate the settings which cannot be implemented, like referencing non-existing lists or the attempt to activate settings which are not supported by R&S WinIQSIM2.

8.2 Storing and recalling application settings

This section deals with the save, load, and reset functions of the application settings.

Apart from presetting the application to an initial state, the functions "Save" and "Open", as well as "Save" and "Recall" enable you to store a configured waveform signal for later reuse. These functions store or reload either all performed settings, or exclusively the settings of a digital standard.

For example, if you want to repeat, or restore a specific waveform signal you have already generated. Or you want to transfer the waveform signal to several instruments.

In each of these cases, you can create a file with the complete application settings, or you can choose to store only the settings of a particular digital standard. Both options are scope of this section.

Save/Open the complete application settings

You can save and upload the complete settings of your configuration in a defined storage location with a user-defined filename. The file extension is `*.svrcltxt`. Settings files created in this way are visible in the file system and accessible with the known "File > Open / Save / Save As...." functions for file handling.

The "File > Open" process replaces the current configuration with the reloaded values.

Save/Recall the settings belonging to the digital standards

Each of the digital standards provides a special "Save/Recall" function to manage directly the settings associated to the corresponding digital standard, e.g. all settings in the "3GPP FDD" dialog.

Two different methods are available for managing the settings of a particular digital standard:

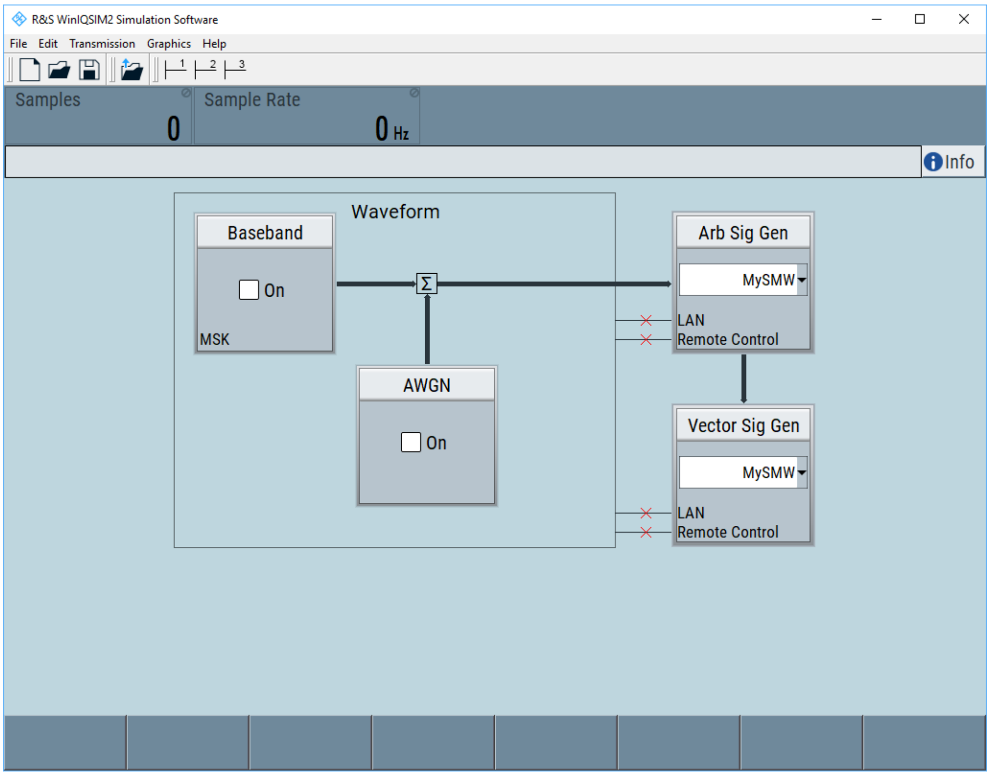
- Immediate (quick) Save/Recall
  A defined set of settings are stored or recalled quickly in just one step, without defining a file name or storage location. This function enables a fast switching between different settings.
- Save/Recall in files with user-defined names
  The defined set of settings are stored in 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.

The "Save/Recall" functions create 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.

8.2.1 Resetting the application

To perform a reset of R&S WinIQSIM2

► In the menu bar, select "File > New".



The function sets the parameters and operating modes to default values predefined in R&S WinIQSIM2.

8.2.2 Save / open complete application settings

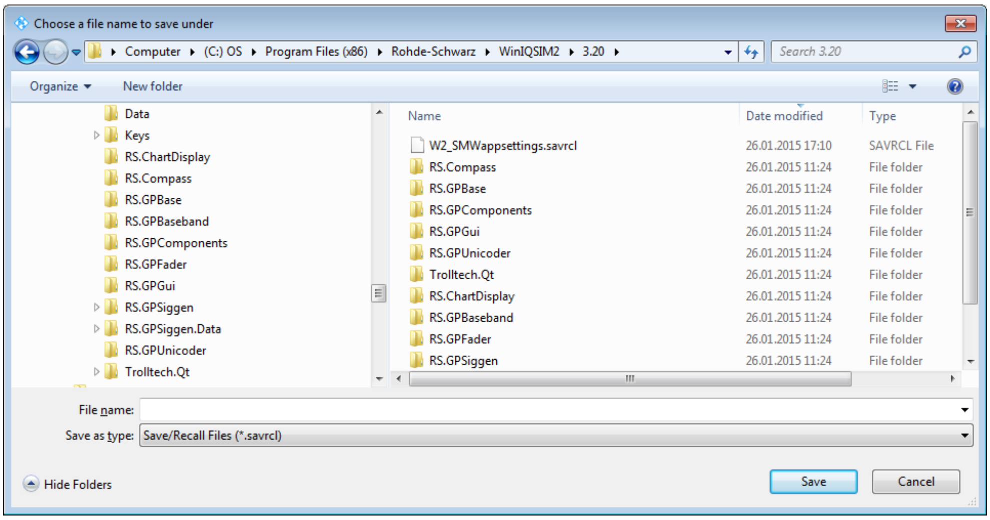
To access the dialogs for storing or loading the complete application settings

Depending on the task, perform one of the following:

► In the menu bar,

a) Select "File > Open".
b) Select "File > Save".

c) Select "File > Save As...".



The provided settings of these operations are similar and closely related. These browser functions detect, display and store only settings files with the file extension `*. svrcl`.

Settings

File

Provides the functions for handling of settings files.

Open ← File

Accesses the standard file browser for loading a previously saved R&S WinIQSIM2 settings file. A file contains the complete application settings.

Save / Save As.. ← File

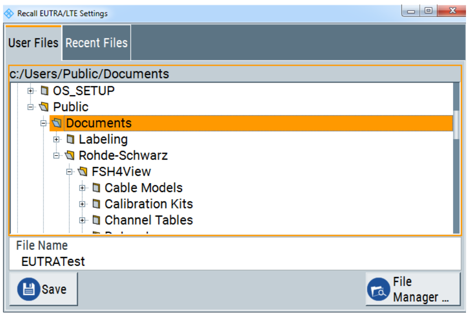
Stores the settings of the current session in a previously selected file or in a new file.

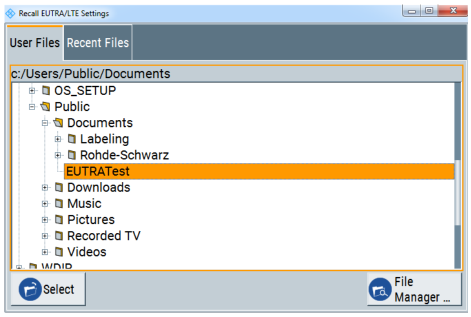
8.2.3 Save/recall settings

To access the dialog for storing and loading the settings of a digital standard

► In the general tab of a digital standard dialog, select the "Save" or "Recall".

E.g., select "Block Diagram > Baseband > EUTRA/LTE > General > Save".





The name of the dialog is context-sensitive and varies depending on the performed function and the particular digital standard. The provided functions are similar.

Settings

Select Operation

Accesses the functions for storing ("Save") and loading ("Recall") the current configuration of a digital standard.

Directory, File List and File Name

Note:

You access this generic function each time you perform one of the following:

- Store or load (settings) files
- Define a folder these files are to be stored in
- Navigate through the file system

The name of the dialog is context-sensitive but the provided functions are self-explanatory and similar.

With the provided settings, you can ...

- Navigate through the file system, use the directory tree
- Create a new file, load and store files, use the dedicated functions "New", "Select", Using the file manager and Recent files.
- Perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Using the file manager).

Remote command:

To list all files in a directory:

`:MMEMory:CDIRectory` on page 288

`:MMEMory:CATalog?` on page 287

Refer to the description of the digital standards for the syntax of the corresponding SCPI command: `[:SOURce<hw>]:BB:<Digital Standard>:SETTing:CATalog`.

Recent files
Displays the files last used.

Save
Saves the current settings belonging to a digital standard under the defined file name.

Remote command:
`:MMEMory:STORe:STATe` on page 294
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`

Recall
Restores the selected configuration.

During recall, signal generation software considers all related settings, for example active state or lists. An error message indicates the settings which cannot be implemented.

Remote command:
`:MMEMory:LOAD:STATe` on page 292
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:
`[:SOURce<hw>]:BB:<Digital Standard>:SETTing:LOAD`

File Manager
Accesses the "File Manager" dialog, see Chapter 8.6, "Using the file manager", on page 217.

8.2.4 How to save and recall settings

You can save your settings into a file, e.g. for the reuse of the waveform in repeated tests with the same settings.

To save and recall complete application settings

1. In the menu bar, select "File > Save".
2. Select the storage location.
3. To save the settings, perform one of the following:
   a) For an update, select an existing file.
   b) For creating a file, assign the file name.
4. Confirm with "Save".

   R&S WinIQSIM2 stores the current configuration in the file with the defined name and path and the extension `*.savrcltxt` is created.
5. To restore settings, select "File > Open" in the menu bar.
6. In the target directory, select the previously stored settings file.

7. Confirm with "Open".

   The settings are restored and you can process the waveform signal with the same settings.

8.2.5 How to save and recall digital standard settings

Some test setups, e.g. for MIMO tests, require that two or more signal generators generate a digital standard baseband signal with similar settings. An easy way to speed up configuration is to use the dedicated save/recall function provided in each digital standard configuration dialog.

To save and to reuse a configuration related to a digital standard

1. In the block diagram, select "Baseband > Digital Standard, e.g. 3GPP FDD" and adjust the settings as required.
2. In the "3GPP FDD > General" tab, select "Save", navigate in the file selection dialog and select a file name and storage location for the settings file.

   A file with the defined name and path and a predefined extension (`*.3g`) is created.
3. Reuse the saved configuration by selecting "Recall" and selecting the settings file from the storage location.

   You can also use a USB stick to transfer the created file to another instance, on which another R&S WinIQSIM2 software is running.
   Reuse the configuration by selecting "Recall" in the "Baseband > Digital Standard" dialog in this software.

8.3 Accessing files with user data

By the calculation of signals according to the different digital standards or by the generation of custom digitally modulated signals, R&S WinIQSIM2 uses the data from different data sources (see also Chapter 3.3.1.1, "Data and signal sources", on page 51). To simulate the signal of one UE for instance, R&S WinIQSIM2 modulates and codes the provided data for each channel and further processes the signal as described in the corresponding standard.

Whenever a data list file is enabled as a data source, R&S WinIQSIM2 provides direct access to the standard "File Select" function. You can select, create and edit data list files.

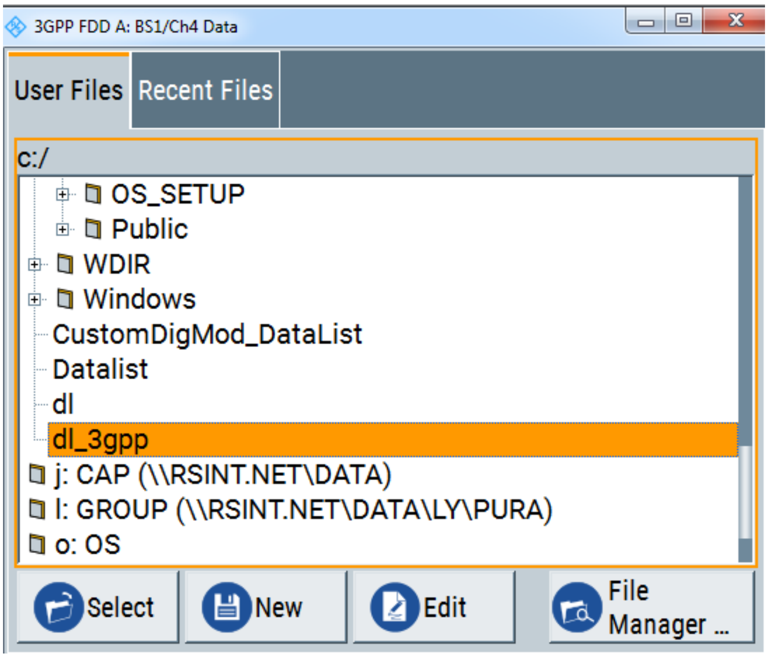
8.3.1 File select settings

The "File Select" dialog opens automatically each time you select a data list file as data source or you select a control list.

To access a loadable data list file

1. Select the "Data List Name" in the individual dialog, e.g. for "Baseband > 3GPP FDD > Basestations > BS1 > Channel Table > P-CCPCH > Data = Data List" select "DList = None".

   A "File Select" dialog for loading, creating and modifying a file is displayed.

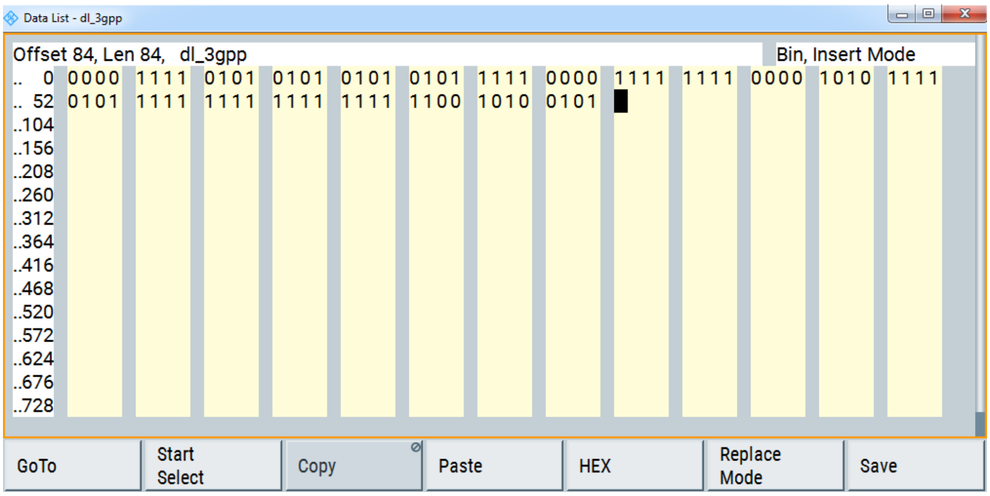
   

   Tip: The name of the dialog is context-sensitive and varies according to the digital standard and accessing function. However, the provided functions are similar.

2. To load an existing file:
   a) In the file system, navigate to the destination folder.
   b) Select the file.
   c) Confirm with "Select".
3. To create a file, for example if there is no data list file specified:
   a) In the file system, navigate to the destination folder.
   b) Select "New".
   c) Enter the file name.
   d) Confirm with "Ok".

   R&S WinIQSIM2 creates and stores a new empty file.
4. To edit an existing or newly created file:
   a) In the file system, navigate to the destination folder.
   b) Select the file.
   c) To open the file, select "Edit".

   The standard "Data List Editor" dialog opens, see Chapter 3.4.2.8, "Data list editor", on page 75.



5. Edit the file content.

6. Confirm with "Save".

Settings

Directory, File List and File Name

Note:

You access this generic function each time you perform one of the following:

- Store or load (settings) files
- Define a folder these files are to be stored in
- Navigate through the file system

The name of the dialog is context-sensitive but the provided functions are self-explanatory and similar.

With the provided settings, you can ...

- Navigate through the file system, use the directory tree
- Create a new file, load and store files, use the dedicated functions "New", "Select", Using the file manager and Recent files.
- Perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Using the file manager).

Remote command:

To list all files in a directory:

`:MMEMory:CDIRectory` on page 288

`:MMEMory:CATalog?` on page 287

Refer to the description of the digital standards for the syntax of the corresponding SCPI command: `[:SOURce<hw>]:BB:<Digital Standard>:SETTing:CATalog`.

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 360
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:
`[:SOURce<hw>]:BB:<Digital Standard>:...:DATA DLISt`
`[:SOURce<hw>]:BB:<Digital Standard>:...:DSELect`

"New" Creates a file with the specified "File Name".
To confirm, select "OK"; use "Cancel" to undo the operation.
To edit the file content, select "File Select > Edit".

"Edit" Accesses the "Data List Editor" and loads the selected file for editing, see Chapter 3.4.2.8, "Data list editor", on page 75.

Functions for handling of control lists
Provided are the following standard functions for file handling:

"Select" Select and load the file.

Remote command:
`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 358

"New" Creates a file with the specified name. To edit the file content, select "File Select > Edit".

"Edit" Accesses the "Control List Editor" and loads the selected file for editing, see Control and marker lists editor.

Recent files
Displays the files last used.

File Manager
Accesses the "File Manager" dialog, see Using the file manager.

8.3.2 How to create and access data and control lists

The general principle for accessing files with user data is described in "To access a loadable data list file" on page 214. Detailed and further information on how to create and access files with user data like data lists and control lists is provided in the following sections:

- Chapter 3.4.3.2, "How to create and assign a data list", on page 84
  Overview of the possible ways and detailed description on how to create data lists
- Chapter 3.4.3.1, "How to create and assign a control list", on page 82
  Overview of the possible ways and detailed description on how to create control lists
- "Storing and Loading Current Settings" on page 286
  Information on accessing files in a remote environment

8.4 Exporting remote command lists

To set specific instrument settings or perform a task automatically, you can create scripts that contain the settings in the form of remote control command sequences.

You can either record or manually create SCPI lists, or generate a list of the current application state in one step, see .

Completed scripts are stored in files, converted to different formats, depending on the used language of the source code.

The R&S WinIQSIM2 supports the most commonly used languages by default, as there are:

- Plain SCPI: `*.txt`
- MATLAB: `*.m`
- NICVI: `*.c`

It is also possible, to convert the SCPI command list to a user-specific language, see .

8.5 Loading, importing and exporting lists

R&S WinIQSIM2 provides built-in editors for creating data, control lists and lists for the list mode or lists with user correction data. If you want to create or evaluate data with an external application, R&S WinIQSIM2 provides interfaces with the following functionality:

- Import and export list files in a standard ASCII format file
- Load files with modulation and control information
- Load of internally or externally generated waveform file

Lists are stored and loaded in the appropriate dialogs. For example, the user correction data list is created and stored in the "User Correction" dialog; waveform files are created with the signal generation software R&S WinIQSIM2 or in the dialogs of some of the digital standards.

For more information, refer to Chapter 8.3.2, "How to create and access data and control lists", on page 216.

8.6 Using the file manager

The "File Manager" is a tool similar to the standard Windows Explorer that helps you to manage mass storage media and files.

It is embedded in R&S WinIQSIM2, especially designed for managing file formats for applications in signal generation. It supports direct data exchange between instruments from Rohde & Schwarz.

You can perform the following tasks:

- Copying files from disk to other media.
  See Chapter 8.7, "Transferring a file to an instrument", on page 220
- Copying files into another directory, renaming and deleting files.
  See "Cut, Copy&Paste and Delete" on page 220
- Creating directories.
  See "Create New Directory" on page 220

Access:

You can access the "File Manager" via the "File Manager" button. It is available in all dialogs that provide loading or saving data from or to files, e.g. in the dialogs of the *digital Standards*, *Custom digital Modulation* or list management. The instruction leads you to the file manager, by the example of the digital standard application 3GPP FDD:

1. In the block diagram, select "Baseband > 3GPP FDD".
2. Select "Recall".

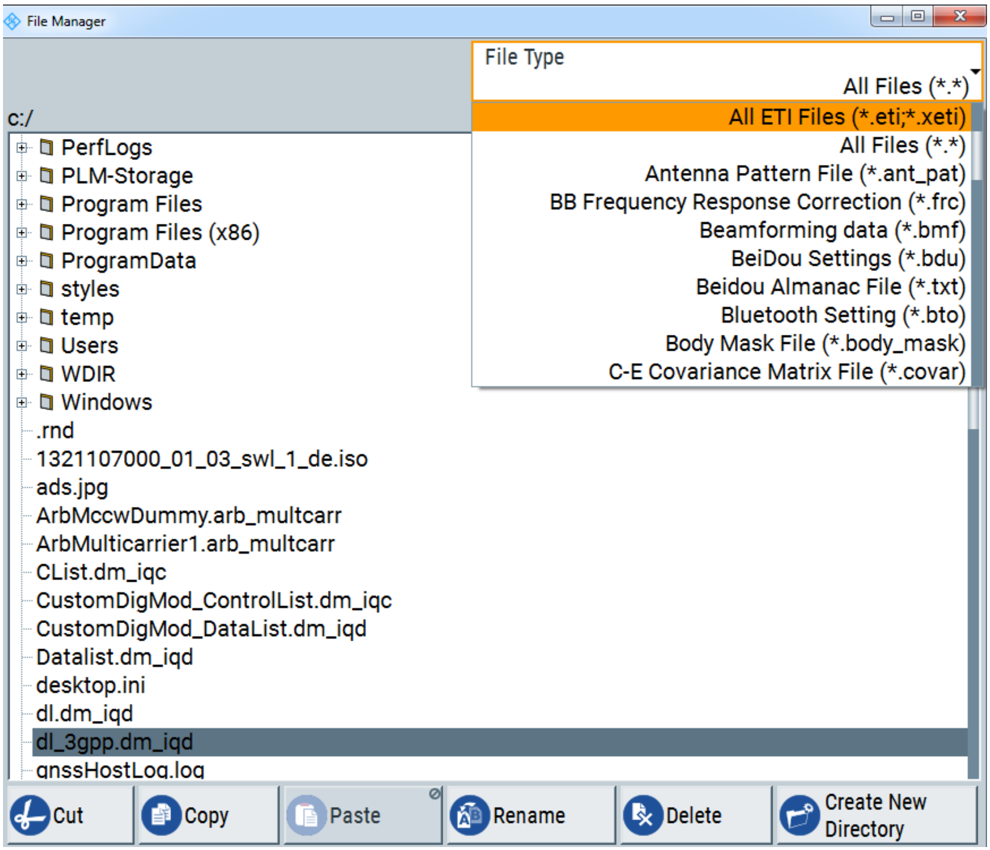
   Tip: Each "Save/Recall" dialog and each "File Select" dialog provides a quick access to the "File Manager", i.e. whenever you select data lists or files with user data.
3. Select "File Manager".

8.6.1 File manager settings

Access:

1. In the block diagram, select e.g. "Baseband > 3GPP FDD".
2. In the "General" tab, select "Recall".

3. Select "File Manager".



The dialog provides all standard functions required to manage files. It displays the contents of the selected folder and provides functions to rename, delete, copy or to move files.

Settings:

File Type

Selects the file types to be indicated. If a file type with a specific file extension is selected, only files with this particular extension are listed.

See Chapter A, "Extensions for user files", on page 406 for an overview of the supported file extensions.

Directory and File Name

Allows you to navigate in the contents tree to select the directory and file.

The dialog lists all files of the selected directory, and highlights the selection. The path is indicated above the directory tree.

Unlike the "Save/Recall" and "File Select" dialogs, the "File Manager" displays the full file names including extensions.

Remote command:
`:MMEMory:CDIRectory` on page 288

Cut, Copy&Paste and Delete
Standard file management functions.

Before a file is deleted, a message prompts you to confirm the deletion.

Remote command:
`:MMEMory:DELete` on page 292
`:MMEMory:COPY` on page 288

Rename
Renames the selected file or directory.

Remote command:
`:MMEMory:MOVE` on page 293

Create New Directory
Creates a folder and opens an edit dialog to enter name and path (absolute or relative to the current directory) of the new folder.

Remote command:
`:MMEMory:MDIRectory` on page 293

8.7 Transferring a file to an instrument

As explained in Chapter 7, "Transferring data", on page 200, you can transfer a waveform file to an instrument via one of the following ways:

- Directly to an instrument connected over LAN, GPIB or USB, see "To transmit the generated waveform to the R&S SMW" on page 32 for an example.
- Manually via a connected USB storage device, as described in "To transfer the generated waveform signal to the instrument via USB" on page 203.

Mainly because of security reasons, the access to the file system of an instrument can be denied, because one or all 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.

To get more detailed information on the security settings of your instrument, refer to the corresponding user manual. For comprehensive information, refer to the application note 1GP72: Connectivity of Rohde&Schwarz Signal Generators.

9 General software functions

The general functions include basic settings, regardless of the selected operating mode and signal generation. You can access these settings mainly in the file menu or, alternatively via the icons in the toolbar in the main application window.

Refer toMenu bar, icons and shortcuts for an overview.

The general functions of the menu entries at a glance:

- "File > New", presets R&S WinIQSIM2 to a predefined state, see Chapter 8.2.1, "Resetting the application", on page 209.
- "File > Open, Save, Save As", saves application settings for reuse, see Chapter 8.2, "Storing and recalling application settings", on page 207.
- "File > Setup", provides information on the software, see Chapter 9.1, "Setup", on page 222
- "Exit", shuts down the application.
  R&S WinIQSIM2 stores the current settings, and reloads this configuration with the next start.
- "Help", provides access to the online help and information on the software version, see Chapter 2.6, "Getting information and help", on page 44.

For the description of the application-specific menu entries, see:

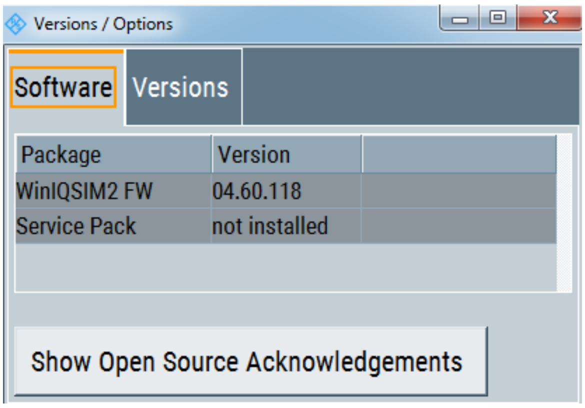
- "Transmission", provides the settings for configuring instruments and data transfer.
  - "Instruments...", see Chapter 6, "Setting up instruments", on page 185.
  - "Transmit", see Chapter 7, "Transferring data", on page 200.
- "Graphics", see Chapter 5, "Displaying simulated waveforms graphically", on page 161

9.1 Setup

9.1.1 Software/options settings

Access:

► Select "File" > "Setup" > "Software/Options".



The dialog shows the software components of the firmware.

Software
Shows the versions of the software package and the software platform.

Note: Software updates and the release Notes describing the improvements and modifications are provided on the Internet at the download site of the Rohde & Schwarz WinIQSIM2 home page. This home page always offers the latest information on R&S WinIQSIM2. How to install/uninstall the software and changes of the software installation procedure, is also described in the release notes.

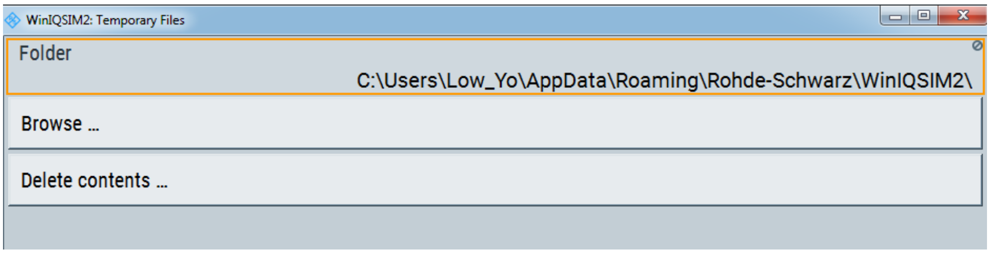
Versions
The "Versions" tab shows the versions of the technical specification of the R&S WinIQSIM2 and of the software components that comprise the firmware.

"Package"	Name of the component.
"Version"	Current issue of the component.

Remote command:
n.a.

9.1.2 Temporary files

► To access the "Temporary Files" dialog, select "File > Setup > Temporary Files".



The dialog contains the parameters for selecting the file location or removing temporary files.

Folder
Indicates the directory where temporary files are stored.

Browse
Accesses the browser for selecting the file location for temporary files.

Delete contents...
Deletes all temporary files in the selected directory.

9.1.3 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.

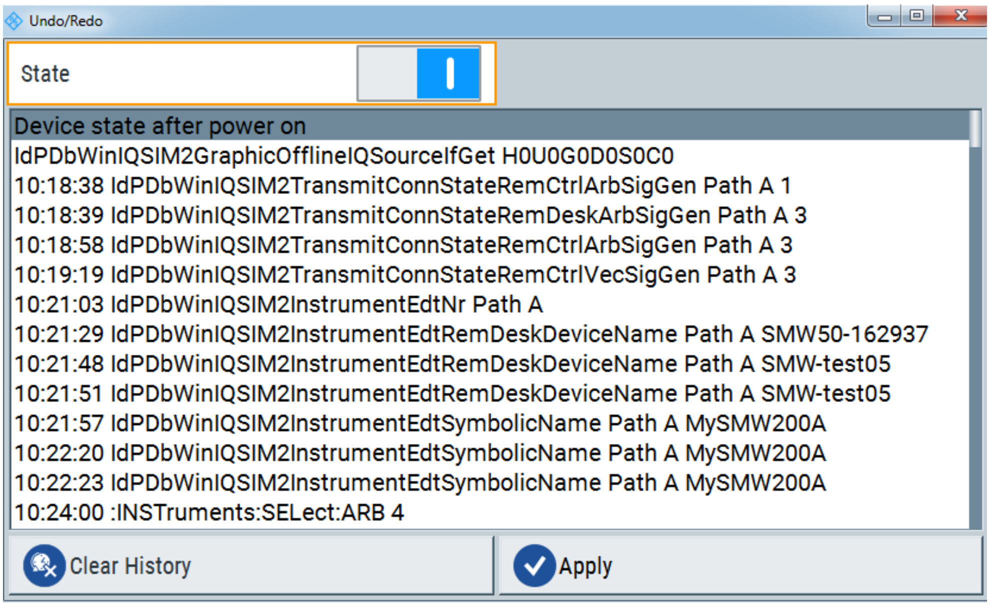
You can "Undo/Redo" actions according to two criteria:

- Step by step
  Gradually undo/redo the actions in reverse order as previously performed. Depending on the available memory, the "Undo/Redo" steps can 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.

9.1.3.1 Undo/redo settings

Access:

► Select "Edit > Settings > Undo/Redo".



The dialog contains all functions for enabling the "Undo/Redo" functionality.

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.

9.1.4 Deleting temporary files

To determine the storage location for temporary files

In this example, we create a destination folder for temporary files. If the directory already exists, skip the second step.

1. In the main application window, select "File > Setup > Temporary Files..."

   R&S WinIQSIM2 displays the current storage location for temporary files in the "Folder" field.

2. Select "Browse" to access the browser, e.g. to create a folder, or to select the new destination folder.

3. Confirm with "Select Folder".

   R&S WinIQSIM2 changes the destination location and displays the complete directory name in the "Folder" field.

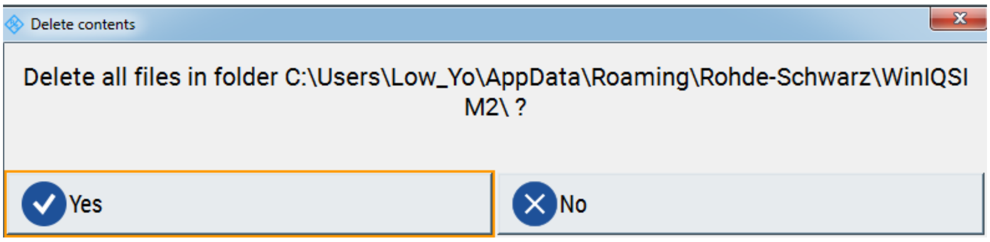
To delete temporary files

Note: This function deletes all files in a directory.

Therefore, before deleting content, verify the currently selected directory, shown under "Folder". If necessary, select the destination folder, as described in To determine the storage location for temporary files.

1. To delete the contents in the folder, select "Delete Contents".

   R&S WinIQSIM2 prompts you to confirm deleting of contents.



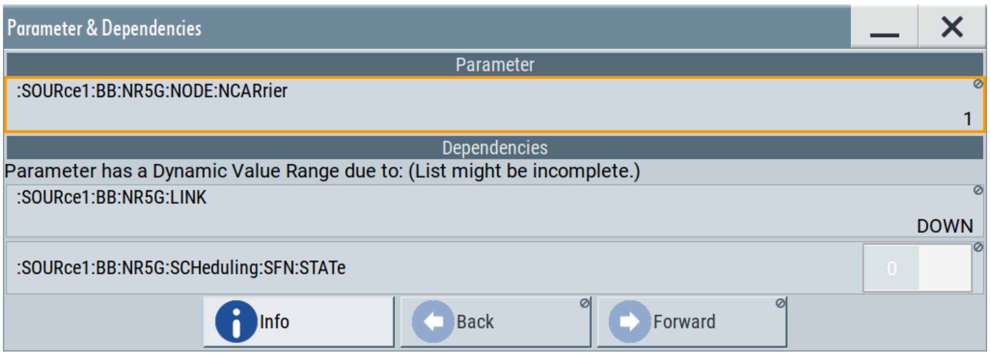
2. Confirm with "Yes"

   The function removes all temporary files in the selected folder.

9.2 Checking parameters and dependencies

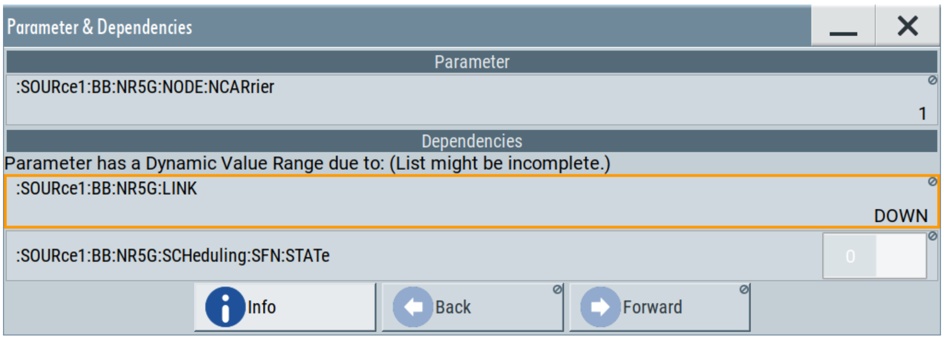
You can check settings on a parameter-level for incoming dependencies. These dependencies include R&S WinIQSIM2 configurations that affect properties of the parameter. Properties are, for example, selectable values, ranges, minimum or maximum value depending on the parameter type. After the dependency check, a dialog displays R&S WinIQSIM2 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".

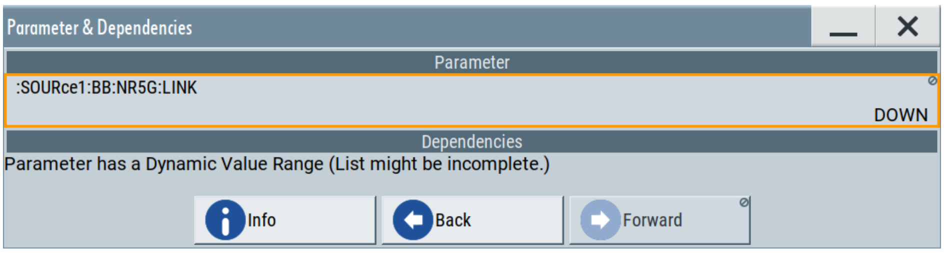


The "Parameter & Dependencies" dialog opens. The "Parameter" panel of this dialog displays the SCPI command including its setting or query parameters. The "Dependencies" panel displays dependent parameters and their settings that affect the setting of the parameter, that you want to check initially (2).

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 Chapter 9.2, "Checking parameters and dependencies", on page 225.

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.

9.3 Querying notifications

The R&S WinIQSIM2 monitors the functions performed and automatically detects errors and irregularities. The signal generation software displays the notifications in the "Info" line and records all notifications in a history with detailed description.

If any critical error occurs, R&S WinIQSIM2 automatically shows the icon in the task-bar. Select the icon to obtain information on the error and the number of occurrences. The icon is assigned to permanent notifications, i.e. the notification and icon are dis-played until the error is eliminated.

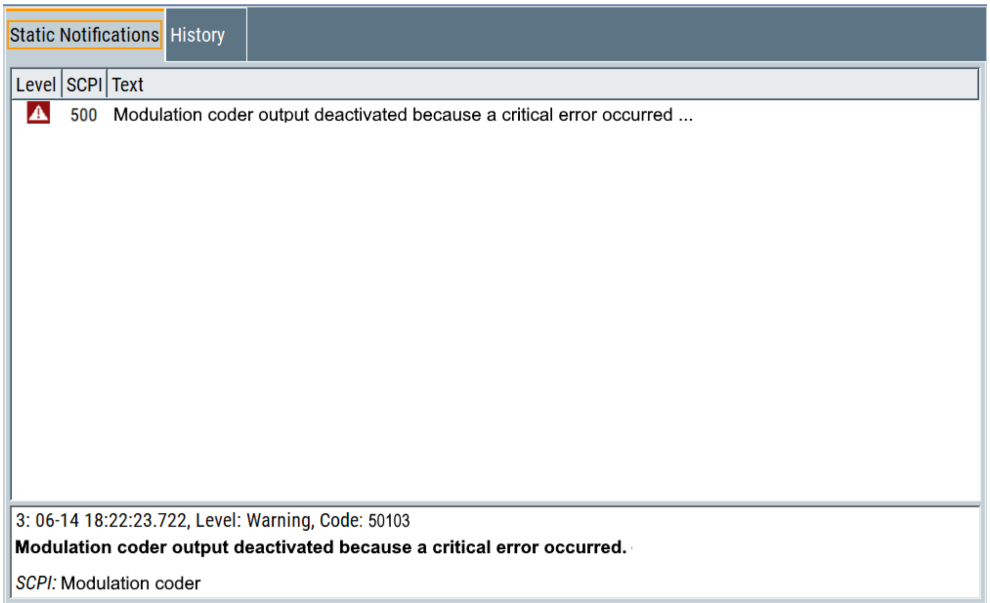
See also Chapter 12, "Troubleshooting and notifications", on page 402.

To display information on notifications and history

If an event occurs, the R&S WinIQSIM2 displays the notification in the "Info" line. To get details on the notification, proceed as follows:

Access:

► In the main application window, select "Info".

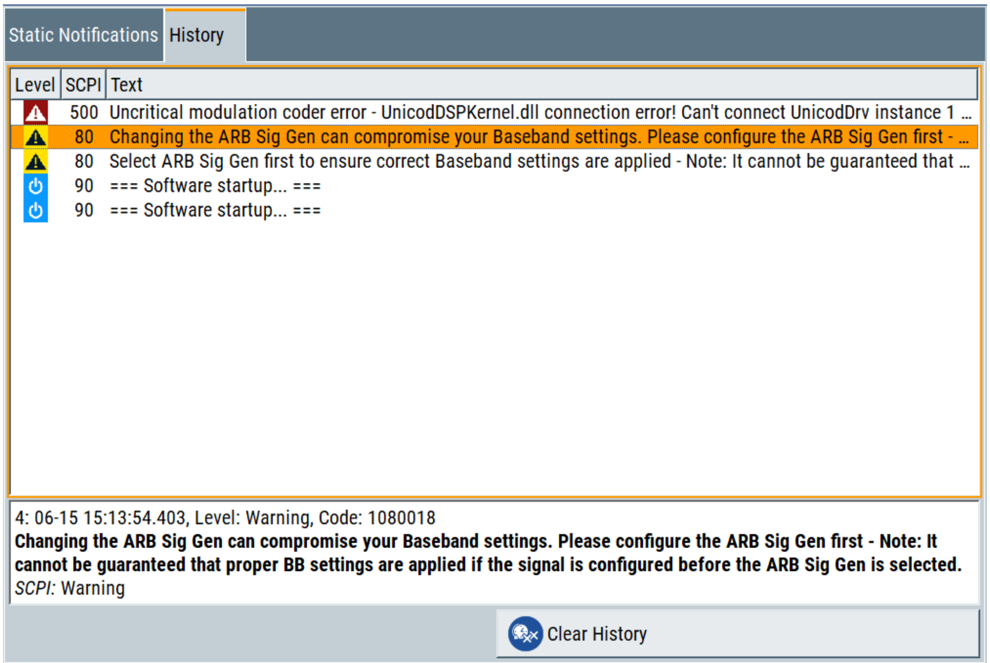


The "Static Notifications" dialog lists the recently monitored permanent notifications chronologically and displays detailed information on the selected notification.

9.3.1 History settings

Access:

1. In the main application window, select "Info".
2. Select "History".



The "History" dialog lists all accumulated notifications with a short detailed description.

Static Notifications / Error History
Selects the view of the info dialog.

- "Static Notifications"
  Shows the permanent monitored notifications.
- "Error History"
  Shows all the accumulated notifications.

"Level" Symbol for type of message.

The following messages types are distinguished:
- "Err": Error notification (red colored)
- "Info": Information notification (black)
- "Sys": System notification
- "Crit": Critical notification (red)

"SCPI" SCPI error code of a notification.

"Text" Description of the notification.

Remote command:
`:SYSTem:ERRor:ALL?` on page 396
`:SYSTem:ERRor[:NEXT]?` on page 398
`:SYSTem:ERRor:STATic?` on page 398

Clear History ← Static Notifications / Error History
Deletes the history list.

Remote command:
`:SYSTem:ERRor:HISTory:CLEar` on page 398

9.3.2 How to manage messages in the history view

Since the functions in the history view are self-explanatory, the following instructions show you a brief outline of their use.

To display notifications

Access:

1. In the main application window, select "Info".
2. Select "Static Notifications".
   R&S WinIQSIM2 lists all permanent notifications.
3. Select "History"
   R&S WinIQSIM2 lists all notifications generated during the current session chronologically in descending order.

To find additional information to a notification

► In the upper panel of the "History" dialog, select the message.

The lower section displays additional information to the selected message.

To delete the history list

Note: You can delete the history in the history view. In the "Static Notifications", a notification remains until the error is eliminated.

1. In the main application window, select "Info".
2. Select "History"
3. Select "Clear History".

   R&S WinIQSIM2 deletes all notifications.

10 Automation of R&S WinIQSIM2

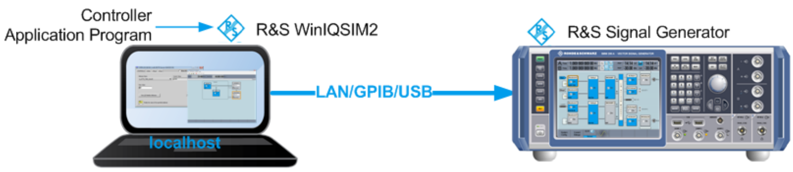
As an alternative to manual operation via the user interface, you can operate R&S WinIQSIM2 from a remote location. Remote control operation allows you to automate and execute R&S WinIQSIM2 operation tasks with higher speed.R&S WinIQSIM2 can run either on the controller PC or on a separate PC connected via LAN, see "Remote control operation modes" on page 231.

The following descriptions require basic knowledge of the remote control operation. For basic knowledge on remote control operation and additional information, see Remote control via SCPI getting started available on the Rohde & Schwarz website.

Remote control operation modes

The following figures show the possible scenarios for remote control operation of R&S WinIQSIM2 including a connected instrument:

- The controller and R&S WinIQSIM2 are on the same PC.



- In some rare cases, the controller and the software are installed on two separate PCs.

The following sections focus on the possibilities to control R&S WinIQSIM2 remotely. The contents include basics on the remote operation modes, the interfaces and examples for setting up a remote control session with several access tools.

Do not mistake *remote control operation* with the remote control functions provided in the "Arb/Vector ...Sig Gen" blocks, i.e. "Remote Control (SCPI)" and "Remote Desktop".

R&S WinIQSIM2 uses these remote operating modes for controlling a connected instrument, see Chapter 6.2, "Configuring remote operation modes", on page 190.

Remote control (SCPI)

Remote control operation of R&S WinIQSIM2 is characterized by:

- A controller program controls R&S WinIQSIM2, usually via VISA ("Virtual Instrument Software Architecture") interfaces.
- The GUI is not visible.

- Remote control commands (SCPI) perform the settings, either individually or in sequences (SCPI programs).

A detailed description of specific SCPI commands available for R&S WinIQSIM2 is provided in Chapter 11, "Remote control commands", on page 257. The remote control commands for the digital standards are described in detail after each related function section.

10.1 Remote control interfaces and protocols

R&S WinIQSIM2 supports various protocols to be remotely controlled via the LAN interface:

Table 10-1: Remote control protocols for controlling R&S WinIQSIM2

Interface	Protocols, VISA*) address string and library	Remarks

Local Area Network (LAN)	• **HiSLIP** high-speed LAN Instrument Protocol (IVI-6.1)
	`TCPIP::host address::hislip0[::INSTR]`
	VISA
	• **VXI-11**
	`TCPIP::host address[::LAN device name][::INSTR]`
	VISA
	• **socket communication** (Raw Ethernet, simple Telnet)
	`TCPIP::host address[::LAN device name]::<port>::SOCKET`
	VISA or socket controller
		The interface is based on TCP/IP and supports various protocols.
		For a description of the protocols refer to:
		• Chapter 10.1.1.2, "HiSLIP protocol", on page 234
		• Chapter 10.1.1.3, "VXI-11 protocol", on page 235
		• Chapter 10.1.1.4, "Socket communication", on page 235

*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control over LAN (when using VXI-11 or HiSLIP protocol), USB and serial interface. For remote control via socket communication VISA installation is optional. For basic information, see Remote control via SCPI.

Rohde & Schwarz provides the standardized I/O software library R&S VISA for communication via TCP/IP (LAN: HiSlip, VXI-11 and raw socket), USB (USBTMC) or serial interfaces.

R&S VISA is available for download at the Rohde & Schwarz website http://www.rohde-schwarz.com/rsvisa.

How to configure the remote control interfaces is described in Chapter 10.3, "How to set up a remote control connection", on page 239.

10.1.1 LAN interface

For remote control, the controller PC and the PC with R&S WinIQSIM2 (if not the same) must be connected via the LAN interface to a common network. The network must support the TCP/IP network protocol. The controller software and, for particular protocols the VISA program library must be installed on the controller PC.

Identifying devices in a network

If several devices (PCs, instruments) are connected to the network, each device has its own IP address and associated resource string. The controller identifies these devices by their resource string.

10.1.1.1 VISA resource strings

The VISA resource string is required to establish a communication session between the controller and R&S WinIQSIM2 in a LAN. The resource string is a unique identifier, composed of the specific IP address of the PC 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 R&S WinIQSIM2. It is automatically assigned by the DHCP server the first time that the device is registered on the network. Alternatively, you can also assign its **LAN device name**.

See below the characteristics of the VISA resource strings for the corresponding interface protocols. The highlighted characters are crucial.

HiSLIP

TCPIP::host address::**hislip0**[::INSTR]

hislip0 = HiSLIP device name, designates that the interface protocol HiSLIP is used (mandatory).

hislip0 is composed of [::HiSLIP device name[,HiSLIP port]] and must be assigned.

For details of the HiSLIP protocol, refer to Chapter 10.1.1.2, "HiSLIP protocol", on page 234.

VXI-11

TCPIP::host address**[::inst0]**[::INSTR]

[::inst0] = LAN device name, indicates that the VXI-11 protocol is used (optional).

inst0 currently selects the VXI-11 protocol by default and can be omitted.

For details of the VXI-11 protocol, refer to Chapter 10.1.1.3, "VXI-11 protocol", on page 235.

Socket Communication

TCPIP::host address::**port::SOCKET**

Port = Determines the used port number
SOCKET = Indicates the raw network socket resource class

Socket communication requires the specification of the port (commonly referred to as port number) and of "SOCKET" to complete the VISA resource string with the associated protocol used.

The registered port for socket communication is port 5025, but can be configured, see Chapter 10.1.2, "Remote settings", on page 235.

See also Chapter 10.1.1.4, "Socket communication", on page 235.

10.1.1.2 HiSLIP protocol

The High Speed LAN Instrument Protocol (HiSLIP) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - one for fast data transfer, the other for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

Using VXI-11, each operation is blocked until a VXI-11 instrument handshake returns. However, using HiSLIP, data is sent to the instrument using the "fire and forget" method with immediate return. Thus, a successful return of a VISA operation such as `viWrite()` guarantees only that the command is delivered to the instrument's TCP/IP buffers. There is no confirmation, that the instrument has started or finished the requested command.

For more information see also the application note:

1MA208: Fast Remote Instrument Control with HiSLIP

10.1.1.3 VXI-11 protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

10.1.1.4 Socket communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred to as "Raw Ethernet communication", does not necessarily require a VISA installation on the remote controller side. It is available by default on all operating systems.

The simplest way to establish socket communication is to use the built-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis (see Chapter 10.3.2, "Setting up a connection over LAN using socket communication", on page 244). For more convenience and to enable automation by programs, user-defined sockets can be programmed.

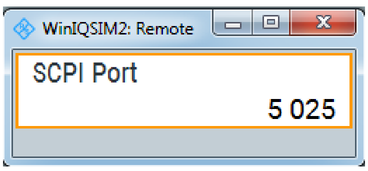
Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. By default, R&S WinIQSIM2 uses port number 5025 for this purpose. The port is configured for communication on a command-to-command basis and for remote control from a program.

It is possible that other applications use this port also. To operate R&S WinIQSIM2 over the remote control simultaneously, you can change the port address under Chapter 10.1.2, "Remote settings", on page 235.

10.1.2 Remote settings

Access:

► In the menu bar, select "File > Setup > Remote".



SCPI Port
Sets the port number of the LAN interface for remote control with TCP/IP socket protocol.

Remote command:
`:SYSTem:COMMunicate:SOCKet:PORT` on page 395

10.1.3 VISA library

VISA is a standardized software interface library providing input and output functions to communicate with devices and applications. Thus, you can configure the interface without having to adjust the application program to the used interface. The I/O channel (LAN or TCP/IP, USB, GPIB,...) is selected at initialization time with the channel-specific address string ("VISA resource string"). Alternatively, you can define a VISA alias (short name), see Table 10-1 for an overview.

Access via VXI-11 or HiSLIP protocols is achieved from high level programming platforms using VISA as an intermediate abstraction layer. VISA encapsulates the low-level VXI or GPIB function calls and thus makes the transport interface transparent for the user.

A VISA installation is a prerequisite for remote control using the following interfaces:

- LAN Interface using HiSLIP protocol
- LAN interface using VXI-11 protocol

Access via the LAN socket protocol can be operated both, with or without the VISA library, see Chapter 10.1.1.4, "Socket communication", on page 235. For more information about the VISA library, refer to the corresponding user documentation.

10.2 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 Chapter 11.13, "STATus subsystem", on page 390.

10.2.1 Overview of the status registers

The Figure 10-1 shows the hierarchical structure of information in the status registers (ascending from left to right).

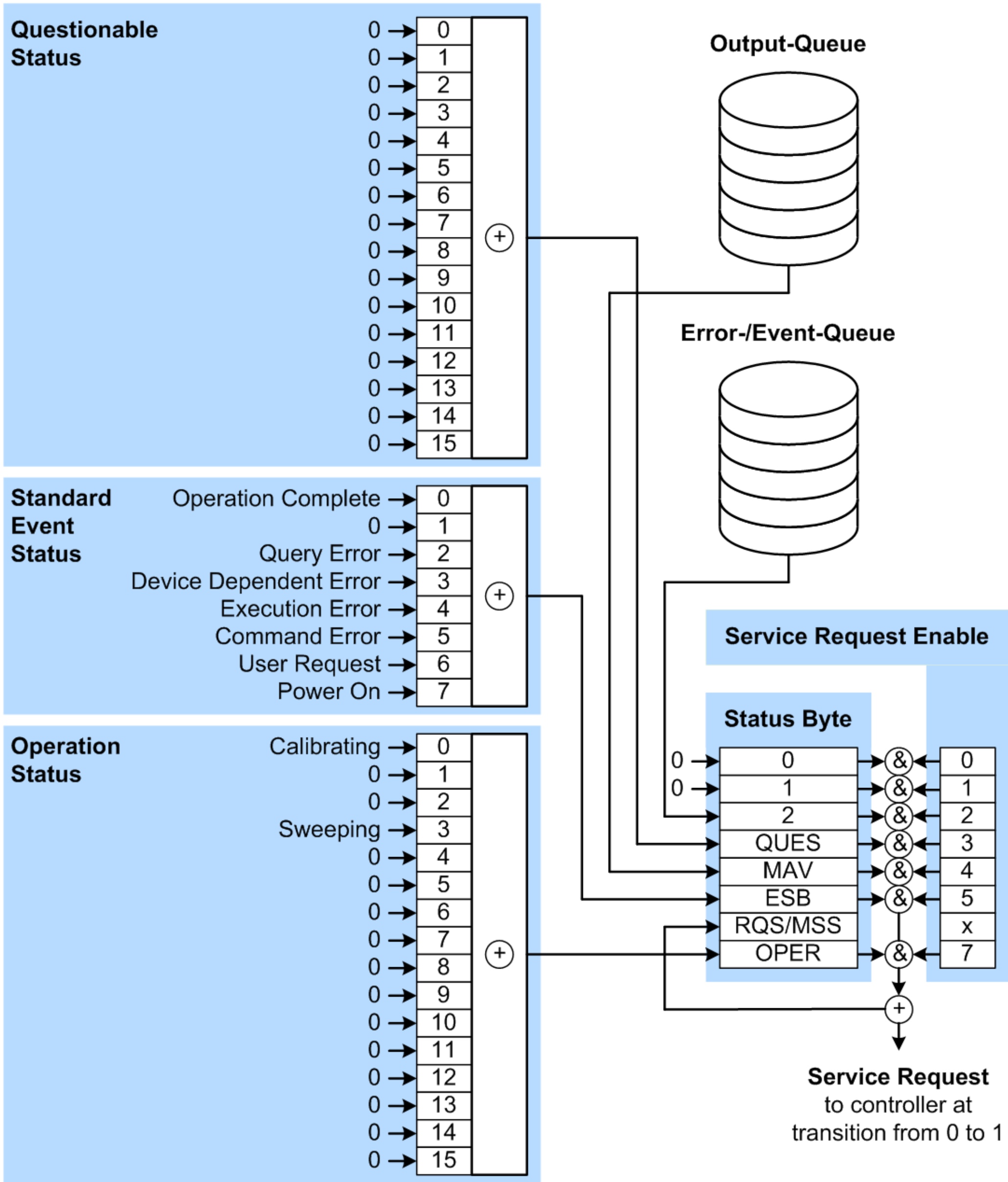


Figure 10-1: Graphical overview of the status registers hierarchy

OPER	= Operation Status Summary Bit
RQS/MSS	= Service Request Generation
ESB	= Standard Event Status Summary Bit
MAV	= Message Available in Output Queue
QUES	= Questionable Status Summary Bit
2	= Error- /Event-Queue
1, 0	= not used

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

10.2.2 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 391 and `:STATus:OPERation[:EVENt]` on page 391.

The remote commands for the status questionable register are described in Chapter 11.13, "STATus subsystem", on page 390.

Table 10-2: 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

10.2.3 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 392 or `:STATus:QUEStionable[:EVENt]` on page 393.

The remote commands for the status questionable register are described in Chapter 11.13, "STATus subsystem", on page 390.

Table 10-3: Assignment of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

10.2.4 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 10-4: 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.

10.3 How to set up a remote control connection

This section guides you through the steps required to set up remote control connections of the available interfaces.

- Setting up a connection over LAN using VXI-11 protocol
- Setting up a connection over LAN using socket communication

A remote control program must open a connection to R&S WinIQSIM2, before it can send commands to and receive device responses from R&S WinIQSIM2.

10.3.1 Setting up a connection over LAN using VXI-11 protocol

In this example, the I/O software library R&S VISA from Rohde & Schwarz is used to set up a LAN remote control link and remotely control the R&S WinIQSIM2. R&S VISA is running on the controller PC that can be the same or a different PC. When the connection is set up you can send commands to the instrument, and receive the responses.

A 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 either the R&S WinIQ-SIM2's computer name (hostname) or the IP address. See also Chapter 10.1.1, "LAN interface", on page 233.

In this example, it is assumed that:

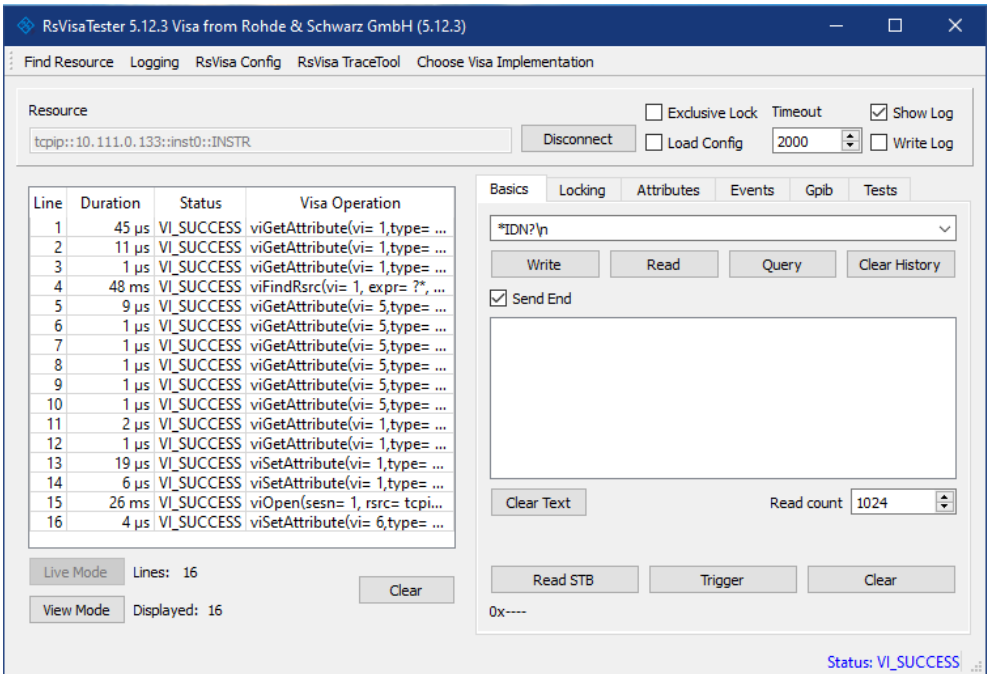
- A LAN remote control link between the controller PC and the R&S WinIQSIM2 is set up.
- The R&S VISA program is installed on the remote PC, see "http://www.rohde-schwarz.com/rsvisa > RS VISA Release Notes".

For detailed information, refer to section "Remote Control Basics" in the user manual or to the online help of the "R&S VISA" program.

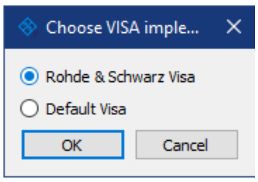
To set up the controller with R&S VISA

To remote control the R&S WinIQSIM2, we use the "R&S VISA Tester" application. The application communicates via TCP/IP protocol.

1. On the controller, start "R&S VISA > Tester 32bit" or "R&S VISA > Tester 64bit", respectively.

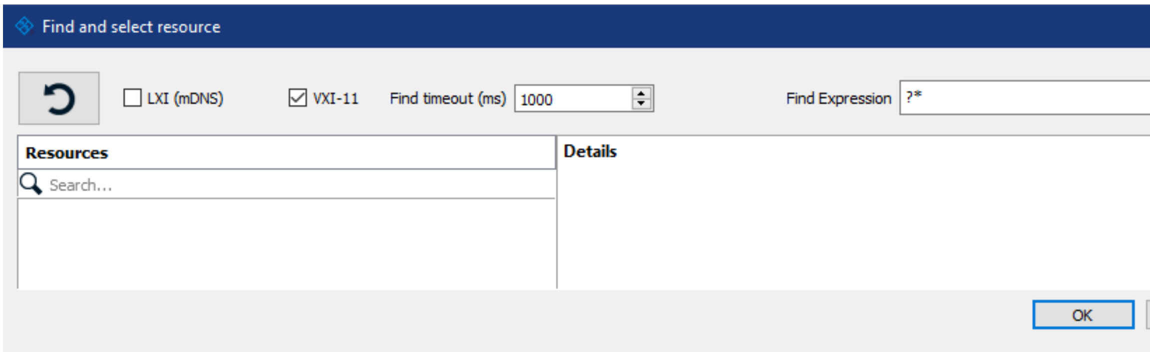


2. In the menu bar, select "Choose VISA Implementation > Rohde & Schwarz Visa".



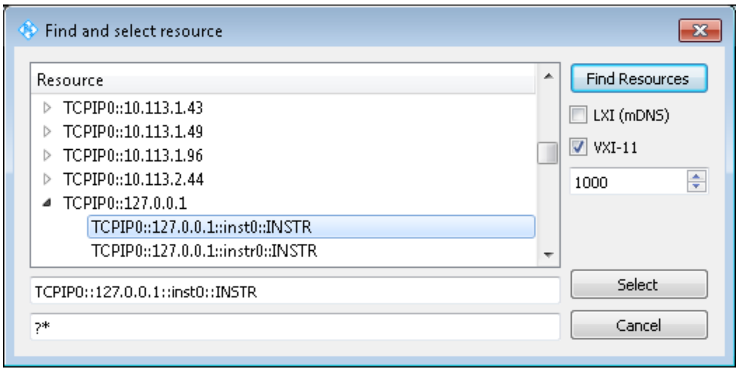
3. Select "Rohde & Schwarz Visa".

4. Confirm with "OK".
5. In the menu bar, select "Find Resource" to search for the corresponding computer in the LAN.



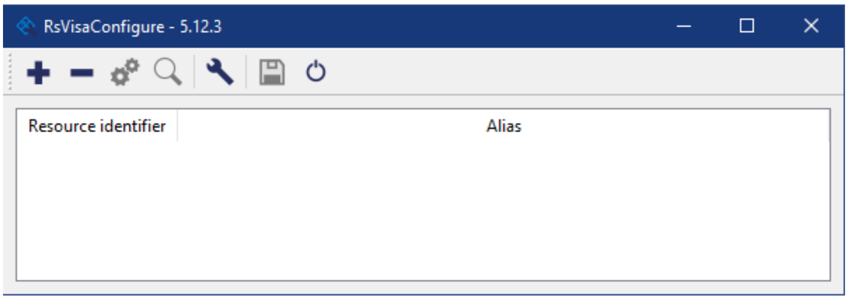
6. Select "VXI-11" and "Find Resources".

   R&S VISA scans the network for all connected devices and lists all detected devices in the "Resource" list.
   Note: The search can take some time, particularly in large networks.
7. Select the IP address of the corresponding PC.
8. Confirm with "Select".

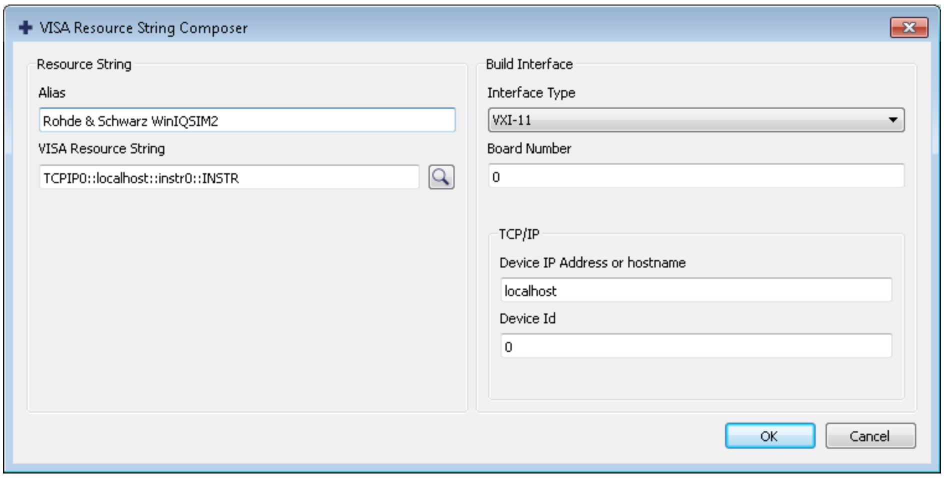


   The "Find and select resource" dialog closes and R&S VISA indicates the IP address in the "Resource" field of the main application window.
9. As an alternative to the IP address, you can assign an alias name to the R&S WinIQSIM2:

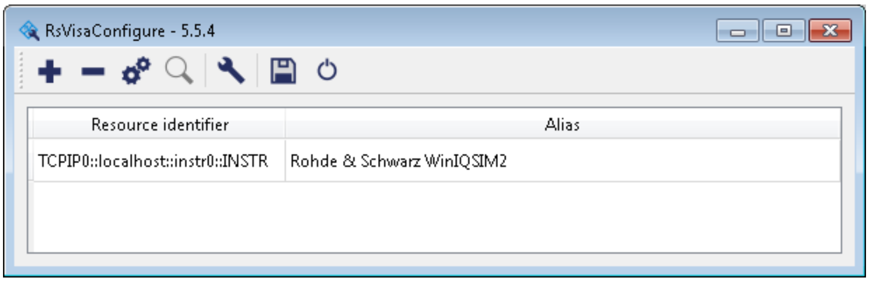
a) In the menu bar, select "RsVisaConfig".



b) In the toolbar, select "+" to access the "VISA Resource String Composer".
c) Fill in the "Alias" name, the "VISA Resource String" and the "Device IP Address or host name" as shown in the figure.
d) Confirm with "OK".



The application assigns the "Alias" name.



e) Close the dialog.
The program registers the R&S WinIQSIM2. Address R&S WinIQSIM2 via the resource string or alias name.

10. In the main window, select "Connect".

R&S VISA establishes the connection to R&S WinIQSIM2.

Now 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. For information on how to proceed when network failures occur, see Chapter 12.4, "Resolving network connection failures", on page 404.

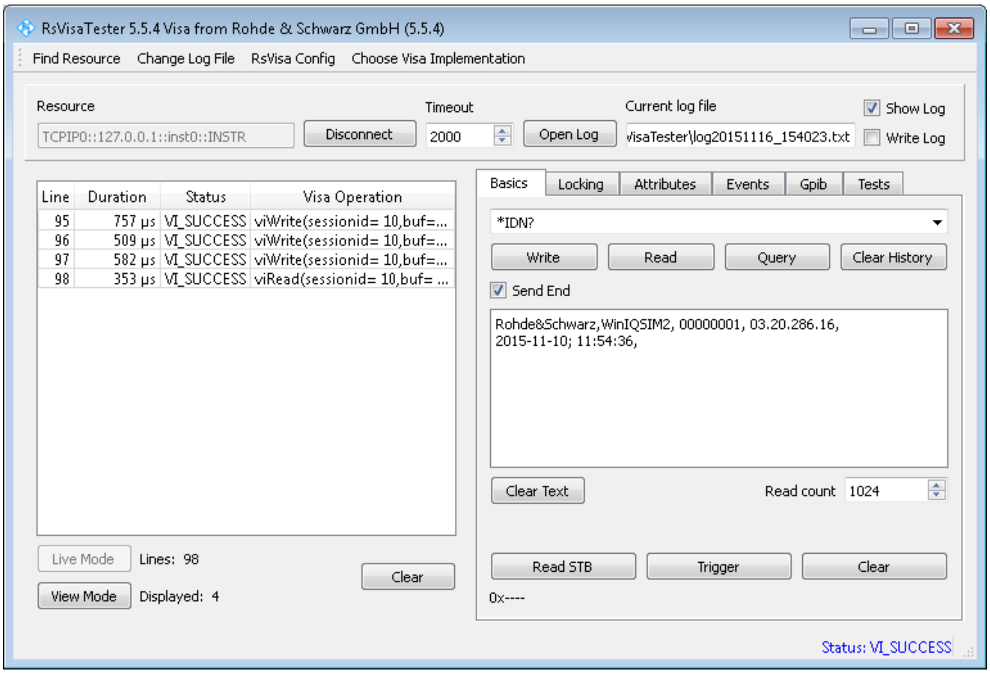
For further information on the functions to read and write to an open session and the utility applications the software provides, see the R&S VISA User Manual.

Starting a remote control session over LAN with R&S VISA

To set R&S WinIQSIM2 to remote control, you can use the addressed command `&GTR`, or send any command from the controller.

1. Start the "R&S VISA Tester".
2. To establish the connection to the R&S WinIQSIM2, see "To set up the controller with R&S VISA" on page 240.
3. In the "R&S VISA > Basics" tab, enter a SCPI command, e.g. "*IDN?".
4. Confirm with "Query".

   R&S WinIQSIM2 is switched to remote control when it receives a command from the controller.
5. Select "Read" to obtain the response from R&S WinIQSIM2.



Tip: If the "Show Log" checkbox is checked, R&S VISA displays each VISA function call in the log-view on the left. If you check the "Write Log" checkbox, the log-view entry is written to the log file as well. You can operate the log-view in two modes: the "Live Mode" shows only the most recent messages whereas the "View Mode" allows you to scroll the history.

6. To activate baseband signal generation, select e.g. `SOUR:BB:W3GP:STAT 1`.

7. Confirm with "Write".
   To check the performed setting, and select "Read".
   Response: `1`.

   Note: R&S WinIQSIM2 does not indicate when it is controlled remotely. To return to manual control, operate R&S WinIQSIM2 directly.

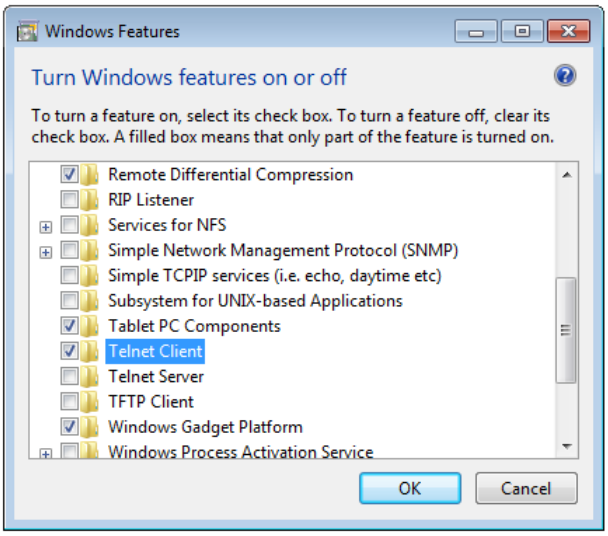
10.3.2 Setting up a connection over LAN using socket communication

This section provides an example of how to establish a remote control connection over the Telnet client, which is embedded in every operating system.

Activating Telnet

If you cannot open the Telnet program, activate the feature, as shown in the example of the Microsoft®Windows operating system:

1. In the taskbar of your PC, select "Start > Control Panel > Programs and Features".
2. In the navigation panel, select "Turn Windows Features on or off".
3. Select the "Telnet Client" checkbox.



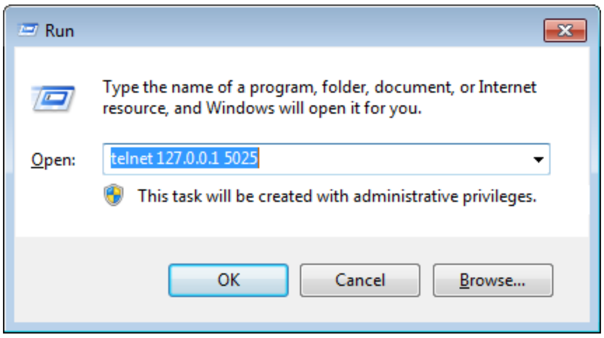
Note that the Telnet client transmits information unencrypted. Therefore, for sensitive information we recommend that you use a client which supports secure protocols as, e.g., SSH.

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 remote-control R&S WinIQSIM2 with Telnet

1. In the taskbar of your PC, select "Start".

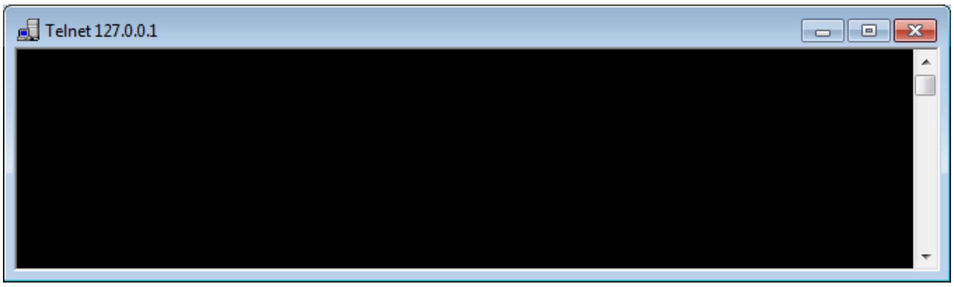
2. In the "Search programs and files" entry field, enter "telnet <ip address of the PC> 5025".
   The socket address is a combination of the IP address or the hostname of the PC with R&S WinIQSIM2, and the port number configured for remote-control via socket communication.



   The port number is 5025 by default, but you can change to another port, see Chapter 10.1.2, "Remote settings", on page 235.

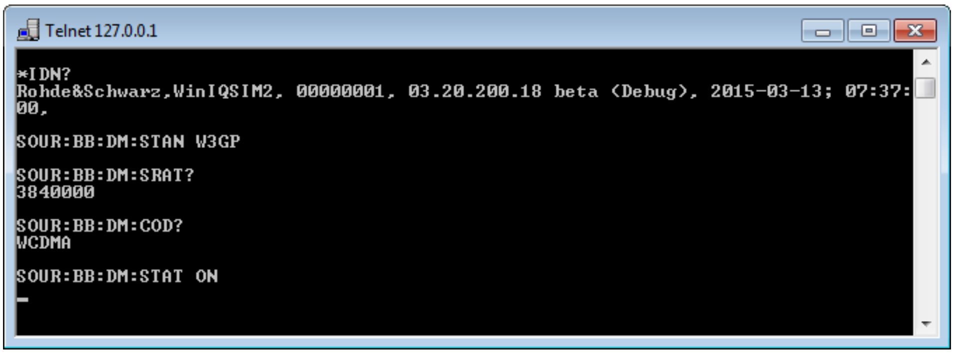
3. Enter the socket address.

   The connection to R&S WinIQSIM2 is set up and you can send remote commands.



4. Enter a command, e.g. `*IDN`.
   Note, that Telnet does not reflect your first entry.

5. Confirm with "Enter".
   If you get a response, the connection is working properly. Then the client displays all subsequent inputs and responses.



10.4 Automating tasks with remote command scripts

To achieve fast configuration, work with complex test setups or with reproducible repeating measurements, you can automate the required settings with remote command scripts. A script contains a series of remote commands that perform the settings sequentially. When completed, it is converted to an executable format, stored in a file and can be run whenever needed.

10.4.1 About the creation and use of remote command scripts

For creating remote command scripts, R&S WinIQSIM2 provides a function, which records manual settings in SCPI format.

Creating a SCPI list

You can create a SCPI command list directly in R&S WinIQSIM2 and save the list in a file. If you want to edit or write a script manually, use a suitable editor.

Even if you manually write the command sequence, R&S WinIQSIM2 supports you by displaying the command syntax for a parameter, including the current parameter value, see e.g. "To find out the remote command with "Show SCPI Command"" on page 252, and "To find out the remote command using the "Online Help"" on page 252.

Directly in R&S WinIQSIM2, you can create a SCPI list at any time of operation. Both, automatic or manual SCPI recording is possible. I.e., you can record all the settings that you perform between a start and an end point, or select deliberately the commands you want to record.

- Record all performed steps automatically
  The instrument records the SCPI commands including the setting values of each step that you perform, and then writes the commands to the file system, see "To record SCPI lists" on page 250.
  Some parameters cannot be set by a SCPI command. If so, "no SCPI command found" is entered instead of a command.
- Write a script manually
  To write or edit settings in a script, you must know the exact syntax of the SCPI command and the setting value. R&S WinIQSIM2 helps you, if you need to look up a command:
  - "Show SCPI command" (context-sensitive menu)
    Displays the SCPI command of the selected parameter with the setting value. With the "Copy" function, you can paste the command directly into the script, see "To find out the remote command with "Show SCPI Command"" on page 252.
  - Online help
    Describes each function, and includes a cross-reference to the corresponding SCPI command. The referenced section describes the SCPI command syntax with all setting values and their functionality, see "To find out the remote command using the "Online Help"" on page 252.

Tip: Conversely, if you are looking for a function in the GUI, which belongs to a SCPI, you find it via the cross-reference in the online help, see "To find out the GUI function, which corresponds to a SCPI command" on page 253.

Displaying a recorded SCPI list

R&S WinIQSIM2 lists the recorded remote commands in the "SCPI Sequence dialog", see Chapter 10.4.2, "SCPI sequence settings", on page 248.

Depending on the starting point, you can access the "SCPI Sequence" dialog as follows:

- During recording
  Select "Show current SCPI Sequence" in the context sensitive menu.
- At any time outside recording
  Select "Show last SCPI Sequence" in the context sensitive menu.
  This function implies that at least one recording has been executed after power-on.
- At the end of the recording
  The dialog automatically opens. That is, when you have selected "Stop automatic SCPI recording" or "Stop manual SCPI recording".
- After you have exported the script to a file, select "Show file content" in the "SCPI Recording Export" dialog, see Chapter 10.4.3, "SCPI recording export settings", on page 249.

Checking and revising a recorded SCPI list

It is recommended that you check a recorded list and revise if necessary. It can be that ...

- A parameter has not assigned a SCPI command.
- An element of the user interface has not an assigned parameter.

In these cases, the recording function writes `:SYST:INF:SCPI 'SCPI command not available'` in the list instead.

Such entries are also detected during execution. The instrument recognizes an incomplete command and displays an error message.

See "To check a recorded SCPI list" on page 256 for some suggestions on how you validate the recorded commands.

Creating and exporting an executable 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 store the script in a file with an extension corresponding to the programming language.

The R&S WinIQSIM2 provides the following predefined code templates by default:

- Plain SCPI
  Represents SCPI base format that is ASCII format, stored as text file (`*.txt`).
- MATLAB

A programming environment, frequently used in signal processing and test and measurement applications (`*.m`).
You can directly use this format with MATLAB(c) toolkit. For comprehensive information on this topic, refer to the application note 1GP60: MATLAB Toolkit for R&S Signal Generators.

- NICVI
  An ANSI C programming environment designed for measurements and tests (`*.c`).
  You can directly use this format with "National Instruments LabWindows CVI".

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 store the script in a file, see "To convert and store SCPI lists" on page 255.

Executing a SCPI script

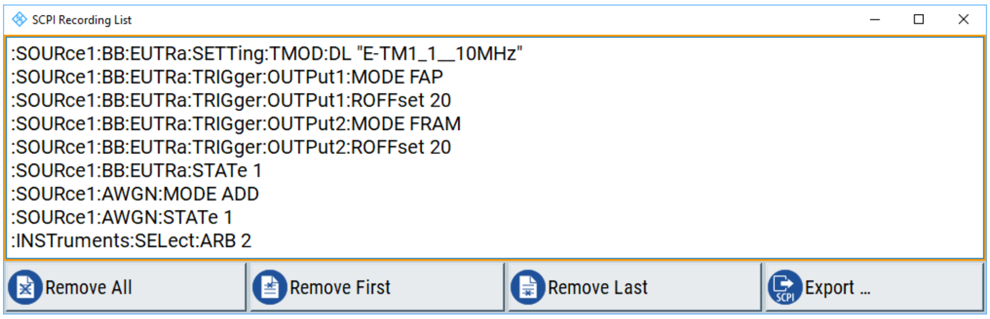
To run a remote command script, you need a remote control program on the controller PC, which supports the corresponding script format.

10.4.2 SCPI sequence settings

Access:

Depending on the starting point, perform the corresponding step:

1. When recording is in progress:
   In the context-sensitive menu, select "Show current SCPI Sequence".
2. When recording is not running:
   In the context-sensitive menu, select "Show last SCPI Sequence".
3. When you stop recording, the dialog opens automatically.



The "SCPI Sequence" dialog lists the last recorded and exported SCPI command list. It enables you to delete the last recorded command, and you can access the export dialog for storing the list in a file.

Export
Accesses the Chapter 10.4.3, "SCPI recording export settings", on page 249 dialog for configuring the file parameters for export.

Remove All, Remove First, Remove Last
Deletes either the first, the last or all recorded SCPI commands.

Once the recording is stopped, the entries are internally stored and cannot be changed.

10.4.3 SCPI recording export settings

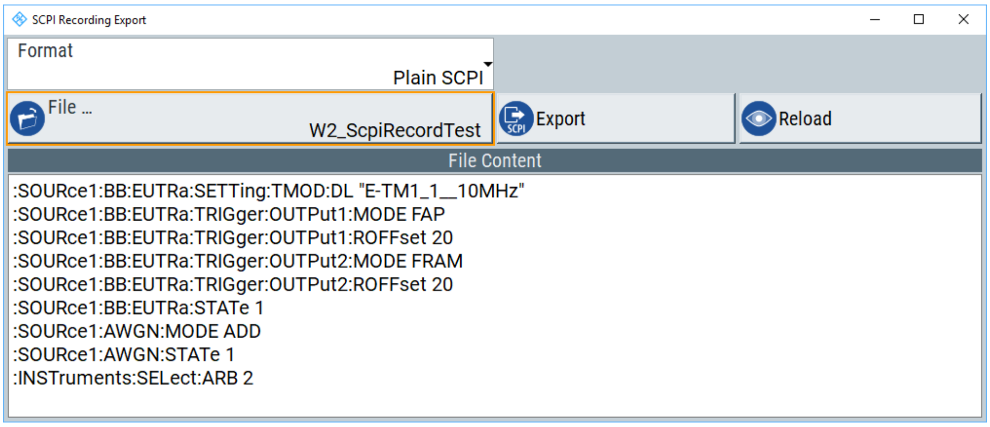
R&S WinIQSIM2 enables you to store recorded command lists in the "SCPI Recording Export" dialog. It provides access to this dialog directly after a recording, or if you have recorded and stored a command list at a previous time.

In any case, you can access the dialog only in the "SCPI Sequence" dialog by selecting the "Export" button.

Access:

You can access the dialog only in the "SCPI Sequence" dialog by selecting the "Export" button.

1. To open the "SCPI Sequence" dialog, proceed as described in "Access:" on page 248
2. In the "SCPI Sequence" dialog, 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 file name and display the file content.

Format
Selects the source code format for the command list.

"Plain SCPI" Uses SCPI syntax.

"Predefined Code Generator"
Accesses the predefined templates for common source code generators that convert the recorded settings in the programming languages MATLAB or NICVI or Python.

"User Code Generator"
Use this setting to convert a script by a user-specific code generator.

Code Template
Requires "Format > Predefined/User Code Generator."

Opens the standard file select dialog "Select Predefined/User Code Template" and lists the predefined or user-defined code templates.

See Chapter 8.3.1, "File select settings", on page 213.

File
Opens a standard file select dialog "Select Output File", see Chapter 8.3.1, "File select settings", on page 213.

Export
Executes data export.

The SCPI list is saved in as file with the selected filename and in the selected directory, see File.

Reload
Reloads a SCPI list from a file.

You can export recorded SCPI lists to files (see File and Export), that can be modified.

File Content
Displays the content of the script in the selected format and code template.

10.5 How to use the SCPI record function

This section describes how you record the remote control commands during the manual setting. It contains short instructions how to convert the recorded command lists to executable script files.

To record SCPI lists

This example explains briefly how to proceed when you want to record all performed steps.

For comprehensive information on this topic, refer to the application note 1GP98: SCPI Recorder Test Automation on a Fingertip.

1. On the screen, open the context-sensitive menu with a right mouse click.
2. Select "Start SCPI Recording".

   Starting from now, all steps you perform are recorded.
3. To stop SCPI recording, in the context-sensitive menu, select "Stop SCPI Recording".

The "SCPI Sequence" dialog opens automatically.

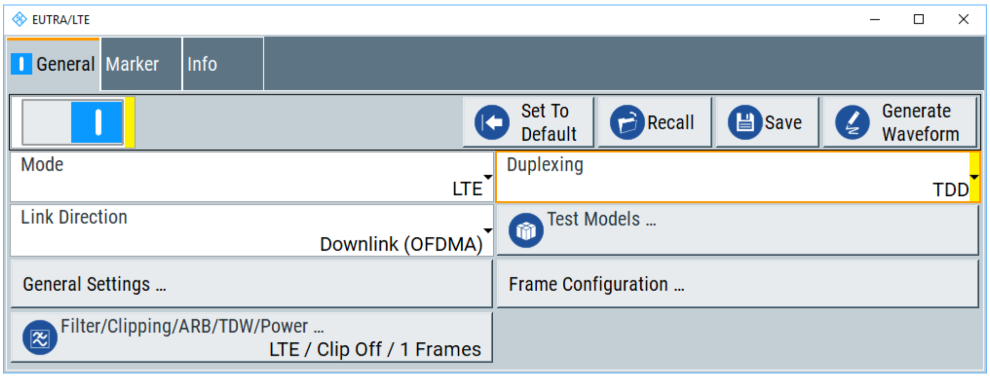
4. Proceed with "To check a recorded SCPI list" on page 256.

To record SCPI lists manually

Using this function, you can deliberately determine the settings, you need in the script. For this application, it is useful to mark all modified parameters. It helps you to check if you have recorded all necessary settings.

1. To retrace your settings, open the context-sensitive menu.
2. Select "Mark all parameters changed from preset".

This function marks changed settings both in the block diagram and in the dialogs.



3. For selectively recording your steps:
   a) Set the parameter.
   b) Open the context-sensitive menu.
   c) Select "Add SCPI command to Recording List"

   Tip: You cannot see "Add SCPI ..." in the menu?
   It happens, if you open the context-sensitive menu outside of a dialog or input field, for example in the block diagram. Open the context-sensitive menu within the corresponding dialog or input field, and the feature is available.
   d) Continue with the next setting, and repeat steps *a to b* whenever needed.

   Each time you select "Add SCPI ...", the SCPI command is appended to a temporary list.
4. To check the progress of the recording, select "context-sensitive menu > Show current SCPI sequence".

The "SCPI Sequence" dialog opens displaying all recorded settings so far.

5. To stop SCPI recording, select "context-sensitive menu > Stop SCPI recording".

The "SCPI Recording Export" dialog automatically opens.

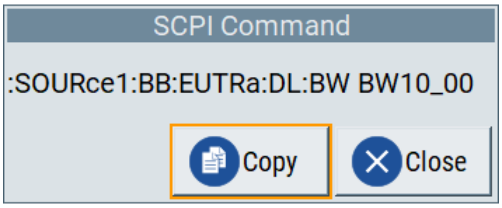
6. Proceed with "To check a recorded SCPI list" on page 256.

To find out the remote command with "Show SCPI Command"

To find out the SCPI command of a parameter in manual operation, perform the following:

1. Select the corresponding parameter.
2. Select "context-sensitive menu > Show SCPI command".

You get the detailed command syntax, including the currently set value.



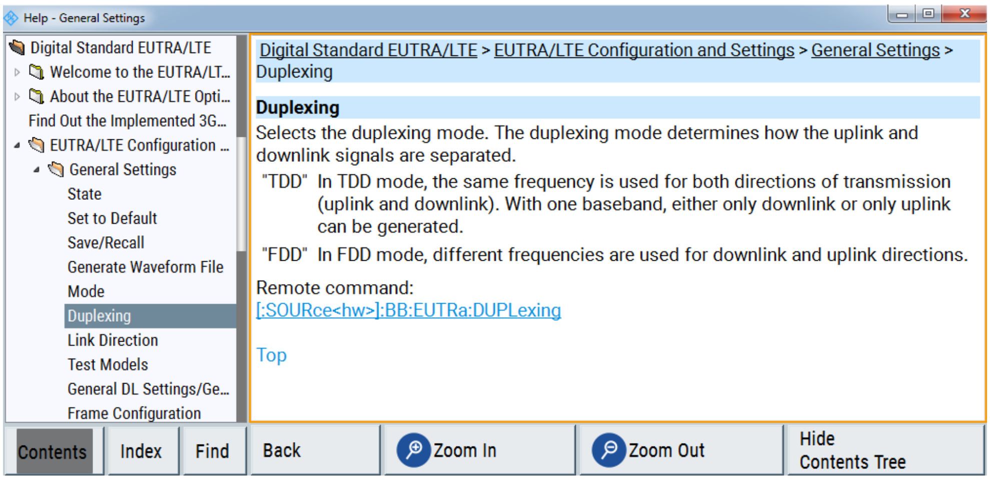
To find out the remote command using the "Online Help"

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. Select the corresponding parameter.
2. Select "context-sensitive menu > Help".

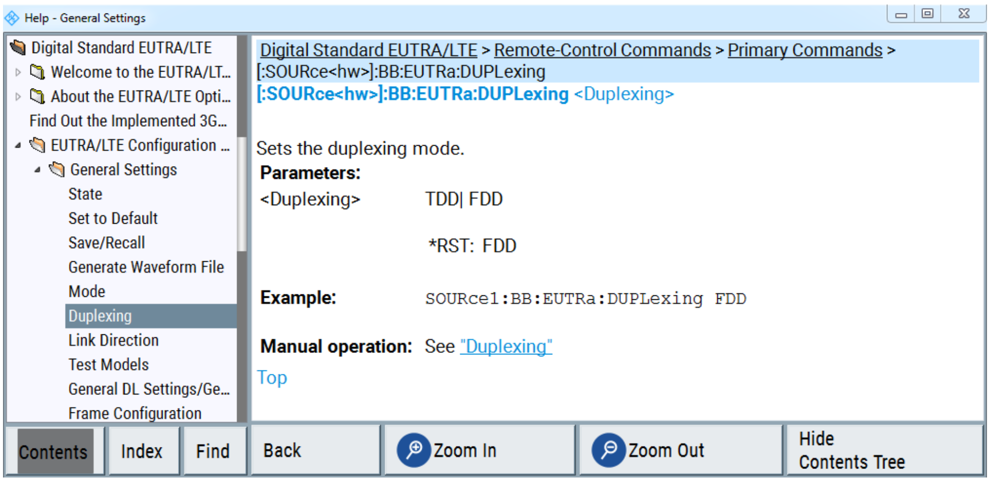
Alternatively, you can open the online help with the "F1" key.

The help topic opens. It describes the function and the corresponding parameter values, if applicable. A link leads you to the description of the remote command.



3. To find out the syntax of the remote command including the parameter values, follow the link.

   The help topic of the SCPI command description opens.

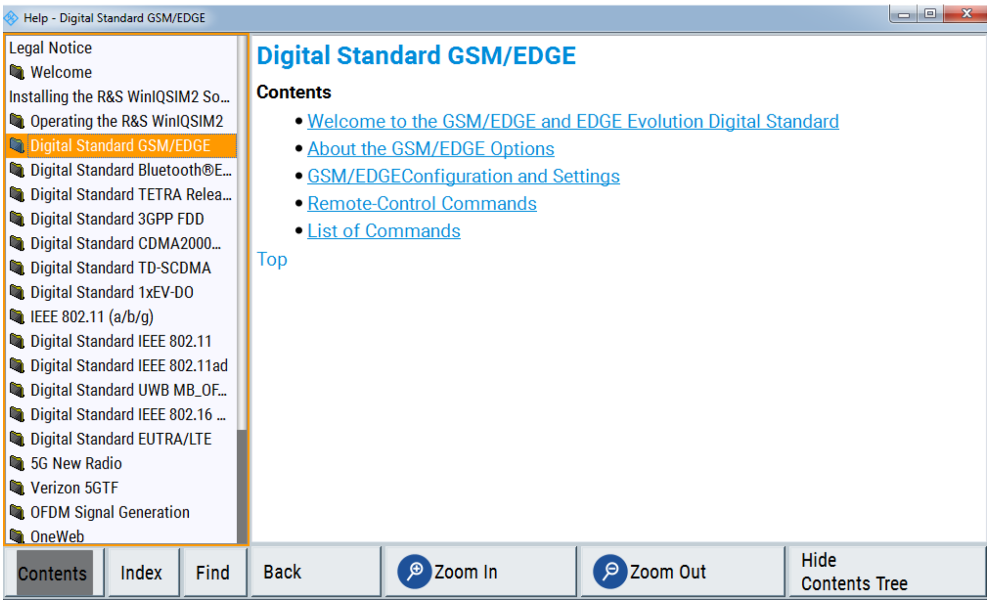


To find out the GUI function, which corresponds to a SCPI command

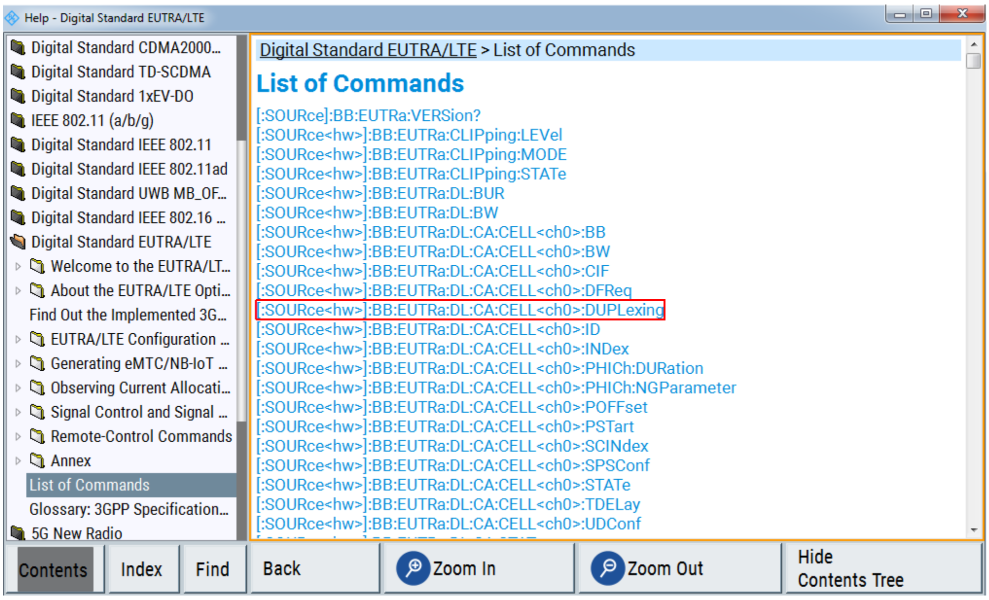
If you have a SCPI command, and look for the associated function in the manual operation (GUI), you find it via the cross-reference in the online help.

1. Select any block or parameter in the graphical user interface of R&S WinIQSIM2.
2. Select "context-sensitive menu > Help".
3. In the navigation panel of the online help, select the section to which the command applies, e.g. "Operation of WinIQSIM", "Digital Standard EUTRA/LTE", etc.

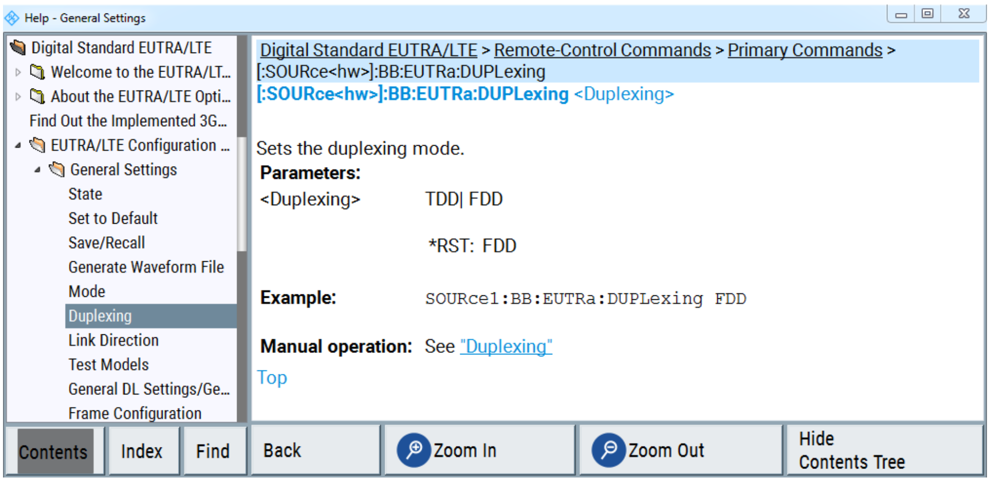
   E.g., you are looking for the function of the command `[SOURce:BB:EUTRa:DL:CELL<ch0>DUPLexing`.



4. Select "List of Commands".



5. Select the command.



6. Follow the link under "Manual Operation:"

   The help topic of the manual operation opens. The breadcrumb navigation on top shows you where this parameter is located.

To convert and store SCPI lists

To convert a SCPI list to the desired format, you need to load the list into the "SCPI Recording Export" dialog.

You can access this dialog only in the "SCPI Sequence" dialog by selecting the "Export" button.

1. To open the "SCPI Sequence" dialog, proceed as described in Chapter 10.4.2, "SCPI sequence settings", on page 248.
2. In the "SCPI Sequence" dialog, select "Export".
3. Select the "Format" for the command syntax to which you want to convert and save the list.
4. Select "Export".
5. Select "Select Code Template".
   Note: To export a code template, you have to select a code template.
   Depending on the selected format, proceed accordingly:
   a) "Plain SCPI"
   b) "Predefined Code Generator"
      The "SCPI Recording Export - Select Predefined Code Template" dialog opens.
      Select the desired predefined code template.
      Confirm with "Select".
   c) "User Code Generator"
      A file system ("SCPI Recording Export - Select User Code Template") dialog opens.
      Select your user-defined code template. The code template must have file extension `*.expcodetmpl`.

6. "Select File..."
   The "SCPI Recording Export - Select Output File" dialog opens.
   a) Select the directory.
   b) Assign a file name for storing the recorded list.
   c) Confirm with "Save".
7. "Export data to file"
   Stores the recorded data either in ASCII format (plain SCPI), or in the corresponding format of the used code template, and activates the "Show File Content" button.
8. "Show file content"
   Displays the source code in the corresponding syntax.

To check a recorded SCPI list

Some suggestions on how you can check and revise a list:

1. Export the list file as described in "To convert and store SCPI lists" on page 255.
2. Open the list file in a suitable editor.
3. Search and remove missing command entries, e.g.:`SYST:INF:SCPI 'SCPI command not available'`.
4. Remove unnecessary content resulting from a preset.
5. Rearrange the commands into a reasonable order. E.g., if you set a `STATe` command to the last position of a list, you can avoid intermediate calculations of the signal.
6. Preview the list for completeness by comparing it with the modified settings in the manual mode.
   a) To retrace your settings in manual operation, open the context-sensitive menu.
   b) Select "Mark all parameters changed from preset".
      The function identifies all settings that you have changed, both in the block diagram, and in the dialogs. They appear orange.
   c) Check whether there is a command in the list for all modified settings.

11 Remote control commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

11.1 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 WinIQSIM2 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.

11.2 Common commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

***CLS**

Clear status

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Usage: Setting only

***ESE** <Value>

Event status enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

Parameters:

<Value> Range: 0 to 255

***ESR?**

Event status read

Returns the contents of the event status register in decimal form and then sets the register to zero.

Return values:

<Contents> Range: 0 to 255

Usage: Query only

***IDN?**

Identification

Returns the instrument identification.

Return values:
<ID> "Rohde&Schwarz,<device type>,<part number>/<serial number>,<firmware version>"

Example: `Rohde&Schwarz,WinIQSIM2,1412.0000K02/000000, 03.01.158`

Usage: Query only

***IST?**

Individual status query

Returns the contents of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

Return values:
<ISTflag> 0 | 1

Usage: Query only

***OPC**

Operation complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query writes a "1" into the output buffer when all preceding commands have been executed, which is useful for command synchronization.

***OPT?**

Option identification query

Queries the options included in the instrument. For a list of all available options and their description, refer to the specifications document.

Return values:
<Options> The query returns a list of 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

***PRE** <Value>

Parallel poll register enable

Sets parallel poll enable register to the indicated value. The query returns the contents of the parallel poll enable register in decimal form.

Parameters:

<Value>	Range:	0 to 255

***PSC** <Action>

Power on status clear

Determines whether the contents of the `ENABle` registers are preserved or reset when the instrument is switched on. Thus a service request can be triggered when the instrument is switched on, if the status registers ESE and SRE are suitably configured. The query reads out the contents of the "power-on-status-clear" flag.

Parameters:

<Action> 0 | 1

0
The contents of the status registers are preserved.

1
Resets the status registers.

***RCL** <Number>

Recall

Loads the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command `*SAV` with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>, <file_name.extension>` command.

***RST**

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

Usage: Setting only

***SAV** <Number>

Save

Stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command `*RCL` with the associated number.

To transfer the stored instrument settings in a file, use the command `:MMEMory:STORe:STATe`.

***SRE** <Contents>

Service request enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

Parameters:

<Contents> Contents of the service request enable register in decimal form. Bit 6 (MSS mask bit) is always 0.

Range: 0 to 255

***STB?**

Status byte query

Reads the contents of the status byte in decimal form.

Usage: Query only

***TRG**

Trigger

Triggers all actions waiting for a trigger event. In particular, *TRG generates a manual trigger signal. This common command complements the commands of the `TRIGger` subsystem.

`*TRG` corresponds to the `INITiate:IMMediate` command.

Usage: Event

***TST?**

Self-test query

Initiates self-tests of the instrument and returns an error code.

Return values:

<ErrorCode> **integer > 0 (in decimal format)**
An error occurred.
(For details, see the Service Manual supplied with the 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

11.3 Tags for waveforms, data and control lists

R&S WinIQSIM2 uses a simple tag-oriented format for externally or internally generated waveforms, data and control lists.

Tag general format

Tags are self-contained information units, enclosed in braces { }. Their general format is `{Name: Data}` or `{Name-Length: Data}`. The colon separates the name part and the data part. The colon can be followed by a space for the sake of legibility.

- The **`Name`** identifies the tag. It is always expressed in capital letters.
- The **`Data`** is tag-specific, and usually it is in ASCII plain text.
- The **`Length`** specifies the number of bytes in a `WAVEFORM` tag, `DATA LIST` tag or `EMPTYTAG`
  Length is an ASCII integer value, defining the number of bytes from the colon `:` to the end brace `}`

Rules

Each waveform file must begin with the `TYPE` tag. The sequence of the remaining tags is arbitrary. For each tag, an indication shows whether it must be included in the file concerned (mandatory) or may be included (optional).

Unknown tags are not analyzed by an instrument; they are left unchanged and saved without an error message for a possible further read back.

In all examples of file contents listed in this section, the tags have been separated by line breaks for better reading.

11.3.1 Tag description

This section describes the mandatory `TYPE` tag followed by description of all other tags in an alphabetical order. Most tags are valid for all three file types. If a tag is valid only for a single file type, e.g. only for a waveform, this fact is indicated in the description.

{TYPE: magic, xxxxxxxx}

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

Identifies the file as a valid R&S WinIQSIM2 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 WinIQSIM2 waveform.

SMU-MWV
A valid R&S WinIQSIM2 multi-segment waveform.

SMU-DL
A valid R&S WinIQSIM2 data list.

SMU-CL
A valid R&S WinIQSIM2 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.

{CLOCK: frequency}

(mandatory for waveforms)

The tag specifies the clock frequency at which the waveform has to be output, in Hz (on multi-segment waveforms this tag contains the maximal clock of all segments).

A query of `ARB:CLOCk?` after loading the waveform returns the value set using the `CLOCK` tag. This value can later be altered with the command `ARB:CLOCk?`.

Example:

`{CLOCK: 54000000}`
`BB:ARB:WAV:TAG? 'CLOCK'`
Queries the content of the `CLOCK` tag.
`Response: 54000000`
The clock frequency is set to 54 MHz.

Usage: Setting only

{COMMENT: string}

The tag contains a plain text ASCII string of arbitrary length. The string is not analyzed in R&S WinIQSIM2. 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 R&S WinIQSIM2. It is used to store copyright information about the file content.

Example:
`{COPYRIGHT: Rohde&Schwarz}`
`BB:ARB:WAV:TAG? 'COPYRIGHT'`
queries the content of the `COPYRIGHT` tag of the selected waveform file.
`Response: 'Rohde&Schwarz'`
copyright resides with Rohde&Schwarz.

Usage: Setting only

{DATA BITLENGTH: BitLength}

(mandatory for data lists)

The tag contains the length of the data held in the `DATA LIST` tag in bits in ASCII format.

Example:
`{DATA BITLENGTH: 444}`
`BB:DM:DLIS:SEL "D:\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

{DATE: yyyy-mm-dd;hh:mm:ss}

(optional)

The tag contains the date and time at which the file was created. The year must be expressed as four digits. The instrument does not analyze this tag.

Example:
`{DATE: 2009-04-02;14:32:12}`
`BB:ARB:WAV:TAG? 'DATE'`
queries the content of the `DATE` tag of the selected waveform file.
`Response: '2009-04-02;14:32:12'`
the waveform was created on April 2, 2009 at 14 hrs 32 min

Usage:
Setting only

{EMPTYTAG-Length: #EmptySequence}

(mandatory in automatically generated one and multi-segment waveforms)

This tag is empty, i.e. contains no data, and is used as placeholder.

Setting parameters:

Length
An ASCII integer value that specifies the number of bytes in the `EMPTYTAG`, i.e. defines the number of bytes from the colon `:` to the end brace `}`
Note: If you change the content of a waveform file, change also the `{EMPTYTAG-Length}` value. For example, if you add a tag or add bytes to a tag, reduce the length by the number of newly introduced bytes.

EmptySequence
An empty sequence containing blanks only. The number of used blanks is calculated as the difference between the hex addresses of the `{WAVEFORM}` tag and the hash sign `#` in the `{EMPTYTAG}`.
The `{WAVEFORM}` tag always starts at hex address #4000.

Example:

```
{TYPE:SMU-WV, 837236424}
{COPYRIGHT:2003 Rohde&Schwarz SMU}
{DATE:2012-07-11;14:38:01}
{SAMPLES:80000}
{CLOCK:8666666.666666666}
{VECTOR MAX:1.000000038569158}
{LEVEL OFFS:3.333553817875577e-07,0}
{MARKER LIST 1:0:1;1:0;1249:0}
{MARKER LIST 2:0:1;1:0;1249:0}
{MARKER LIST 3:0:1;1:0;1249:0}
{MARKER LIST 4:0:1;1:0;1249:0}
{EMPTYTAG-15947:# ...}
{WAVEFORM-320017:#IQIQIQ...}
```

The example waveform file contains 436 (0x1b4) bytes before the `#` sign in the `EMPTYTAG`; the hex address of the `#` sign is *0x1b5*. The `{WAVEFORM}` starts at *0x4000*. The `EMPTYTAG` contains *15946* blanks and has a length of (15946+1) bytes.

Usage: Setting only

{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 11-1.

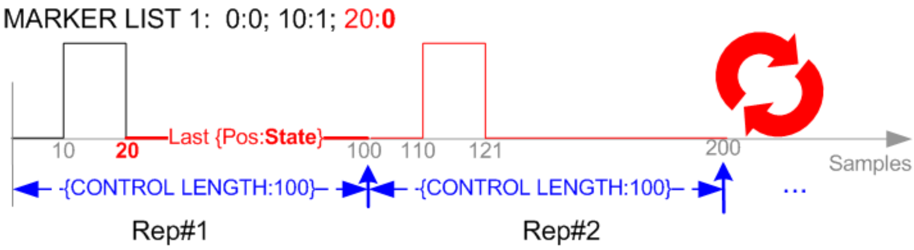


Figure 11-1: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

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 11-2.

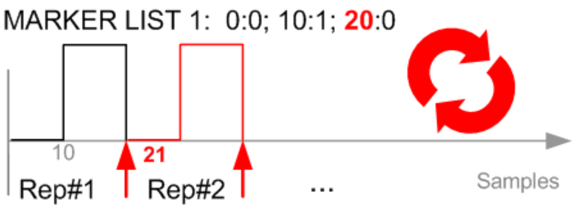


Figure 11-2: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

To maintain marker signals and waveform data synchronized, set the `CONTROL LENGTH` to be equal to the number of samples specified with the tag `SAMPLES`.

See also Chapter 11.3.2, "Defining periodically repeating traces", on page 275.

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 79

{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 four 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 four
Sets the marker number.

Example: `{MARKER MODE 1: GENERATOR}`
`{MARKER MODE 2: GENERATOR}`
`{MARKER MODE 3: GENERATOR}`

Usage: Setting only

{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}

(recommended for waveforms)

The tag determines the level of the ARB signal in the waveform file. The offset levels define the offset of RMS and peak value relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.

Setting parameters:

RMSOffset_dB
: Defines the RMS level offset of the signal relative to full scale ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format. The value is always positive.
A 3 dB value indicates that the RMS level of the signal is 3 dBs below the full scale.
full scale = max. amplitude of vector of I/Q samples = $|S_{IQ}|$max = sqrt(I^2+Q^2)max = 0 dB

PeakOffset_dB
: Defines the peak level offset of the signal relative to full scale for the ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format.
The value usually equals 0 dB as usually the I/Q samples (signed 16-bit integer values) are modulated to full scale: Full scale = 0 dB = max. amplitude of vector of I/Q samples = $|S_{IQ}|$ max = sqrt(I^2+Q^2)max = (2^{15})-1 = 32767.
A positive `PeakOffset_dB` value indicates that a headroom to full scale is provided when generating the waveform. A negative PeakOffset_dB value indicates that overrange is likely for some samples, i.e. clipping might occur.
The crest factor can be calculated from the two values as follows:
`Crest Factor = |PeakOffset_dB - RMSOffset_dB|`

Example:
```
{LEVEL OFFS: 3.45,2}
BB:ARB:WAV:TAG? 'LEVEL OFFS'
```
Queries the content of the `LEVEL OFFS` tag of the selected waveform file.
`Response: 3.45,2`
The level of the waveform is below full scale, clipping does not occur.

Usage: Setting only

{SAMPLES: Samples}

(recommended for waveforms)

The tag contains the number of I/Q samples in the waveform in ASCII format.

On multi-segment waveforms, this tag contains the total I/Q samples of all segments.

Example:
```
{SAMPLES: 1000}
BB:ARB:WAV:TAG? 'SAMPLES'
```
Queries the content of the `SAMPLES` tag of the selected waveform file.
`Response: 1000`
The waveform contains 1000 I/Q samples.

Usage: Setting only

See also Chapter 11.3.2, "Defining periodically repeating traces", on page 275.

{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 267.

How to: Chapter 11.3.2, "Defining periodically repeating traces", on page 275

Also, the processing of the marker traces (MARKER LIST) depends on the presence of the marker mode tag. See {MARKER MODE [#]: GENERATOR} on page 268.

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 four 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 268.
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 79

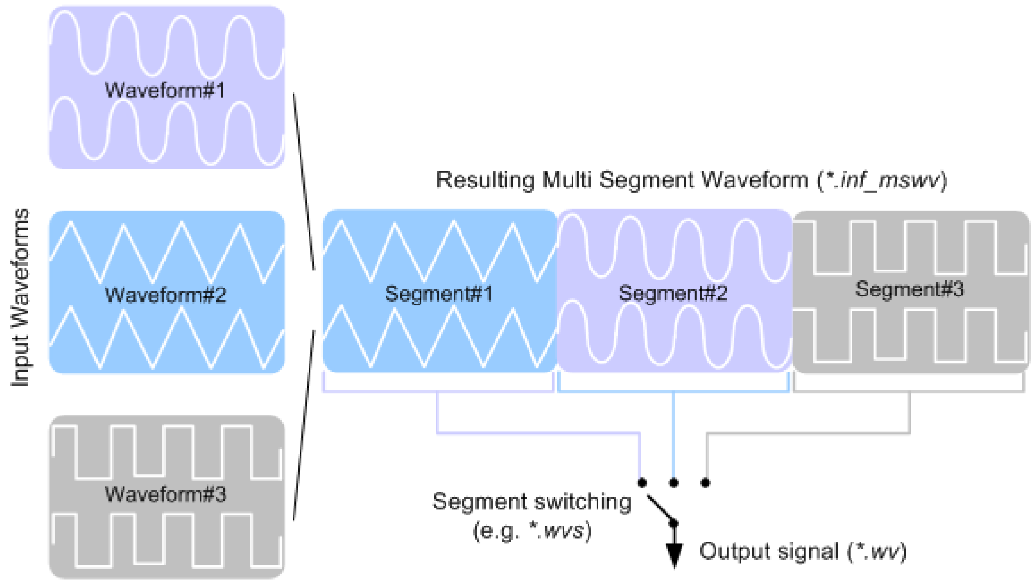
{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}

(mandatory for waveforms)

The tag contains the actual waveform data or multi-segment waveform data (I/Q stream).

Use the `TYPE` tag to define whether the waveform file contains a normal waveform or a multi-segment waveform.

The following figure shows the principle of multi-segment work mode.



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.

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.

Usage: Setting only

{MWV_SEGMENT_COUNT: NumOfSeg}

(mandatory for multi-segment waveforms)

The tag contains the number of segments in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_COUNT: 2}`
Multi-segment waveform with 2 segments

Usage: Setting only

{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample lengths for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_LENGTH: 100,200}`
2 segments: 100 samples in segment 0 and 200 samples in segment 1.

Usage: Setting only

**{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}**

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample start offsets for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_START: 0,100}`
2 segments with 100 samples in segment 0 and 200 samples in segment 1.
The start offset of first segment is 0 samples, start offset of next segment 1 is the sample length of segment 0 = 100 samples.

Usage: Setting only

{MWV_SEGMENT_CLOCK_MODE: Mode}

(mandatory for multi segment waveforms)

The tag contains a string in ASCII format which supplies the clock rate mode, that was used for calculation of the multi segment output waveform (see also "Clock" on page 132).

The tag `CLOCK` contains always the highest clock rate of all segments. The tag `MWV_SEGMENT_CLOCK` contains the clock rates of the individual segments.

Setting parameters:
Mode **UNCHANGED**
The segments may have different clock rates; each segment is output with the clock rate defined in its waveform file.
HIGHEST
All segments are output at the highest available clock rate.
USER
All segments are output at the user-defined clock rate.
Note: Only upsampling is allowed, no downsampling.

Example: `{MWV_SEGMENT_CLOCK_MODE: UNCHANGED}`

Usage: Setting only

{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1}

(mandatory for multi segment waveforms)

The tag contains a list of clock frequencies for every segment in the multi segment waveform in ASCII floating point format.

Example: `{MWV_SEGMENT_CLOCK: 100e6,80e6}`
2 segments: clock of segment 0 is 100 MHz, clock of segment 1 is 80 MHz.
Note: If the segments have different clock frequencies, there are some restrictions on signal output, i.e. seamless switching between segments is only possible, if all segments have the same clock frequency. Software resampling (upsampling) can be used to bring all segments to the same clock.

Usage: Setting only

**{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}**

(mandatory for multi segment waveforms)

The tag contains a list of level pairs in ASCII floating point format, one pair for every segment in the multi segment waveform. The first value of a level pair defines the rms offset and the second value the peak offset relative to the 16-bit full scale modulation (-32767; + 32767) = 0 dB. The meaning of one level value pair is the same as in the `LEVEL OFFS` tag for normal waveforms.

Example: `{MWV_SEGMENT_LEVEL_OFFS: 3.0,0.0,6.0,0.0}`
2 segments: RMS level of segment 0 is 3dB below full scale;
RMS level of segment 1 is 6 dB below full scale.
Peak level of both segments is 0 dB full scale.

Usage: Setting only

**{MWV_SEGMENT_FILES:
"FileNameSeg0.wv", "FileNameSeg1.wv", …, "FileNameSegN-1.wv"}**

(optional for multi segment waveforms)

The tag contains a list of file names for every segment in the multi segment waveform in ASCII format.

Example: `{MWV_SEGMENT_FILES: "d:\waveforms\sine.wv", "d:\waveforms\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 given out synchronously to the I/Q sample sequence. One marker element `mx` consists of 4 bit, which are assigned to the 4 possible marker lines of the instrument (1 bit per marker line). A 4-bit marker element is required for every I/Q sample in the `WAVEFORM` tag. Hence, the number of marker elements `m` is recommended to be equal to the number of I/Q samples. The `CONTROL LENGTH` tag has to contain the number of all marker elements `m`.

<table>
<tr><td>MSB 7</td><td colspan="6">Byte</td><td>LSB 1</td></tr>
<tr><td colspan="4">Marker element m_x
(synchronous to I/Q Sample x)</td><td colspan="4">Marker element m_{x+1}
(synchronous to I/Q Sample x+1)</td></tr>
<tr><td>Marker 4</td><td>Marker 3</td><td>Marker 2</td><td>Marker 1</td><td>Marker 4</td><td>Marker 3</td><td>Marker 2</td><td>Marker 1</td></tr>
</table>

Figure 11-3: Marker element in 4-bit binary format bit order

For standard waveforms, the `MARKER LIST x` tags are a more compact way to define markers, but in principle this `CONTROL LIST WIDTH4` format can also be used instead of the `MARKER LIST x` tags.

For multi segment waveforms, the `CONTROL LIST WIDTH4` format is required for marker definition. The binary marker streams of the individual segments are directly concatenated (without any gap) to one collectively marker stream.

Setting parameters:

Length — Defines the number of bytes in the `CONTROL LIST WIDTH4` tag in ASCII Format and is calculated as follows:
*Length = Size of "#" (1 byte) + Number of marker elements m_x * (4 bit) / (8 bits/byte).*
The value is rounded up for byte alignment.

mx — Marker element in 4-bit binary format.

Example: {CONTROL LIST WIDTH4-51: #$m_0m_1 \dots m_x \dots m_{99}$}
100 marker elements, each marker element with 4 bits

Usage: Setting only

11.3.2 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".

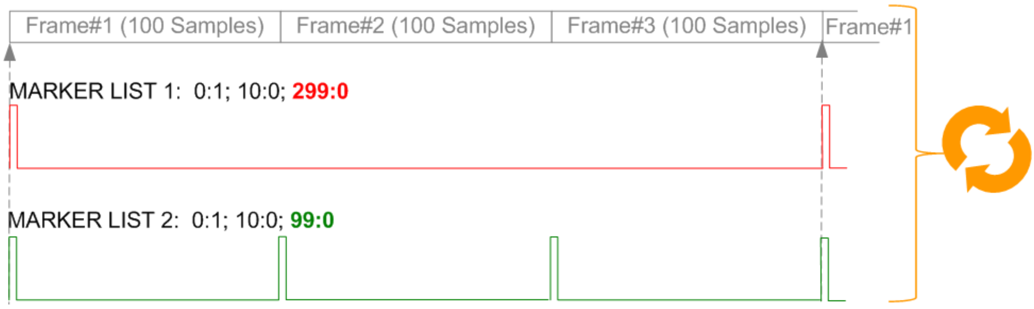


Figure 11-4: Example: Defining marker traces without CONTROL LENGTH tag

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}`.

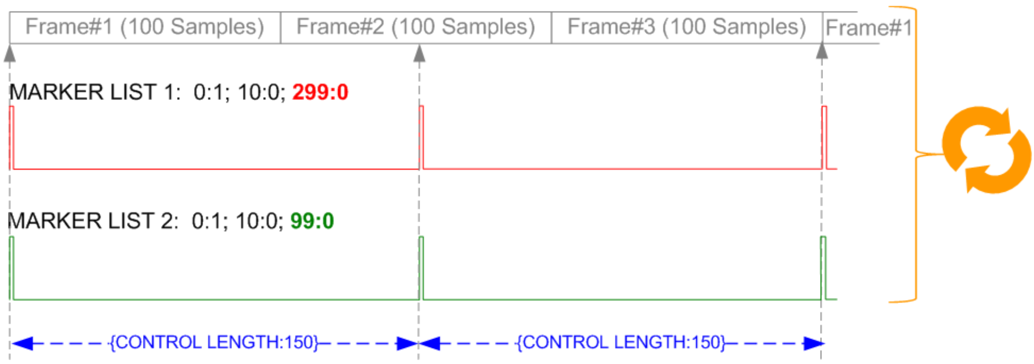


Figure 11-5: Example: Processing control signals with CONTROL LENGTH tag

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.

11.3.3 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 280). They are saved in the file `SICO.txt`. The decimal values in `SICO.txt` are normalized such that they are between –1.0 and +1.0. The data is converted into binary format. The appropriate mandatory tags are added and the data is packed into the `WAVEFORM` tag. As result, the waveform file `SICO.wv` is generated.

This example follows the general principle of creating of a waveform manually, using the tag file format. The Figure 11-6 illustrates this general workflow.

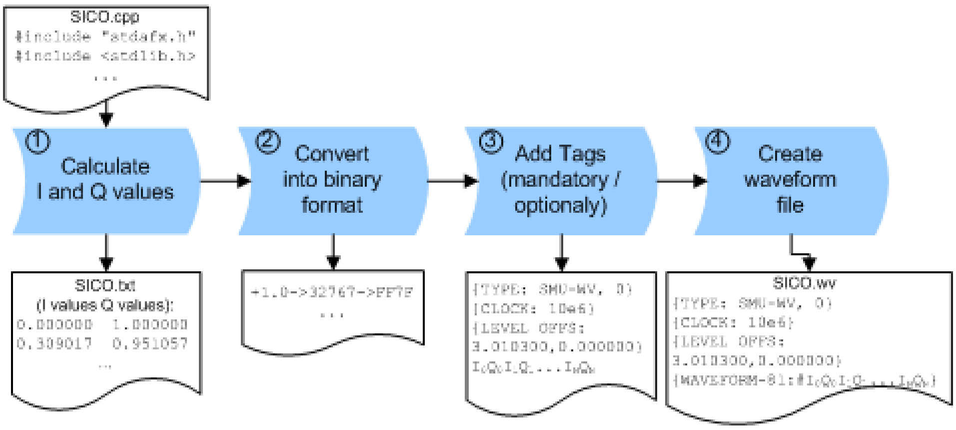


Figure 11-6: Principle of creating a waveform manually

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 11-7: Contents of SICO.txt: first column Sine (I), second column Cosine (Q)

2. Convert the values from the file `SICO.txt` into binary format consisting of 16-bit signed integer numbers. The numeric range between –1.0 and +1.0 corresponds to the modulation range of the waveform 16-bit D/A converter of -32767 to +32767.

+1.0 ->	32767 ->	= 0x7FFF
0.0 ->	0 ->	= 0x0000
-1.0 ->	-32767 ->	= 0x8001

The Figure 11-8 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 11-8: 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.

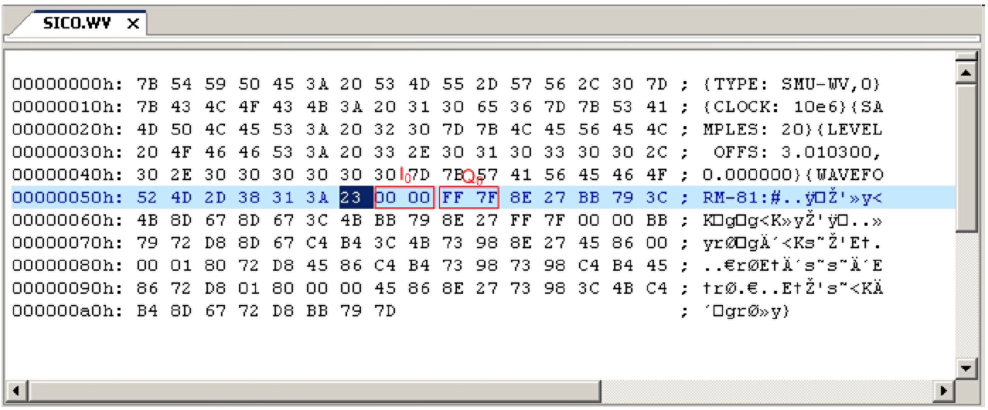
   ```
   {WAVEFORM-Length: #I0Q0I1Q1I2Q2 ... InQn}
   ```

   - 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;
}
```

11.3.4 How to create a control list using tag file format

R&S WinIQSIM2 provides the following ways to create a file containing control signals:

- to use the dedicated "Control Data Editor" and create a file in ASCII format and with extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 82
- to use the tag-oriented format and create a control list file, see "To create a control list using tag file format" on page 282

To create a control list using tag file format

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

1. Use a hex data editor.
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. Use a hex data editor.
4. Create the **recommended** tag CONTROL LENGTH.

   This tag defines the *periodicity* of the total control list.
5. Add the required optional tags.
6. Insert them after the TYPE tag in arbitrary order.

   An example of the control list file contents could be:

```
{TYPE:SMU-CL}{COPYRIGHT:Rohde&Schwarz}
{DATE:2012-06-11;15:00:09}{HOP LIST:0:0;498:1;506:0}
{CW MODE LIST:0:0;380:1}{LEVATT LIST 3:0:0;464:1}
{BURST LIST:0:0;122:1;270:0;582:1;924:0}
{MARKER LIST 4:0:0;706:1;764:0}
{MARKER LIST 3:0:0;530:1;633:0}
{MARKER LIST 2:0:0;350:1;457:0}
{MARKER LIST 1:0:0;108:1;160:0}
{CONTROL LENGTH:1000}
```

   The Figure 3-6 shows the representation of the created control list in the "Control Data Editor".
   Compare the displayed ramp values of "Marker 1" and the "Total List Length" with the values in the corresponding tags.
   Note: In the provided example, the tags have been separated by line breaks for better reading.
   See also Example "How to assign and activate control signals from a control list" on page 283.

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

Note: Irrespective of the way they are created, generated control lists are not automatically used.

We assume, that a control list `clist.dm_iqc` containing information on marker 2, burst gate and level attenuation control signals is created and stored in the directory `D:\user\temp\`.

The following example shows how to enable R&S WinIQSIM2 to:

- use the control list for a particular marker output, e.g. the "Custom Digital Modulation > Marker 2".
- use the Burst Gate and Level Attenuation control signals as defined in a control list.

```
MMEM:CDIRectory "/var/user/temp"
SOURce1:BB:DM:CLISt:CATalog?
// Response: clist
SOURce1:BB:DM:CLISt:SELect "clist"
SOURce1:BB:DM:TRIGger:OUTPut2:MODE CLISt

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

11.3.5 How to create a data list using tag file format

R&S WinIQSIM2 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 a data list manually" on page 84.
- to use the tag-oriented format and create a data list file, see "To create a data list using tag file format" on page 283.

To create a data list using tag file format

To create a data list file directly, use the provided tag commands.

1. Use a hex data editor.
2. Create the mandatory tags, the `TYPE`, the `{DATA BITLENGTH}` and `{DATA LIST-Length}`.
   Consider the rules of the required tags.

   An example of the data list file contents could be:
   ```
   {TYPE:SMU-DL}{COPYRIGHT:Rohde&Schwarz}
   {DATE:201-06-11;15:00:09}
   {DATA BITLENGTH: 8}
   {DATA LIST-2: #01110101}
   ```
   Note: In the provided example, the tags have been separated by line breaks for better reading.
   See Figure 3-7 for representation of the created data list in the "Data List Editor".
   See also Example "How to assign and activate a data list" on page 284.

Example: How to assign and activate a data list

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

We assume, that a data list `dl.dm_iqd` is created and stored in the directory `D:\user\`.

The following example shows how to enable R&S WinIQSIM2 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"
```

11.3.6 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.

11.4 MMEMory subsystem

The MMEMory subsystem (**M**ass **Mem**ory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

The various drives can be selected using the "mass storage unit specifier " <msus>. The internal hard disk is selected with `D:\`, and a memory stick which is inserted at the USB interface is selected with `E:\`. The resources of a network can also be selected with <msus> in the syntax of the respective network, for example using the UNC format (Universal Naming Convention): `\\server\share`.

The default drive is determined using the command `MMEMory:MSIS <msus>`.

The `C:` drive is a protected system drive. This drive should not be accessed. Reconstruction of the system partition will not be possible without loss of data.

Use the command :SYSTem:MMEMory:PATH:USER? to query the path of the directory for user-defined data.

11.4.1 File naming conventions

To enable files in different file systems to be used, the following file naming conventions should be observed.

The file name can be of any length and no distinction is made between uppercase and lowercase letters.

The file and the optional file extension are separated by a dot. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). If possible, special characters should not be used. The use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved for the operating system, e.g. CLOCK$, CON, AUX, COM1...COM4, LPT1...LPT3, NUL and PRN.

In the R&S WinIQSIM2 all files in which lists and settings are stored are given a characteristic extension. The extension is separated from the actual file name by a dot (see Chapter A, "Extensions for user files", on page 406 for an overview of the file types).

The two characters "*" and "?" function as "wildcards", meaning they are used for selecting several files. The "?" character represents exactly one character, while the "*" character represents all characters up to the end of the file name. "*.*" therefore stands for all files in a directory.

When used in conjunction with the commands, the parameter <file_name> is specified as a string parameter with quotation marks. It can contain either the complete path including the drive, only the path and the file name, or only the file name. The file name must include the file extension. The same applies for the parameters <directory_name> and <path>.

Depending on how much information is provided, either the values specified in the parameter or the values specified with the commands MMEM:MSIS (default drive) and MMEM:CDIR (default directory) are used for the path and the drive settings in the commands.

Before the instrument settings can be stored in a file, they have to be stored in an intermediate memory using common command *SAV <number>. The specified number is subsequently used in the :MMEMory:STORe:STATe on page 294 command. Also, subsequently to loading a file with instrument settings with command :MMEMory:LOAD:STATe on page 292, these settings have to be activated with the common command *RCL <number>.

11.4.2 Examples

In these examples, the current instrument setting is stored in the file test1.savrcl in the directory D:\user\.

Storing and Loading Current Settings

1. Store the current setting in an intermediate memory with the number 4. This setting can be called using command `*RCL` and the associated number of the memory, for example `*RCL 4`.
   `*SAV 4`
2. To store the settings in a file in a specific directory, specify the complete path.
   `MMEM:STOR:STAT 4,"D:\user\test.savrcl"`
3. To store the settings in a file in the default drive, set the default drive and specify only the file name.
   `MMEM:MSIS 'D:\user\'*SAV 4`
   `MMEM:STOR:STAT 4,"test.savrcl"`
4. Load the file `test.savrcl` in the `user` directory.
   `MMEM:LOAD:STAT 4,'D:\user\test.savrcl'`
5. Activate the instrument setting of the file `test.savrcl`.
   `*RCL 4`

Working with Files and Directories

1. Read out all files in the specified directory.
   `MMEM:CAT? 'E:\user'`

   Response: `127145265,175325184,"test,DIR,0","temp,DIR,0", "readme.txt,ASC,1324","state.savrcl,STAT,5327", "waveform.wv,BIN,2342"`

   the directory `E:\user` contains the subdirectories `test` and `temp` as well as the files `readme.txt`, `state.savrcl` and `waveform.wv` which have different file types.

   Tip: To query only the subdirectories of the current or specified directory, perform:
   `MMEM:DCAT? 'E:\user'`

   Response: `'test', 'temp'`

   To query only the number of subdirectories in the current or specified directory, perform:

   `MMEM:DCAT:LENG? 'E:\user'`

   Response: `2`
2. To query the number of files in the current or specified directory, perform:
   `MMEM:CAT:LENG? 'E:\user'`
   Response: `3`
3. Create a new subdirectory for mass memory storage in the specified directory.
   `MMEM:MDIR 'E:\new'`
4. Copy the file `state` to a new file.
   `MMEM:COPY 'D:\user\state.savrcl','E:\new'`
5. Rename the file `state`.

```
MMEM:MOVE 'state.savrcl','state_new.savrcl'
```

6. Remove the `test` directory.
   `MMEM:RDIR 'E:\test'`

11.4.3 Remote control commands

: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.

Example: See "Working with Files and Directories" on page 286.

Usage: Query only

Manual operation: See "Directory, File List and File Name" on page 211

:MMEMory:CATalog:LENGth? [<Path>]

Returns the number of files in the current or in the specified directory.

Query parameters:

<Path> string

String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with :MMEMory:CDIRectory command.

Return values:

<FileCount> integer

Number of files.

Example: See "Working with Files and Directories" on page 286.

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 '..' .

Example: See "Working with Files and Directories" on page 286.

Manual operation: See "Directory, File List and File Name" on page 211
See "Directory and File Name" on page 219

: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.

Example: See "Working with Files and Directories" on page 286.

Usage: Setting only

Manual operation: See "Cut, Copy&Paste and Delete" on page 220

:MMEMory:DATA <Filename>, <BinaryData>
:MMEMory:DATA? <Filename>

The setting command writes the block data `<BinaryBlock>` to the file identified by `<Filename>`.

Set the GPIB-bus terminator to `EOI` to ensure correct data transfer.

The query command transfers the specified file from the instrument to the GPIB-bus and then on to the controller. It is important to ensure that the intermediate memory on the controller is large enough to take the file. The setting for the GPIB-bus terminator is irrelevant.

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 'D:\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? 'D:\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.

Parameters:

<Msus>	<Identifier>:<file name>

Mass Storage Unit Specifier
A string that specifies whether I/Q data (`NVWFM`) or marker data (`NVMKR`) is transferred and the file name the data is stored in.
If the file with the specified name does not exist, a file is created.
Any existing content in the file is *overwritten*.
Complete file path and file extension may also be specified. If omitted, files are stored in the default directory and the 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 that follow in the `<Binary data>` part

I0Q0..IxQx…IN-1QN-1
Binary data in ASCII format
`IxQx…` represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each I and Q component consists of 2 bytes in MSB format (most significant byte first).
The values of the 2 bytes in an I component and a Q component are in the range: -32767 to +32767.

M0M1…Mx…MN-1
Binary data in ASCII format
`Mx` represents one marker byte, where only the 4 least significant bits are used. These 4 bits are assigned to the 4 possible markers of the instrument, 1 bit per marker: Bit_0 = Marker 1, ... Bit_3 = Marker 4.
One 4-bit marker element is required for every I/Q sample.

Example:

```
:MMEM:DATA:UNPR "NVWFM:D:\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:D:\user\wave.wv"
:MMEMory:DATA:UNPRotected "NVMKR:D:\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:D:\user\wave.wv"
// note that, the query returns binary values
SOURce1:BB:ARBitrary:WAVeform:CLOCk "D:\user\wave.wv",1.1E6
SOURce1:BB:ARBitrary:WAVeform:CLOCk? "D:\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.

Example: See "Working with Files and Directories" on page 286.

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.

Example: See "Working with Files and Directories" on page 286.

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.

Example: See "Working with Files and Directories" on page 286.

Usage: Setting only

Manual operation: See "Cut, Copy&Paste and Delete" on page 220

:MEMory:HFRee?

Returns the used and available memory in Kb.

Return values:

<TotalPhysMemKb> integer

Total physical memory.

<ApplicMemKb> integer

Application memory.

<HeapUsedKb> integer

Used heap memory.

<HeapAvailableKb> integer

Available heap memory.

Usage: Query only

:MMEMory:LOAD:STATe <SavRclStateNumb>, <file_name>

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

Setting parameters:

<SavRclStateNumb> Determines to the specific <number> to be used with the `*RCL` command, e.g. `*RCL 4`.

<file_name> String parameter to specify the file name with extension `*.savrcl`.

Example: See "Storing and Loading Current Settings" on page 286.

Usage: Setting only

Manual operation: See "Recall" on page 212

: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.

Example: See "Working with Files and Directories" on page 286.

Usage: Setting only

Manual operation: See "Create New Directory" on page 220

: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.

Example: See "Working with Files and Directories" on page 286.

Usage: Setting only

Manual operation: See "Rename" on page 220

: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).

This setting applies to all `MMEMory` commands that do not explicitly specify the drive.

Parameters:
<Path> string
*RST: D:\

Example: See "Storing and Loading Current Settings" on page 286.

:MMEMory:RDIRectory <Directory>

Removes an empty directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

Setting parameters:

<Directory> string
String parameter to specify the directory to be deleted.

Example: See "Working with Files and Directories" on page 286.

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 "Working with Files and Directories" on page 286.

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 `*.savrcl`.

Example: See "Storing and Loading Current Settings" on page 286.

Usage: Event

Manual operation: See "Save" on page 212

:SYSTem:MMEMory:PATH:USER?

Queries the user directory, that means the directory the instrument stores user files on.

Return values:

<PathUser> string

Example: `SYSTem:MMEMory:PATH:USER?`
Response: "D:\user\

Usage: Query only

11.5 Transmission commands

This chapter contains the remote control commands to set waveform generation, instrument configuration and transmission of the file containing the waveform.

Programming Examples

Example: Querying waveform properties

```
// Create and save a waveform file locally, e.g. an LTE waveform.
SOURce1:BB:EUTRa:WAVeform:CREate "c:/User/Waveforms/E_TM1_1_10MHz.wv"
// Query waveform properties.
GENerate:WAVeform:DURation?
// Response: 0.01 (seconds)
GENerate:WAVeform:OSAMpling?
// Response: 1
GENerate:WAVeform:SAMPles?
// Response: 307200
GENerate:WAVeform:SRATe?
// 30.72E6 (Hz)
```

Example: Configuring instruments

```
// Clear the device list and add new instruments manually.
INSTruments:CLEar
INSTruments:NAME "MYSMW200A","MYSMBV100B","MYSMBV100A"
// Define the instrument types by assigning installed options.
INSTruments:TYPE "SMWB10K511K512K522","SMBVBK511K523","SMBVB51K511K512K521K522"
// Specify the remote interface and name or address for the instruments in the
// device list.
INSTruments:REMote:CHANnel LAN,GPIB,USB
INSTruments:REMote:NAME "RSSMW200A1000001","10.124.1.247","RSSMBV100A1000025"
INSTruments:GPIB:ADDRess 6,7,8
INSTruments:USB:SERial 100001,100001,123456
```

Example: Scanning the network or subnet for instruments

```
// Scan the network for instruments connected via LAN, GPIB or USB interface.
INSTruments:SCAN 1
INSTruments:SCAN?
// Response: 1
// Scanning process is still running.
INSTruments:SCAN?
// Response: 0
// Query detected instruments and instrument types from the device list.
INSTruments:NAME?
// Response: "MYSMW200A","SMW-123456"
INSTruments:TYPE?
// Response: "SMWB10K511K512K522","SMWK511K523"
// Query detected instrument interface properties.
INSTruments:REMote:CHANnel?
// Response: "LAN", "LAN"
INSTruments:REMote:NAME?
// Response: "rssmw200a1000001","rssmw200a123456"

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

Example: Transmitting waveforms to instruments or local drives

```
// In the device list, select the instrument to which you transmit the waveform.
INSTruments:NAME?
// Response: "MYSMW200A","SMW-123456"
// Select the second instrument: "SMW-123456"
INSTruments:SELect:ARB 2
// Define instrument destination and name of the transmitted waveform file.
TRANsmit:DESTination INST
TRANsmit:DESTination:IFILe "var/user/waveform/LTE_E_TM1_1_10MHz.wv"
// Add a comment to be written in the header of the transmitted waveform file.
TRANsmit:COMMent "LTE_TestCase_ETM1_1_10_Waveform"
// Automatically load and start the waveform on an instrument-specific path.
TRANsmit:AUTO:PATH A
TRANsmit:AUTO:STATe 1

// Alternatively save the waveform file locally.
TRANsmit:DESTination FILE
TRANsmit:DESTination LFILe "C:/User/Waveforms/E_TM1_1_10MHz.wv"

// Start the waveform file transmission.
TRANsmit:STATe 1
```

```
// Monitor the transmission state with a query.
// After successful transmission the query returns 0.
```


:GENerate:WAVeform:DURation?

Queries the signal duration in seconds of the available samples within the generated waveform file. The value of this parameter is evaluated by parameter `GENerate:WAVeform:SAMPles`.

Return values:

<Duration>	float
Example:	See Example "Querying waveform properties" on page 295.
Usage:	Query only
Manual operation:	See "Total Signal Duration" on page 174

:GENerate:WAVeform:OSAMpling?

Queries the baseband oversampling factor. The value is determined by the content of the generated waveform file. To adjust the oversampling rate, the corresponding parameters defined within the standards must be used, e.g. `SOUR:BB:WLAN:FILT:OSAM`.

Return values:
<Osampling> float

Example: See Example "Querying waveform properties" on page 295.

Usage: Query only

Manual operation: See "Oversampling Factor" on page 174

:GENerate:WAVeform:SAMPles?

Queries the number of available samples within the generated waveform file. It equals to the I and respectively Q sample sequence length and is calculated as follow:

Number of Samples = Number of symbols * Oversampling factor

Return values:
<Samples> float

Example: See Example "Querying waveform properties" on page 295.

Usage: Query only

Manual operation: See "Samples" on page 39
See "Sample Rate (fc)" on page 174

:GENerate:WAVeform:SRATe?

Queries the sample rate in [Hz], where

Sampling Rate = Number of symbols * Oversampling factor.

Return values:
<Srate> float

Example: See Example "Querying waveform properties" on page 295.

Usage: Query only

Manual operation: See "Sample Rate" on page 39
See "Sample Rate (fc)" on page 174

:INSTruments:CLEar

Clears all instruments in the device list.

Example: See Example "Configuring instruments" on page 295.

Usage: Event

Manual operation: See "Clear" on page 193

:INSTruments:GPIB:ADDRess <Address>

Defines the GPIB addresses of the instruments in the device list.

Parameters:

<Address> <Address#1>,<Address#2>,...

Range: 1 to 30

Example: See Example "Configuring instruments" on page 295.

:INSTruments:NAME <Name>

Defines the symbolic name of the instruments in the device list.

Parameters:

<Name> <SymbName#1>,<SymbName#2>,...

Example: See Example "Configuring instruments" on page 295.

Manual operation: See "Available Instruments" on page 193
See "Scan" on page 193
See "Symbolic Name" on page 195

:INSTruments:REMote:CHANnel <Channel>

Defines the remote channels of the instruments in the device list.

Parameters:

<Channel> <Channel#1>,<Channel#2>,...

List of remote channels (LAN | GPIB | USB | HiSLIP) used by individual instruments.

Example: See Example "Configuring instruments" on page 295.

Manual operation: See "Hardware Channel" on page 195

:INSTruments:REMote:NAME <Name>

Defines the instrument (device) names of the instruments in the device list. The instrument name of an instrument is used to access the instrument over the network.

Parameters:

<Name> <InstrName#1>,<InstrName#2>,...

Example: See Example "Configuring instruments" on page 295.

Manual operation: See "Instrument Name / IP Address" on page 195

:INSTruments:SCAN <Scan>

Triggers a scan function to search for instruments connected via one of the possible interfaces, LAN, GPIB or USB.

Parameters:

<Scan> 1 | ON | 0 | OFF

Example: See Example "Configuring instruments" on page 295.

Manual operation: See "Scan" on page 193

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

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

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (no preset. default: 0)

Example: See Chapter 11.5, "Transmission commands", on page 295.

Manual operation: See "Scan Subnet" on page 193

:INSTruments:SCAN:SNET:IPADdress <Address>

Sets the IP address of an instrument within a subnet.

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

Parameters:

<Address> ipaddress

*RST: n.a. (no preset. default: 0)

Example: See Chapter 11.5, "Transmission commands", on page 295.

Manual operation: See "IP Address" on page 193

:INSTruments:SCAN:SNET:PLENgth <Length>

Sets the prefix length of the subnet mask.

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

Parameters:

<Length> integer

Range: 20 to 30
*RST: 20

Example: See Chapter 11.5, "Transmission commands", on page 295.

Manual operation: See "Prefix Length" on page 193

:INSTruments:SELect:ARB <Arb>

Selects one of the instruments available in the network as an ARB instrument

Parameters:

<Arb> 1 | ON | 0 | OFF

Range: 0 (=undefined) to Number of defined devices
Increment: 1
*RST: 0

Example:

`INST:SCAN ON`
starts a scan of the network
`INST:SCAN?`
Queries whether the scan process is still running
`Response: 0`
the scan process is completed, i.e. the list of available instruments can be queried
`INST:NAME?`
Queries the list of the available instruments
`Response: "AFQ100AB10","SMUB10"`
`INST:SEL:ARB 2`
Selects the second instrument in the list (in this case the instrument with name SMUB10) as an ARB instrument.
`INST:SEL:ARB 0`
Selects an “Undefined” instrument

:INSTruments:SELect:VECTor <Vector>

Selects one of the instruments available in the network as a vector signal generator.

Parameters:

<Vector> 1 | ON | 0 | OFF

Range: 0 (=undefined) to Number of defined devices
Increment: 1
*RST: 0

Example:

`INST:SCAN ON`
starts a scan of the network
`INST:SCAN?`
Queries whether the scan process is still running
`Response: 0`
the scan process is completed, i.e. the list of available instruments can be queried
`INST:NAME?`
Queries the list of the available instruments
`Response: "SMW200A","SMBV100A",AFQ100AB10", "SMUB10"`
`INST:SEL:VECT 2`
Selects the second instrument in the list (in this case the instrument with name SMUB10) as an ARB instrument.
`INST:SEL:VECT 0`
Selects an “Undefined” instrument

:INSTruments:TYPE <Type>

Sets the instrument type and instrument equipment in the instruments list. The tables below provide an overview on the related Rohde & Schwarz instrument and the settable parameters.

Table 11-1: Rohde & Schwarz instruments

Instrument	<Type>
R&S CMP180	CMP180
R&S CMP200	CMP200
R&S CMW500	CMWH110A | CMWH110D | CMWH100H
R&S CMW100	CMW100K02K03 | CMW100K06
R&S PVT360A	PVT360A | PVT360AKB505
R&S SFI100A	SFIK510 | SFIK510K517 | SFIK510 | SFIK517K529 | SFIK517K529K530 | SFIK529 | SFIK529K530
R&S SGT100A	SGT | SGTK511 | SGTK511K512 | SGTK511K512K521 | SGTK511K512K521K522 | SGTK511K512K521K522K523 | SGTK511K521 | SGTK511K521K522 | SGTK511K521K522K523 | SGTK521 | SGTK521K522 SGTK521K522K523
R&S SMBV100B	SMBVB | SMBVBK511 | SMBVBK511K523 | SMBVBK511K524 | SMBVBK511K525 | SMBVBK512 | SMBVBK512K523 | SMBVBK512K524 | SMBVBK512K525 | SMBVBK513 | SMBVBK513K523 | SMBVBK513K524 | SMBVBK513K525 | SMBVBK523 | SMBVBK524 | SMBVBK525
R&S SMCV100B	SMCVB | SMCVBK511 | SMCVBK511K512 | SMCVBK511K521 | SMCVBK511K522 | SMCVBK511K523 | SMCVBK512 | SMCVBK512K521 | SMCVBK512K522 | SMCVBK512K523 | SMCVBK521 | SMCVBK522 | SMCVBK523
R&S SMM100A	SMMB9 | SMMB9K511 | SMMB9K511K523 | SMMB9K511K524 | SMMB9K511K525 | SMMB9K512 | SMMB9K512K523 | SMMB9K512K524 | SMMB9K512K525 | SMMB9K513 | SMMB9K513K523 | SMMB9K513K524 | SMMB9K513K525 | SMMB9K523 | SMMB9K524 | SMMB9K525
R&S SMW200A	SMWB9 | SMWB9K515 | SMWB9K515K525 | SMWB9K515K525K527 | SMWB9K515K526 | SMWB9K515K555P2 | SMWB9K525 | SMWB9K525K527 | SMWB9K526 | SMWB9K555P2 | SMWB10 | SMWB10K511 | SMWB10K511K512 | SMWB10K511K512K522 | SMWB10K511K522 | SMWB10K522

Table 11-2: Discontinued Rohde & Schwarz instruments

Instrument	<Type>
R&S AFQ100A	AFQB10 | AFQB11
R&S AFQ100B	AFQ100BB11 | AFQ100BB12
R&S AMU200A	AMUB9 | AMUB10 | AMUB11
R&S BTC	BTC
R&S EX-IQ-Box	EXIQbox
R&S SFU	SFU64MS | SFU128MS | SFU512MS
R&S SMATE200A	SMATEB9 | SMATEB10 | SMATEB11
R&S SMBV100A	SMBVB10 | SMBVB50 | SMBVB51 | SMBVB10B55 | SMBVB50B55 | SMBVB51B55 | SMBVB10K511 | SMBVB10K511K512 | SMBVB10K511K512K522 | SMBVB10K511K522 | SMBVB10K522 | SMBVB51K511 | SMBVB51K511K512 | SMBVB51K511K521 | SMBVB51K511K512K521 | SMBVB51K511K512K521K522 | SMBVB51K511K521K522 | SMBVB51K521 | SMBVB51K521K522

Instrument	<Type>
R&S SMJ100A	SMJB9 | SMJB10 | SMJB11 | SMJB50 | SMJB51
R&S SMU200A	SMUB9 | SMUB10 | SMUB11

Parameters:
<Type> string
For strings of available instruments, see the tables above.

Example: See Example "Configuring instruments" on page 295.

Manual operation: See "Available Instruments" on page 193
See "Instrument Type" on page 195

:INSTruments:USB:SERial <Serial>

Defines the serial numbers of the instruments in the device list. The serial number of an instrument is required to access it over USB.

Parameters:
<Serial> <SerialNumb#1>,<SerialNumb#2>,...

Example: See Example "Configuring instruments" on page 295.

:TRANsmit:AUTO:ARB <Arb>

Requires connected R&S BTC instruments, since these instruments have several ARB generators in a path.

Selects the arbitrary waveform generator.

Parameters:
<Arb> A | B

Example:
```
TRANsmit:AUTO:ARB A
```
Selects the ARB generator in path A of the connected R&S BTC instrument.

Manual operation: See "ARB" on page 202

:TRANsmit:AUTO:PATH <Path>

Defines on which path of the instrument the signal is to be generated, if a transmitted waveform file shall be automatically loaded and started on the instrument.

Parameters:
<Path> A | B

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "In" on page 201

:TRANsmit:AUTO[:STATe] <State>

Defines whether the transmitted waveform file should be automatically loaded and started on the instrument after the waveform file has been transmitted.

Parameters:
<State> 1 | ON | 0 | OFF

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "Automatically Load And Start Waveform" on page 201

:TRANsmit:COMMent <Comment>

Specifies a comment which will be written into the header of generated waveform file.

Parameters:
<Comment> string

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "User Comment for File/Waveform" on page 200

:TRANsmit:DESTination <Destination>

Defines the transmission destination of the waveform file. There are two options: The Instrument (arbitrary signal generator) or a file on a local drive.

Parameters:
<Destination> INSTrument | FILE

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "Transmit to" on page 201

:TRANsmit:DESTination:IFILe <Ifile>

Defines the name of the waveform destination file on the instrument, if `INSTrument` is selected as the transmit destination.

Parameters:
<Ifile> string

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "File" on page 201

:TRANsmit:DESTination:LFILe <Lfile>

Defines the name of the waveform destination file on a local hard disc (file copy), if `FILE` is the selected transmit destination.

Parameters:

<Lfile> string

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "File" on page 201

:TRANsmit:SOURce <Source>

Defines the source of the waveform to be transmitted. The waveform file can be generated internally or generated internally and stored locally.

Parameters:

<Source> INTernal | FILE

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "Transmit from" on page 200

:TRANsmit:SOURce:LFILe <Lfile>

Defines the name of a source file, that is stored locally and is to be transmitted

Parameters:

<Lfile> string

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "File" on page 201

:TRANsmit:STATe <State>

Starts/stops a transmission. The query informs about the current state of a transmission.

Parameters:

<State> 1 | ON | 0 | OFF

Example: See Example "Transmitting waveforms to instruments or local drives" on page 296.

Manual operation: See "Transmit Waveform" on page 202

11.6 SOURce:AWGN subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

These commands require option R&S WinIQSIM2-K262 (Additive White Gaussian Noise).

[:SOURce<hw>]:AWGN:BRATe <BRate>

Sets the bit rate which is used for calculation of bit energy to noise power ratio from carrier/noise ratio for Digital Standard signals.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

Parameters:

<BRate> float

Range: 400 bps to 250E6 bps
Increment: 0.001
*RST: 100000

Example: `SOURce1:AWGN:BRATe?`
queries the bit rate which is used for calculation of the Eb/N0 value from the C/N value.

Manual operation: See "Bit Rate" on page 157

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

For additive noise signals and noise-only signals (`SOUR:AWGN:MODE ADD|ONLY`), sets the system bandwidth.

Within this bandwidth, the baseband signal is superimposed with a noise signal which level corresponds exactly to the set C/N or signal-to-noise ratio.

Parameters:

<BWidth> float

Range: 1000 to 80E6
Increment: 100
*RST: 3.84E6

Example:
```
:SOURce1:AWGN:MODE ADD
:SOURce1:AWGN:BWIDth 10 MHz
```
Sets a system bandwidth of 10 MHz.

Manual operation: See "System Bandwidth" on page 155

[:SOURce<hw>]:AWGN:BWIDth:NOISe?

For additive noise signals and CW interference signals (`SOUR:AWGN:MODE ADD|CW`), queries the real noise bandwidth.

Return values:

<Noise> float

Range: 0 to 200E6
Increment: 100
*RST: 0

Example:
```
:SOURce1:AWGN:BWID:NOIS?
```
Queries the noise bandwidth.
```
// Response: "100E6"
```
The real noise bandwidth is 100 MHz.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 155

[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>

For additive noise signals and CW interference signals (`SOUR:AWGN:MODE ADD|CW`), sets the ratio of minimum real noise bandwidth to system bandwidth.

Make sure that the overall bandwidth remains below the total bandwidth as in the specification document. This bandwidth is calculated as follows:

The value range of this parameter is automatically adjusted depending on the selected instrument. The maximum ratio of the minimum noise bandwidth to system bandwidth depends on the maximum sample clock of the selected instrument. It is calculated so that the overall bandwidth, i.e. "System BW" x "Minimum Noise"/"System BW Ratio" has to be less or equal to the sampling rate of the selected instrument.

Parameters:

<Ratio> float

Range: 1 to Max
Increment: 0.1
*RST: 1

Example: `:SOURce1:AWGN:BWID:RAT 2`
Sets a minimum noise to system bandwidth ratio of 2.

Manual operation: See "Min. Noise/System Bandwidth Ratio" on page 155

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

For additive noise signals and CW interference signals (`SOUR:AWGN:MODE ADD|CW`), sets the carrier to interferer ratio. The value range depends on the selected AWGN mode.

Parameters:
<CnRatio> float

Range: -50 to 40
Increment: 0.01
*RST: 0
Default unit: dB

Example: `:SOURce1:AWGN:CNR 10`
Sets a carrier to noise ratio of 10 dB.

Manual operation: See "Carrier/Noise Ratio, Carrier/Interferer Ratio" on page 157

[:SOURce<hw>]:AWGN:ENRatio <EnRatio>

For additive noise mode, sets the ratio of bit energy to noise power density E_b/N_0.

For digital standard signals, the bit rate used for calculation of E_b/N_0 value from C/N value is defined with command `SOUR:AWGN:BRAT`.

Parameters:
<EnRatio> float

Range: -50 to depends on hardware
Increment: 0.01
*RST: 15.84
Default unit: dB

Example: `AWGN:ENR 10`
Sets a ratio of bit energy to noise power density of 10 dB.

Manual operation: See "E_b/N_0" on page 157

[:SOURce<hw>]:AWGN:FREQuency:RESult?

Queries the actual frequency of the continuous wave (CW) interference signal.

Set this signal via the command `AWGN:MODE CW`.

The resulting "CW Frequency Offset" is the correction of the target value based on generating an integer multiple of periods out of the output sequence length.

Return values:

<Result> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: `AWGN:FREQ:RES?`
Queries the actual frequency of the CW interference signal.

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 155

[:SOURce<hw>]:AWGN:FREQuency:TARGet <Target>

Sets the target frequency of the continuous wave (CW) interference signal.

Set this signal via the command `AWGN:MODE CW`.

The range of this parameter is limited to ± (symbol rate + sample rate) / 4.

Parameters:

<Target> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: `AWGN:FREQ:TARG 2kHz`
Sets a frequency of 2 kHz for the interfering sine.

Manual operation: See "Target CW Frequency Offset" on page 155

[:SOURce<hw>]:AWGN:MODE <Mode>

Selects the mode for generating the interference signal.

Parameters:

<Mode> ONLY | ADD | CW

ADD
The AWGN noise signal is added to the baseband signal.

ONLY
The pure AWGN noise signal is modulated to the carrier. The connection to the baseband is interrupted.

CW
The sine interference signal is added to the baseband signal.

*RST: ADD

Example:
```
:SOURce1:AWGN:MODE ONLY
:SOURce1:AWGN:STATe ON
```
Selects the generation of a pure noise and activates it.

Manual operation: See "Mode" on page 154

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

Sets or queries the carrier power level for additive noise and CW interferer signals.

See also `[:SOURce<hw>]:AWGN:MODE` on page 309.

Parameters:

<Carrier> float

Increment: 0.01
*RST: 0
Default unit: dBm

Example: `AWGN:POW:CARR?`
Queries the carrier power.

Manual operation: See "Carrier Power" on page 157

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

Selects the mode to set the noise power for additive noise signals.

See also `[:SOURce<hw>]:AWGN:MODE` on page 309.

Parameters:

<Mode> CN | SN | EN

CN|SN
The noise power is set based on the value entered for the carrier/noise or signal/noise ratio (`SOURce:AWGN:CNRatio|SNRatio`).

EN
The noise power is set based on the value entered for the ratio of bit energy to noise power density (`AWGN:ENR`).

*RST: CN

Example: `SOUR:AWGN:POW:MODE CN`
The noise power is set based on the value entered for the carrier/noise ratio (`AWGN:CNR`).

Manual operation: See "Set Noise Power Via" on page 156

[:SOURce<hw>]:AWGN:POWer:NOISe <Noise>

Sets or queries the noise power in the system bandwidth depending on the selected mode:

- `SOUR:AWGN:MODE ADD|CW`
  Queries the noise/interferer power which is derived from the entered S/N value.
- "Noise Only" mode
  The command sets the noise power.

Parameters:

<Noise>	float Increment: 0.01 Default unit: dBm

Example: `SOURce:AWGN:POWer:NOISe?`
Queries the noise power in the system bandwidth.
Response: `10`
The noise power in the system bandwidth is 10 dBm.

Manual operation: See "Noise Power (System Bandwidth) / Interferer Power" on page 157

[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?

Queries the noise power level over the total signal bandwidth, for additive noise and CW interferer signals. See also `[:SOURce<hw>]:AWGN:MODE` on page 309.

Return values:

<Total>	float Range: -145 to 20 Increment: 0.01 *RST: -30

Example: `SOURce:AWGN:POWer:NOISe:TOTal?`
Queries the noise power in the total bandwidth.
Response: `15`
The noise power in the total bandwidth is 15 dBm.

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 158

[:SOURce<hw>]:AWGN:POWer:SUM?

Queries the power level of the overall signal. This level consists of the sum of the power levels of a wanted signal and the noise signal.

For noise-only signals, queries the power level of the noise signal. See also `[:SOURce<hw>]:AWGN:MODE` on page 309.

Return values:

<Sum>	float Range: -145 to 20 Increment: 0.01 *RST: 0

Example:

```
SOURce:AWGN:POWer:SUM?
// Response: "10"
// The power level is 10 dBm.
```

Usage: Query only

Manual operation: See "Carrier + Noise Power, Carrier + Interferer Power" on page 158

[:SOURce<hw>]:AWGN:POWer:SUM:PEP?

Queries the peak envelope power (PEP) of the overall signal. This level consists of the sum of the power levels of a wanted signal and the noise signal.

For noise-only signals, queries the PEP of the noise signal. See also `[:SOURce<hw>]:AWGN:MODE` on page 309.

Return values:

<Pep> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example:

```
SOURce:AWGN:POWer:SUM:PEP?
// Response: "10"
// The PEP is 10 dBm.
```

Usage: Query only

Manual operation: See "Carrier+Noise PEP, Carrier + Interferer PEP" on page 158

[:SOURce<hw>]:AWGN:SLENgth <SLength>

In mode Noise Only (`SOUR:AWGN:MODE ONLY`), sets the sequence length of the signal in samples.

The sequence length depends on the configured instrument. If the configured instrument is changed, the value range of this parameter is changed as well.

Parameters:

<SLength> integer

Range: 128 to 1073741824
*RST: 20480

Example:

`AWGN:MODE ONLY`
activates the generation of a pure noise.
`AWGN:STAT ON`
switches on the generation of a pure noise.
`AWGN:SLEN 1024`
sets the sequence legth.

Manual operation: See "Sequence Length" on page 154

[:SOURce<hw>]:AWGN:SRATe <SRate>

This command sets the bit rate which is used for calculation of bit energy to noise power ratio from carrier/noise ratio for Digital Standard signals. For Custom Digital Mod signals, the bit rate which is used for calculation can be queried with this command.

Parameters:

<SRate> float

Range: 400 to 250E6 bps
Increment: 0.001
*RST: 40E6
Default unit: Valid units are bps, kbps and Mbps.

Example: `AWGN:BRAT?`
queries the bit rate which is used for calculation of the Eb/N0 value from the C/N value.

Manual operation: See "Sample Rate" on page 154

[:SOURce<hw>]:AWGN:STATe <State>

Enables the averaged white Gaussian noise (AWGN) generator.

To define set the operation mode of the AWGN generator, use the following command:

`:SOURce1:AWGN:MODE`

See `[:SOURce<hw>]:AWGN:MODE` on page 309.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `:SOURce1:AWGN:STATe ON`

Manual operation: See "State" on page 154

11.7 SOURce:BB:ARB:MCAR subsystem

The `MCARrrier` subsystem contains the commands for setting the Multi Carrier Waveform Generator.

CARRier<ch>

The numerical suffix under `CARRier` distinguish between the carriers. The value range is 0 .. 31.

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt <Count>

Sets the number of carriers in the ARB multi carrier waveform.

Parameters:

<Count> integer

Range: 1 to 512
*RST: 1

Example: `BB:ARB:MCAR:CARR:COUN 10`
sets 10 carriers for the multi carrier waveform.

Manual operation: See "Number of Carriers" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

The command sets the carrier frequency mode.

Parameters:

<Mode> EQUidistant | ARBitrary

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

ARBitrary
Enables you to specify the carrier frequency in the carrier table. Carrier spacing is irrelevant.

*RST: EQUidistant

Example: `BB:ARB:MCAR:CARR:MODE EQU`
sets an equidistant carrier spacing. The carrier frequency can not be set.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

The command sets the frequency spacing between adjacent carriers of the multi carrier waveform. The carriers are generated symmetrically around the RF carrier. The maximum carrier spacing is limited to **Carrier spacing = Total baseband bandwidth / (Number of carriers - 1).**

The total baseband bandwidth is 80 MHz.

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

- For odd number of carriers:
  RoundedCarrierSpacing=1/OutputSignalDuration* round(CarrierSpacing * OutputSignalDuration);
- For even number of carriers:
  RoundedCarrierSpacing=2/OutputSignalDuration*round(0.5 *CarrierSpacing * OutputSignalDuration);

Parameters:

<Spacing> float

Range: 0.0 to 120E6
Increment: 0.01
*RST: 0
Default unit: Hz

Example: `BB:ARB:MCAR:CARR:SPAC 10 MHz`
sets a carrier spacing of 10 MHz.

Manual operation: See "Carrier Spacing" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?

Queries carrier conflicts. A conflict arises when the carriers overlap.

Return values:

<Conflict> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:ARB:MCAR:CARR2:CONF?`

queries the multi carrier conflict state.

Response: `0` no conflict has occurred.

Usage: Query only

Manual operation: See "!!!" on page 119

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay <Delay>

Sets the start delay of the selected carrier.

Parameters:

<Delay> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:CARR15:DEL 5us`

sets a start delay of 50 us for carrier 15.

Manual operation: See "Delay" on page 118

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE <File>

Selects the file with I/Q data to be modulated onto the selected carrier.

Parameters:

<File> <file name>

Example: `BB:ARB:MCAR:CARR15:FILE "D:\user\IQ_wcdma"`

selects file `IQ_wcdma`. The data of the file is modulated onto carrier 15.

Manual operation: See "File" on page 118

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency <Frequency>

Sets or indicates the carrier frequency, depending on the selected carrier frequency mode.

The carrier frequency can be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Parameters:

<Frequency> float

Value range depends on the max bandwidth, see data sheet

Range: -40E6 to 40E6
*RST: 0

Example: `BB:ARB:MCAR:CARR:MODE ARB`
Activates ARB multi-carrier mode.
`BB:ARB:MCAR:CARR:FREQ 5.0`
Sets 5.0 MHz carrier frequency.

Manual operation: See "Carrier Freq [MHz]" on page 118

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe <Phase>

The command sets the start phase of the selected carrier.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

Parameters:

<Phase> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:CARR15:PHAS 90 DEG`
sets a start phase of 90° for carrier 15.

Manual operation: See "Phase" on page 118

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer <Power>

The command sets the gain of the selected carrier.

Parameters:

<Power> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `BB:ARB:MCAR:CARR15:POW -50 dB`
sets the power of carrier 15 to -50 dB.

Manual operation: See "Gain" on page 118

[: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 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables/disables the selected carrier.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier15:STATe ON`

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE <Mode>

The command sets the mode for optimizing the crest factor by calculating the carrier phases.

Parameters:

<Mode> OFF | MIN | MAX

OFF
There is no automatic setting for minimizing or maximizing the crest factor. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is in use.

MIN
The crest factor is minimized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

MAX
The crest factor is maximized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

*RST: OFF

Example: `BB:ARB:MCAR:CFAC:MODE OFF`
switches off automatic crest factor optimization. The setting `SOUR:BB:ARB:MCAR:CARR:PHAS` has an effect.

Manual operation: See "Crest Factor Mode" on page 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor <CFactor>

Sets the value of the desired crest factor, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

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

Parameters:

<CFactor> float

Range: -50 to 50
Increment: 0.01
*RST: 50
Default unit: dB

Example: `BB:ARB:MCAR:CLIP:STAT ON`
enables clipping.
`BB:ARB:MCAR:CLIP:CFAC 37 dB`
sets the target crest factor.

Manual operation: See "Target Crest Factor" on page 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff <Cutoff>

Sets the cut off frequency of the final lowpass filter, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

When the cut off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal, but may also increase the resulting crest factor.

Parameters:

<Cutoff> float

Range: 0 to 50E6
Increment: 0.01
*RST: 50E6
Default unit: MHz

Example: `BB:ARB:MCAR:CLIP:STAT ON`
Enables clipping
`BB:ARB:MCAR:CLIP:CUT 50 MHz`
Sets the cut off frequency of the filter.

Manual operation: See "Filter Cut Off Frequency" on page 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the value set with the command `BB:ARB:MCAR:CLIP:CFAC`.

The resulting clipped peak power is defined by sum of the the RMS level of the unclipped multi carrier signal and the input parameter Target Crest Factor. Note that clipping reduces also the RMS level. Hence the resulting crest factor of the clipped signal is slightly above the Target Crest Factor. In order to get the unclipped parts of the clipped multicarrier signal matched with the unclipped multicarrier signal, the RF output power should be reduced by the difference between resulting crest factor and Target Crest Factor.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:ARB:MCAR:CLIP:STAT ON`
enables clipping
`BB:ARB:MCAR:CLIP:CFAC 37 dB`
sets the target crest factor.

Manual operation: See "Clipping" on page 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates and loads a multi carrier waveform using the current entries of the carrier table.

This multi carrier waveform is saved with the file name specified with command `SOUR:BB:ARB:MCAR:OFIL`. The file extension is `*.wv`.

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:MCAR:OFIL 'mcar1_2'`
defines the file name `mcar1_2.wv` for the multi carrier waveform.
`BB:ARB:MCAR:CLO`
creates multi carrier waveform `mcar1_2.wv`.

Usage: Event

Manual operation: See "Create/Create and Load" on page 116

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?

The command queries the resulting sample rate at which the multi carrier waveform is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers, carrier spacing and input sample rate of the leftmost or rightmost carriers.

Return values:

<Clock> float

Range: 400 to Max
Increment: 1E-3

Example: `BB:ARB:MCAR:CLOC?`
queries the ARB multi carrier output clock rate.

Usage: Query only

Manual operation: See "Clock Rate" on page 116

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multi carrier waveform using the current settings of the carrier table. The multi carrier waveform is saved into the file defined with command `SOUR:BB:ARB:MCAR:OFIL`. The file extension is `*.wv`.

Example:
`MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:MCAR:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi carrier waveform.
`BB:ARB:MCAR:CRE`
creates multi carrier waveform `multi_wv1.wv`.

Usage: Event

Manual operation: See "Create/Create and Load" on page 116

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>

The command sets the step width by which the start delays of the carriers in the defined carrier range will be incremented.

Parameters:

<Step> float

Range: -1 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example:
`BB:ARB:MCAR:EDIT:CARR:DEL 5 us`
sets a start delay of 5 us for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:DEL:STEP 1 us`
the start delay is incremented by 1us for each carrier, i.e. the first carrier has a start delay of 5us, the second a start delay of 6 us, etc.

Manual operation: See "Delay Step" on page 121

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>

The command sets the start delay for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` is used to define a step width, the delay entered here applies only to the starting carrier. The delays of the remaining carriers are stepped up or down by the delay value specified in the `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` command.

Parameters:

<Start> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:EDIT:CARR:DEL 5us`
sets a start delay of 5 us for the carriers in the carrier range.

Manual operation: See "Delay Start" on page 121

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute

The command adopts the settings for the carrier range which has been defined using the `:BB:ARB:MCAR:EDIT:CARR:...` commands.

Example: `BB:ARB:MCAR:EDIT:CARR:STAR 4`
the carrier range starts at carrier 2.
`BB:ARB:MCAR:EDIT:CARR:STOP 20`
the carrier range stops at carrier 20.
`BB:ARB:MCAR:EDIT:CARR:STAT ON`
sets all the carriers in the carrier range (2 to 20) to ON.
`BB:ARB:MCAR:EDIT:CARR:EXEC`
transfers the assistant settings for carrier 2 to 20 into the carrier table.

Usage: Event

Manual operation: See "Apply Assistant Settings" on page 121

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE <File>

Selects input file

Parameters:

<File> string

Example: `BB:ARB:MCAR:EDIT:CARR:FILE "D:\user\IQ_wcdma'`

Manual operation: See "Input Waveform File" on page 121

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>

The command sets the step width by which the start phases of the carriers in the defined carrier range will be incremented.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

Parameters:

<Step>	float Range: -359.99 to 359.99 Increment: 0.01 *RST: 0 Default unit: DEG

Example:
`BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG`
sets a start phase of 90° for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:PHAS:STEP 1 DEG`
the start phase is incremented by 1° for each carrier, i.e. the first carrier has a start phase of 90°, the second a start phase of 91°, etc.

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] <Start>

The command sets the start phase for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:PHAS:STEP` is used to define a step width, the phase entered here applies only to the starting carrier. The phases of the remaining carriers are stepped up or down by the phase value specified in the `:BB:ARB:MCAR:EDIT:CARR:PHAS:STEP` command.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

Parameters:

<Start>	float Range: 0 to 359.99 Increment: 0.01 *RST: 0 Default unit: DEG

Example:
`BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG`
sets a start phase of 90° for the carriers in the carrier range.

Manual operation: See "Phase Start" on page 120

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>

The command sets the step width by which the starting power of the carriers in the defined carrier range will be incremented.

Parameters:

<Step>	float Range: -80 to 80 Increment: 0.01 *RST: 0 Default unit: dB

Example: `BB:ARB:MCAR:EDIT:CARR:POW -80dB`
sets a power of -80 dB for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:POW:STEP 1 dB`
the power is incremented by 1dB for each carrier, i.e. the first carrier has -80dB, the second -79dB, etc.

Manual operation: See "Gain Step" on page 120
See "Phase Step" on page 121

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] <Start>

The command sets the power for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` is used to define a step width, the power entered here applies only to the starting carrier. The power of the remaining carriers is stepped up or down by the power specified in the `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` command.

Parameters:
<Start> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `BB:ARB:MCAR:EDIT:CARR:POW -50 dB`
sets the power of the carriers in the carrier range to -50 dB.

Manual operation: See "Gain Start" on page 120

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP <Stop>

The command selects the last carrier in the carrier range to which the settings with the `:BB:ARB:MCAR:EDIT:CARR:..` commands shall apply.

Parameters:
<Stop> integer

Range: 0 to 511
*RST: 0

Example: `BB:ARB:MCAR:EDIT:CARR:STOP 4`
the carrier range stops at carrier 4.

Manual operation: See "Carrier Start/Stop" on page 120

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

The command switches all the carriers in the selected carrier range on or off.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 1

Example: `BB:ARB:MCAR:EDIT:CARR:STAT ON`
sets all the carriers in the carrier range to ON.

Manual operation: See "State" on page 118
See "Carrier State" on page 120

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

This command defines the output file name for the multi carrier waveform. This file name is used when a waveform is calculated (command `SOUR:BB:ARB:MCAR:CLOad` or `SOUR:BB:ARB:MCAR:CREate`). The file extension is `*.wv`.

Parameters:
<OFile> string

Example: `MMEM:CDIR "D:\user\waveform"`
sets the default directory.
`BB:ARB:MCAR:OFIL 'mcar1_2'`
defines the file name `mcar1_2.wv` for the multi carrier waveform file

Manual operation: See "Output File" on page 116

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all ARB multi carrier parameters to their default values.

Example: `SOURce1:BB:ARB:MCARrier:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?

The command queries the resulting file size. The file size is returned in samples.

Return values:
<Samples> integer

Range: 0 to INT_MAX
*RST: 0

Example: `BB:ARB:MCAR:SAMP?`
queries the file size of the currently calculated multi carrier waveform.

Usage: Query only

Manual operation: See "File Size" on page 116

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

Queries the available settings files in the specified default directory. The settings files are used to set the ARB multi carrier submenu. Only files with the file extension `*.arb_multcarr` will be listed.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR 'D:\user\waveform'`
	sets the default directory
	`BB:ARB:MCAR:SETT:CAT?`
	reads out all the settings files in the default directory.
	`Response: mcar1, mcar2`
	the directory contains the configuration files
	`mcar1.arb_multcarr` and `mcar2.arb_multcarr`.

Usage:	Query only
Manual operation:	See "Save/Recall Frame" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD <Filename>

Loads the settings file. If a settings file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.arb_multcarr` will be loaded or created.

Setting parameters:

<Filename>	string
Example:	`BB:ARB:MCAR:SETT:LOAD 'D:\user\new'` creates settings file `new.arb_multcarr`.
Usage:	Setting only
Manual operation:	See "Save/Recall Frame" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

The command stores the current settings of submenu "Multi Carrier" in a file in the specified directory. The file extension may be omitted, the files are stored with the file extension `*.arb_multcarr`.

Setting parameters:

<Filename>	string
Example:	`BB:ARB:MCAR:SETT:STOR 'D:\user\mcarr2'` stores settings file `mcarr2.arb_multcarr` in the default directory.
Usage:	Setting only
Manual operation:	See "Save/Recall Frame" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

<Fast> 0 | 1 | OFF | ON

*RST: 1

Manual operation: See "Save/Recall Frame" on page 112

[:SOURce<hw>]:BB:ARBitrary:MCARrier:STATe <State>

Activates multi carrier generation and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:ARBitrary:MCARrier:STATe ON`

Manual operation: See "State" on page 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME <Time>

Sets the user-defined signal period. This setting is only possible for Signal Period Mode User (`BB:ARB:MCAR:TIME:MODE USER`).

Parameters:

<Time> float

Range: 0 to 1E9
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:TIME:MODE USER`
selects Signal Period Mode User.
`BB:ARB:MCAR:TIME 10 s`
sets a signal period of 10 seconds

Manual operation: See "Signal Period" on page 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE <Mode>

Selects the mode for calculating the resulting signal period of the multi carrier waveform. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF).

Parameters:

<Mode> LONG | SHORt | LCM

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

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

LCM
The output file duration is the least common multiple of all input file durations.

*RST: LONG

Example: `SPOURce1:BB:ARBitrary:MCARrier:TIME:MODE LONG`
selects signal period mode long

Manual operation: See "Signal Period Mode" on page 114

11.8 SOURce:BB:ARB:WSEG subsystem

The `WSEGment` subsystem contains the commands for setting the Multi Segment Waveform Generator.

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend <SampCount>, <Frequency>

Adds a blank segment to the multi segment file.

Setting parameters:

<SampCount> float

Specifies the number of samples.

Range: 512 to 1E7
Increment: 1
*RST: 1000

<Frequency> float

Determines the clock rate.

Range: 400 Hz to Max (depends on instrument type)
Increment: 0.001
*RST: 1E8

Example: `SOUR:BB:ARB:WSEG:CONF:SEL "MSegFile"`
selects a multi segment file.
`SOUR:BB:ARB:WSEG:CONF:BLAN:APP 1000,100000000`
adds a blank segment with 1000 samples and 100 MHz clock rate to the selected multi segment file

Usage: Setting only

Manual operation: See "Blank Segment" on page 131

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the specified default directory. The configuration files are used to create multi segment waveform files.

Return values:

<Catalog> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:CAT?`
reads out all the configuration files in the default directory.
`Response: mulit1, multi2`
the directory contains the configuration files `multi1.inf_mswv` and `multi2.inf_mswv`.

Usage: Query only

Manual operation: See "Load List" on page 128

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk <Clock>

This command defines the clock rate used for multi segment waveform output in case of Clock Mode "User" (`:BB:ARB:WSEG:CONF:CLOCk:MODE USER`).

Parameters:

<Clock> float

Increment: 1E-3
*RST: max SampleRate

Example: `BB:ARB:WSEG:CONF:CLOC:MODE USER`
selects Clock Mode User.
`BB:ARB:WSEG:CONF:CLOC 50MHz`
defines a clock rate of 50 MHz.

Manual operation: See "User Clock Rate" on page 133

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE <Mode>

Selects the clock rate mode for the multi segment waveform.

Parameters:

<Mode> UNCHanged | HIGHest | USER

UNCHanged
The segments are output with the clock rate defined in the waveform file.

HIGHest
The segments are output at the highest available clock rate.

USER
The segments are output with the clock rate defined with command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk`

*RST: UNCHanged

Example: `BB:ARB:WSEG:CONF:CLOC:MODE UNCH`
selects clock mode unchanged. The segments are output with the clock rate defined in the waveform file.

Manual operation: See "Clock" on page 132

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent <Comment>

This command enters a comment for the configuration file. The configuration file must be specified with command `:BB:ARB:WSEG:CONF:SEL`.

Parameters:

<Comment> string

Example: `BB:ARB:WSEG:CONF:COMM <3gpp_up>`
enters comment "3gpp_up".

Manual operation: See "Comment" on page 129

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete <Filename>

Deletes the configuration file. The configuration files are used to create multi segment waveform files.

Setting parameters:

<Filename> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:DEL 'multi1'`
deletes configuration file `multi1.inf_mswv`.

Usage: Setting only

Manual operation: See "Multi Segment Table, Append/Delete/Shift Seg." on page 130

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE] <Mode>

This command selects the level mode for the multi segment waveform.

Parameters:

<Mode> UNCHanged | ERMS

UNCHanged
The segments are output exactly as defined in the files.

ERMS
The segments are output so that all segments have the same rms value.

*RST: UNCHanged

Example: `BB:ARB:WSEG:CONF:LEV:MODE UNCH`
selects level mode unchanged. The segments are output as defined in the waveform file.

Manual operation: See "Level" on page 132

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment <Mode>

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

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

Parameters:

<Mode> OFF | MRK1 | MRK2 | MRK3 | MRK4

OFF
No additional marker is generated.

MRK1|MRK2|MRK3|MRK4
Generates a restart marker signal at the beginning of each segment for the corresponding marker.
The segment begin is defined by the low-high slope of the marker. This applies for switching between two segments as well as in case of segment replay.

*RST: OFF

Example:
```
BB:ARB:WSEG:CONF:SEL 'ConfComm'
BB:ARB:WSEG:CONF:MARK:ESEG MRK3
```

Manual operation: See "Segment Restart" on page 133

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment <Mode>

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

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

Parameters:

<Mode> OFF | MRK1 | MRK2 | MRK3 | MRK4

OFF
No additional marker is generated.

MRK1|MRK2|MRK3|MRK4
Generates a restart marker signal at the beginning of the first segment for the corresponding marker.
Use this setting to generate a restart marker for the complete sequence.

*RST: OFF

Example:
```
BB:ARB:WSEG:CONF:SEL 'ConfComm'
BB:ARB:WSEG:CONF:MARK:FSEG MRK3
```

Manual operation: See "Sequence Restart" on page 133

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE <Mode>

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

Parameters:

<Mode> IGNore | TAKE

IGNore
The marker information carried in the individual segment waveform files is not considered.

TAKE
The output waveform file contains the marker information as configured in the individual waveform files.

*RST: TAKE

Example: `BB:ARB:WSEG:CONF:SEL 'ConfComm'`
`BB:ARB:WSEG:CONF:MARK:MODE TAKE`

Manual operation: See "Segment Marker" on page 133

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

Defines the file name for the multi segment waveform. The file extension is `*.wv`.

Parameters:
<OFile> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi1'`
creates the configuration file `multi1.inf_mswv` in default directory.
`BB:ARB:WSEG:CONF:OFIL 'mseg1_2'`
defines the file name `mseg1_2.wv` for the multi segment waveform file created using configuration file `multi1.inf_mswv`.

Manual operation: See "Save List/Save List As..." on page 129
See "Output file" on page 129

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend <Waveform>

Appends the specified waveform to the configuration file.

Setting parameters:
<Waveform> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory
`BB:ARB:WSEG:CONF:SEL 'new'`
creates the configuration file `new.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'arb1'`
appends waveform `arb1.wv` to configuration file `new`. Waveform `arb1` will be the first segment of a multi segment waveform created with configuration file `new`.

Usage: Setting only

Manual operation: See "Multi Segment Table, Append/Delete/Shift Seg." on page 130

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?

Queries the segments of the currently selected configuration file.

Return values:
<Catalog> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi_sin'`
selects the configuration file `multi_sin.inf_mswv`.
`BB:ARB:WSEG:CONF:SEGM:CAT?`
queries the segments of the selected configuration file.
`Response: arb4, arb2`
The configuration file includes the segments `arb4.wv` and `arb2.wv`.

Usage: Query only

Manual operation: See "Multi Segment Table, Append/Delete/Shift Seg." on page 130

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect <Filename>

Selects the configuration file in the default directory.

A path can also be specified, in which case the files in the specified directory are selected. If a configuration file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.inf_mswv` will be selected or created.

Parameters:

<Filename> string

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'new'`
create configuration file `new.inf_mswv` in the default directory.

Manual operation: See "New List" on page 128
See "Load List" on page 128

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate <FilenameInput>

Creates a multi segment waveform using the current settings of the specified configuration file. The multi segment waveform is saved into the file defined in the configuration file. The file extension is `*.wv`.

Setting parameters:

<FilenameInput> string

Example: `MMEM:CDIR 'D:\user\'`
sets the default directory
`BB:ARB:WSEG:CONF:SEL 'new'`
creates the configuration file `new.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'arb1.wv'`
'includes waveform `arb1.wv` as segment 1 in the configuration file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi segment waveform.
`BB:ARB:WSEG:CRE 'D:\user\new.inf_mswv'`
creates multi segment waveform `multi_wv1.wv` using the settings of the configuration file `new.inf_mswv`.

Usage: Setting only

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT <Next>

Selects the segment to be output.

Parameters:

<Next> float

Range: 0 to 1023
*RST: 0

Example: `MMEM:CDIR 'D:\user\waveform'`
sets the default directory.
`BB:ARB:WSEG:NEXT 2`
selects segment 2 to be output.
`BB:ARB:TRIG:SMOD NEXT`
selects extended trigger mode next, i.e. the segment specified with command `:BB:ARB:WSEG:NEXT` will be output.
`BB:ARB:SEQ AUTO`
selects trigger mode Auto.
`BB:ARB:WAV:SEL 'multi_wv1'`
loads multi segment waveform `multi_wv1.wv`. Generation of segment 2 starts.
`BB:ARB:WSEG:NEXT 3`
switched at once to output of segment 3.

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute

Triggers manually switchover to the subsequent segment in the mutli segment file. A manual trigger can be executed only when an internal next segment source (`BB:ARB:WSEG:NEXT:SOUR INT`) has been selected.

To perform a switchover to any segment within the multi segment file, select the next segment with the command `BB:ARB:WSEG:NEXT`.

This command is disabled, if a sequencing play list is enabled.

Example: `BB:ARB:WSEG:NEXT:SOUR INT`
selects internal next segment source.
`BB:ARB:WSEG:NEXT 2`
selects segment 2 to be output.
`BB:ARB:WSEG:NEXT:EXEC`
executes a switchover to the next segment.

Usage: Event

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend <State>, <Segment>, <Count>, <Next>

Appends a new segment to the selected sequencing play list.

Setting parameters:

<State> ON | OFF
activates/deactivates the appended segment
*RST: ON

<Segment> integer
indicates the number of the segment as in the multi segment waveform file
Range: 0 to SegmentCount - 1

<Count> integer
defines how many times this segment is repeated
Range: 1 to 65535

<Next> NEXT | BLANk | ENDLess | SEG0 | SEG1 | ... | SEG31 | 0...maxSegment
determines the action after completing the current segment, like for instance which segment is processed after the processing of the current one is finished.

Example: `BB:ARB:WSEG:SEQ:SEL 'D:\user\play_list_1'`
selects the sequencing list `play_list_1.wvs`.
`BB:ARB:WSEG:SEQ:APP ON,3,15,BLANK`
appends the segment number 3 as a new segment to the sequencing list; this segment is activated and will be repeated 15 times and followed by a blank segment.

Usage: Setting only

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:

<Filename> string

Example: `BB:ARB:WSEG:SEQ:SEL 'D:\user\play_list_1'`
selects the sequencing list `play_list_1.wvs`.

[:SOURce<hw>]:BB:ARBitrary:WSEGment:STATe <State>

Enables/disables multi segment generation.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:ARBitrary:WSEGment:STATe ON`

Manual operation: See "State" on page 128

11.9 SOURce:BB:DM subsystem

The commands in the `SOURce:BB:DM` subsystem are described in two sections, separated into configuring digital modulation and lists for digital modulation.

11.9.1 DM general remote-control commands

The following section contains the commands for generating the digital modulation signal.

11.9.1.1 Common settings

[:SOURce<hw>]:BB:DM:PATTern <Pattern>, <BitCount>

The command selects the data pattern for the internal data.

Parameters:

<Pattern>	numeric *RST: #H0
<BitCount>	integer Range: 1 to 64 *RST: 1

Example: `BB:DM:SOUR PATT`
`BB:DM:PATT #B01110111010101010,17`

[:SOURce<hw>]:BB:DM:PRBS[:LENGth] <Length>

The command 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: `BB:DM:SOUR PRBS`
The internal pseudo-random generator is used as the data source.
`BB:DM:PRBS 9`
An internal pseudo-random sequence of 511 bits will be generated.

Manual operation: See "Data Source" on page 67

[: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: `SOURce1:BB:DM:PRESet`

Usage: Event

Manual operation: See "Set To Default" on page 64

[:SOURce<hw>]:BB:DM:SOURce <Source>

The command selects the data source.

Parameters:

<Source> ZERO | ONE | PRBS | PATTern | DLISt

ZERO|ONE
An internally generated 0 or 1 data sequence is used.

PRBS
The pseudo-random sequence generator is used as the data source. The length of the random sequence is defined with the command `SOURce:BB:DM:PRBS`.

PATTern
Internally generated data with a fixed pattern is used. The data pattern is dafined using command `SOURce:BB:DM:PATTern`.

DLISt
Data from the selected data list is used.

*RST: PRBS

Example:

```
BB:DM:SOUR DLIS
BB:DM:DLIS:SEL 'test'
// the data list test.dm_iqd is used
```

Manual operation: See "Data Source" on page 67

[:SOURce<hw>]:BB:DM:SRATe <SRate>

Sets the symbol rate. The value range is dependent on the selected modulation type. On changing to an FSK modulation type, excessively high values are automatically limited to the maximum value that can be set for FSK (see data sheet). The symbol rate can be entered in Hz/kHz/MHz or Symb/s / kSymb/s and MSymb/s.

When a standard is selected (`DM:STANdard`), the symbol rate is automatically set to the appropriate default value.

The value range is dependent on the selected modulation type (`:BB:DM:FORM`). When a standard is selected (`:BB:DM:STAN`), the symbol rate is set to the default value.

Parameters:

<SRate> float

Range: 400 to depends on hardware
Increment: 0.001
*RST: 270833.333
Default unit: Hz

Example: `BB:DM:SRAT 10 MHz`
sets a symbol rate of 10 MHz.

Manual operation: See "Symbol Rate" on page 65

[:SOURce<hw>]:BB:DM:STANdard <Standard>

Selects the standard.

After selection, modulation parameters "Modulation Type" (`:BB:DM:FORMat`), "Symbol Rate" (`:BB:DM:SRATe`), "Filter" (`:BB:DM:FILTer:TYPE` and `:BB:DM:FILTer:PARameter:...`) and "Coding" (`:BB:DM:CODing`) are automatically set in accordance with the standard.

The `USER` parameter cannot be set. A query returns this value if a user-defined Custom Dig Mod setting was loaded or if one of the associated settings was changed subsequent to the selection of a standard. The user defined settings are stored and loaded with commands `:BB:DM:STAN:ULIS:...` (see Chapter 11.9.2, "DM lists", on page 353).

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

*RST: GSM

Example: `BB:DM:STAN DECT`
Selects digital modulation according to the DECT standard.

Manual operation: See "Set acc. Standard" on page 65

[:SOURce<hw>]:BB:DM:STATe <State>

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

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:DM:STATe ON`

Manual operation: See "State" on page 64

[:SOURce<hw>]:BB:DM:SLENgth <Slength>

Sets the sequence length of the signal in symbols. The signal is calculated in advance, saved as waveform file, and output in the selected arbitrary waveform generator.

Note: Sequence Length * Oversampling must not exceed the maximum number of samples in the arbitrary waveform generator.

Parameters:

<Slength> integer

Range: 1 to max
*RST: 10000

Example: `BB:DM:SLEN 500`
sets the sequence length to 500 symbols.

Manual operation: See "Sequence Length" on page 65

[:SOURce<hw>]:BB:DM:WAVeform:CREate <Filename>

This command creates a waveform using the current settings of the "Digital Modulation" menu. The file name is entered with the command. The file is stored with the predefined file extension `*.wv`. The file name and the directory it is stored in are user-definable.

Setting parameters:

<Filename> string

Example: `MMEM:CDIR 'd:/user/waveform'`
sets the default directory to `d:/user/waveform`.
`BB:DM:WAV:CRE 'dm_1`
creates the waveform file `dm_1.wv` in the default directory.

Usage: Setting only

Manual operation: See "Generate Waveform File" on page 65

[: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 70

[: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 70

11.9.1.2 Marker settings

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

Parameters:

<Mode> CLISt | PULSe | PATTern | RATio

CLISt
A marker signal that is defined in the selected control list is generated.

PULSe
A pulsed marker signal is generated. The pulse frequency (= symbol rate/divider) is defined with the `SOUR:BB:DM:TRIG:OUTP:PULSe:DIVider` command and can be queried with the `SOUR:BB:DM:TRIG:OUTP:PULSe:FREQuency?` command.

PATTern
A marker signal is generated with the aid of a user-definable bit pattern. The bit pattern is entered with the aid of command `SOURce:BB:DM:TRIGger:OUTPut:PATTern`. The bit pattern is a maximum of 32 bits long.

RATio
A regular marker signal corresponding to the Time Off / Time On specifications in the commands `SOURce:BB:DM:TRIGger:OUTPut:OFFT` and `SOURce:BB:DM:TRIGger:OUTPut:ONT` is generated.

*RST: RATio

Example: `BB:DM:TRIG:OUTP2:MODE PULS`
selects the pulsed marker signal on output MARKER 2.

Manual operation: See "Marker Mode" on page 66

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of symbols in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:DM:TRIGger:OUTPut:MODE RATio` on the marker outputs is OFF.

Parameters:

<OffTime> integer

Range: 1 to 16777215
*RST: 1
Default unit: symbol

Example: `BB:DM:TRIG:OUTP2:OFFT 20`
sets an OFF time of 20 symbols for marker signal 2.

Manual operation: See "Marker Mode" on page 66

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime <OnTime>

Sets the number of symbols in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:DM:TRIGger:OUTPut:MODE RATio` on the marker outputs is ON.

Parameters:

<OnTime> integer

Range: 1 to 16777215
*RST: 1
Default unit: symbol

Example: `BB:DM:TRIG:OUTP2:ONT 20`
sets an ON time of 20 symbols for marker 2

Manual operation: See "Marker Mode" on page 66

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Sets the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric

0 is marker off, 1 is marker on.

*RST: #H2

<BitCount> integer

Range: 1 to 64
*RST: 2

Example:
```
BB:DM:TRIG:OUTP2:PATT #B000000011111111,15
BB:DM:TRIG:OUTP2:MODE PATT
```

Manual operation: See "Marker Mode" on page 66

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for Pulse marker mode (`SOUR:BB:DM:TRIGr:OUTP:MODE PULSe`). The resulting pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: BB:DM:TRIG:OUTP2:PULS:DIV 2
sets the divider to 2 for the marker signal on output MARKER 2.
BB:DM:TRIG:OUTP2:FREQ?
queries the resulting pulse frequency of the marker signal.
Response: 66 000
the resulting pulse frequency is 66 kHz.

Manual operation: See "Marker Mode" on page 66

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal in the setting SOURce:BB:DM:TRIGger:OUTPut:MODE PULSe. The pulse frequency is derived by dividing the symbol rate by the divider.

Return values:
<Frequency> float

Example: BB:DM:TRIG:OUTP2:PULS:DIV 2
sets the divider marker signal on output MARKER 2 to the value 2.
BB:DM:TRIG:OUTP2:MODE PULS
enables the pulsed marker signal.
BB:DM:TRIG:OUTP2:PULS:FREQ?
queries the pulse frequency of the marker signal.
Response: 33 000
the resulting pulse frequency is

Usage: Query only

Manual operation: See "Marker Mode" on page 66

11.9.1.3 Filter settings

[:SOURce<hw>]:BB:DM:FILTer:ILENgth <ILength>

The command sets the impulse length (number of filter tabs).

Parameters:

<ILength> integer

Range: 1 to 128
*RST: 10

Example: `BB:DM:FILT:ILEN 10`
sets the number of filter tabs to 10.

Manual operation: See "Impulse Length" on page 71

[:SOURce<hw>]:BB:DM:FILTer:ILENgth:AUTO <Auto>

The command activates/deactivates the impulse length state. If activated, the most sensible parameter values are selected. The value depends on the coherence check.

Parameters:

<Auto> 0 | 1 | OFF | ON

*RST: 1

Example: `BB:DM:FILT:ILEN:AUTO ON`
The most sensible parameters are selected automatically.

Manual operation: See "Impulse Length" on page 71

[:SOURce<hw>]:BB:DM:FILTer:OSAMpling <OSampling>

The command sets the upsampling factor.

Parameters:

<OSampling> integer

Range: 1 to 32
*RST: 32

Example: `BB:DM:FILT:OSAM 32`
sets the upsampling factor to 32.

Manual operation: See "Oversampling" on page 72

[:SOURce<hw>]:BB:DM:FILTer:OSAMpling:AUTO <Auto>

The command activates/deactivates the upsampling factor state. If activated, the most sensible parameter values are selected. The value depends on the coherence check. If deactivated, the values can be changed manually.

Parameters:

<Auto> 0 | 1 | OFF | ON

*RST: 1

Example: `BB:DM:FILT:OSAM:AUTO ON`
The most sensible parameters are selected automatically.

Manual operation: See "Oversampling" on page 72

[: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>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 <Apco25>

Sets the roll-off factor.

Parameters:

<Apco25> float

Range: 0.05 to 0.99
Increment: 0.01
*RST: 0.2

<Cosine> float

Range: 0.05 to 1
Increment: 0.01
*RST: 0.35

<Gauss> float

Range: 0.15 to 100000
Increment: 0.01
*RST: 0.3

<LPass> float

Range: 0.05 to 2
Increment: 0.01
*RST: 0.5

<LPassEvm> float

Range: 0.05 to 2
Increment: 0.01
*RST: 0.5

<PGauss> float

Range: 0.15 to 2.5
Increment: 0.01
*RST: 0.3

<RCosine> float

Range: 0.05 to 1
Increment: 0.001
*RST: 0.35

<SPhase> float

Range: 0.15 to 2.5
Increment: 0.01
*RST: 2

Example: `BB:DM:FILT:PAR:APCO25 0.2`
Sets the roll-off factor to 0.2 for filter type APCO25.

Manual operation: See "Filter Parameter" on page 71

[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth <Bandwidth>

Sets the bandwidth of the cosine filter.

Parameters:
<Bandwidth> float

Range: 400 to 25E6
Increment: 1E-3
*RST: 270833.333

Example:
```
:BB:DM:FILT:TYPE COS
:BB:DM:FILT:PAR:COS:BAND 7200
```

Manual operation: See "Bandwidth" on page 71

[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs <Gauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass <FiltParm>

Sets the cut off frequency for the lowpass/ gauss filter.

Parameters:
<FiltParm> float

Range: 400 to 25E6
Increment: 1E-3
*RST: 270833.333

Example:
```
:BB:DM:FILT:TYPE APCO25Lsm
:BB:DM:FILT:PAR:APCO25L:LOWP 5166.667
:BB:DM:FILT:PAR:APCO25L:GAUS 1700
```

Manual operation: See "Cut Off Frequency Factor" on page 71

[:SOURce<hw>]:BB:DM:FILTer:TYPE <Type>

The command selects the filter type.

When a standard is selected (`:BB:DM:STAN`), the filter type and filter parameter are set to the default value.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | USER | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LTEFilter | LPASSEVM | APCO25Hcpm | APCO25Lsm

*RST: GAUSs

Example: `BB:DM:FILT:TYPE COS`
selects the Cosine filter type.

Manual operation: See "Filter" on page 71

[: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 347.

Parameters:

<Parameter> float

Range: 0.05 to 2.5
Increment: 0.01
*RST: 0.35

Example: `BB:DM:FILT:TYPE COS`
`DM:FILT:PAR 0.5`
sets 0.5 roll-off factor for the cosine filter.

11.9.1.4 Modulation settings

[: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`
selects modulation type AQPSK.
`BB:DM:AQPS:ANGL 45`

Manual operation: See "Angle Alpha" on page 69

[:SOURce<hw>]:BB:DM:ASK:DEPTh <Depth>

The command sets the ASK modulation depth when modulation type ASK is selected.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 100
Default unit: PCT

Example: `BB:DM:FORM ASK`
selects the ASK modulation type.
`BB:DM:ASK:DEPT 50 PCT`
sets a modulation depth of 50 percent.

Manual operation: See "ASK Depth" on page 69

[:SOURce<hw>]:BB:DM:CODing <Coding>

The command selects the modulation coding.

If the modulation type selected (`:BB:DM:FORM`) is not possible with the coding that has been set, it is automatically set to OFF (`:BB:DM:COD OFF`).

When a standard is selected (`:BB:DM:STAN`), the coding is set to the default value.

Parameters:

<Coding> OFF | DIFF | DPHS | DGRay | GRAY | GSM | NADC | PDC | PHS | TETRa | APCO25 | PWT | TFTS | INMarsat | VDL | EDGE | APCO25FSK | ICO | CDMA2000 | WCDMA | APCO258PSK

DPHS
Phase Difference

DGRay
Difference + Gray

*RST: INTernal

Example: `BB:DM:COD GRAY`
selects GRAY coding. This coding is valid for all modulation types.

Manual operation: See "Coding" on page 65

[:SOURce<hw>]:BB:DM:FORMat <Format>

Selects the modulation type.

If the coding that is set (`:BB:DM:COD`) is not possible with the modulation type selected, it is automatically set to OFF (`:BB:DM:COD OFF`).

When a standard is selected (`:DM:STAN`), 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: `BB:DM:FORM QPSK`
Selects modulation type QPSK.

Manual operation: See "Modulation Type" on page 68

[:SOURce<hw>]:BB:DM:FSK:DEViation <Deviation>

Sets the frequency deviation when FSK modulation is selected. The range of values depends on the symbol rate that is set (see data sheet) and the maximum deviation is 10 MHz.

If the symbol rate that is set exceeds the maximum possible value for the chosen frequency deviation, it is suitably adapted (`:BB:DM:SRAT`).

Parameters:

<Deviation> float

Range: 1 to 40E6
Increment: 0.5
*RST: 135416.5

Example: `BB:DM:FORM FSK`
selects FSK modulation.
`BB:DM:FSK:DEV 10 MHz`
sets the frequency deviation to 10 MHz.

Manual operation: See "FSK Deviation" on page 69

[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation <Deviation>

The command sets the deviation of the selected symbol for variable FSK modulation mode.

Suffix:

<ch> 0 to 16
The number of symbols (and therefore the suffix range) depends on the selected FSK modulation type.

Parameters:

<Deviation> float

The range of values depends on the symbol rate that is set (see data sheet) and the maximum deviation is 10 MHz.

Range: -40E6 to 40E6
Increment: 0.5
Default unit: Hz

Example:
`BB:DM:FORM FSKV`
selects Variable FSK modulation.
`BB:DM:FSK:VAR:TYPE FSK16`
selects 16FSK modulation.
`BB:DM:FSK:VAR:SYMB0:DEV 135000`
sets the frequency deviation of the least significant symbol to 135 kHz.

Manual operation: See "Deviation xxxx" on page 70

[: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:
`BB:DM:FORM FSKV`
selects Variable FSK modulation.
`BB:DM:FSK:VAR:TYPE FSK16`
selects 16FSK modulation.

Manual operation: See "FSK Type" on page 69

11.9.1.5 Power ramp

[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation <Attenuation>

Sets the level attenuation for signal ranges that are flagged with level attribute attenuated by the LEV_ATT control signal.

Parameters:
<Attenuation> float

Range: 0 to 50
Increment: 0.1
*RST: 15
Default unit: dB

Example: `BB:DM:PRAM:ATT 15 dB`
sets a level attenuation of 15 dB.

Manual operation: See "Attenuation" on page 73

[:SOURce<hw>]:BB:DM:PRAMp:FDELay <FDelay>

Sets the delay in the falling edge. A positive value gives rise to a delay and a negative value causes an advance.

Parameters:
<FDelay> float

Range: -4 to 4
Increment: 0.01
*RST: 0
Default unit: symbol

Example: `BB:DM:PRAM:FDEL 1`
The falling edge starts 1 symbol later.

Manual operation: See "Fall Delay" on page 73

[:SOURce<hw>]:BB:DM:PRAMp:RDELay <RDelay>

Sets the delay in the rising edge. A positive value gives rise to a delay and a negative value causes an advance.

Parameters:
<RDelay> float

Range: 0 to 4
Increment: 0.01
*RST: 0
Default unit: symbol

Example: `BB:DM:PRAM:RDEL 1`
The rising edge starts 1 symbol later.

Manual operation: See "Rise Delay" on page 73

[:SOURce<hw>]:BB:DM:PRAMp:SHAPe <Shape>

The command sets the edge shape of the ramp envelope.

Parameters:

<Shape>	LINear | COSine *RST: COSine

Example: `BB:DM:PRAM:SHAP COS`
selects a cosine-shaped rise and fall for the transmitted power edge.

Manual operation: See "Ramp Function" on page 73

[: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: `BB:DM:PRAM:TIME 2`
sets a time of 2 symbols for the edges to rise and fall.

Manual operation: See "Ramp Time" on page 73

[:SOURce<hw>]:BB:DM:PRAMp[:STATe] <State>

The command enables or disables power ramping.

Parameters:

<State>	0 | 1 | OFF | ON *RST: 0

Example: `BB:DM:PRAM:STAT ON`
switches power ramping on.

Manual operation: See "State" on page 73

11.9.2 DM lists

The following section brings together the commands for defining and managing the data lists and control lists for digital modulation.

Lists are stored as files with specific file extensions in a user-definable directory (see Table 11-3). To specify the default directory, use the command `:MMEMory:CDIRectory`. To access files in this directory, enter their file name; the path and extension are optional.

Table 11-3: Overview of the used list types

List type	Content	File extension
Data List	Digital modulation data	`*.dm_iqd`
Control List	Digital modulation control data	`*.dm_iqc`
User Standards	User settings of digital modulation	`*.dm_stu`
Usr Filter	Usr filter settings	`*.vaf`
User Mapping	User mapping settings	`*.vam`

It is not possible to use other file extensions with the commands. Attempting to do so will cause an error message. If the file extension is changed in any other way (e.g. by directly accessing the file system) the lists are no longer recognized and therefore invalid.

The `CLISt` commands always create a binary control list, even if ASCII format is specified.

To create a `*.wv` file with R&S WinIQSIM2 using a control list, use the input control list in ASCII format.

List of Commands

[:SOURce<hw>]:BB:DM:CLISt:CATalog?
[:SOURce<hw>]:BB:DM:DLISt:CATalog?
[:SOURce<hw>]:BB:DM:FLISt:CATalog?
[:SOURce<hw>]:BB:DM:MLISt:CATalog?

Queries the user mapping lists present in the default directory. The default directory is set using command `MMEM:CDIRectory`. When the names of the files are returned they are separated by commas.

The command only reads out files with the `*.vam` extension (see also Table 11-3).

Return values:

<Catalog> string

Example:

`BB:DM:FORM USER`
selects the User modulation type.
`MMEM:CDIR 'D:\user\mapping_List'`
sets the default directory for the user mapping lists.
`BB:DM:MLIS:CAT?`
queries the user mapping lists in the directory.

Usage: Query only

Manual operation: See "Load User Mapping" on page 69

[:SOURce<hw>]:BB:DM:CLISt:FREE?
[:SOURce<hw>]:BB:DM:DLISt:FREE?
[:SOURce<hw>]:BB:DM:FLISt:FREE?
[:SOURce<hw>]:BB:DM:MLISt:FREE?

Queries the user modulation mapping list free memory.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 0

Example:

`BB:DM:FORM USER`
selects the User modulation type.
`BB:DM:FLIS:FREE?`
queries the free memory.

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:COPY <Filename>
[:SOURce<hw>]:BB:DM:DLISt:COPY <Filename>

The command copies the selected data list into the data list specified by <list name>. If a data list with the specified name already exists, it is overwritten. If it does not yet exist, it is created.

The source file has to be available in the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can be specified, in which case the source file is copied into the file <list name> in the specified directory. The file extension may be omitted.

Only files with the file extension `*.dm_iqc` will be copied (see also Table 11-3).

Setting parameters:

<Filename> string

Example: `BB:DM:DLIS 'd_list1'`
selects data list `d_list1`.
`BB:DM:DLIS:COPY 'd_list2'`
copies the content of data list `d_list1` into data list `d_list2`.
Any existing content in data list `d_list2` is overwritten.

Usage: Setting only

Manual operation: See "Select Data List..." on page 67
See "Select Data List" on page 74

[:SOURce<hw>]:BB:DM:CLISt:TAG?
[:SOURce<hw>]:BB:DM:DLISt:TAG?

The command queries the content of the specified tag in the selected file.

Return values:

<Tag> <control list>,<tag name>

Example: `BB:DM:DLIS:TAG 'D_list1','date'`
queries the Date tag in control list `D_list1`.
Response:`10.10.2008`
the data list was created on 10.10.2008.

Usage: Query only

[: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 follows:

Signal	Order	Decimal value of bits
Marker 1 Marker 2	LSBit	1 2
Burst =	LSBit	16
LevAtt1	LSBit	32
CWMod	LSBit	64
Hop	MSBit	128

You can also send the data as a binary block. Each binary block is a 2-byte value in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSB first).

For query purposes, the command `:FORMat ASCii | PACKed` can be used to switch between the formats. The byte sequence is defined in the IEC bus standard as 'most significant byte first'

`*RST` has no effect on data lists. This command is without query.

Setting parameters:
<Data> string

Example: `BB:DM:CLIS:SEL 'c_list1'`
Selects the control list.
`BB:DM:CLIS:DATA 0,0,0,0,8,8,8,0,0,0,0...`
Enters the control values in list c_list1. In the example, only ramps for marker 4 are set.

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 79

[:SOURce<hw>]:BB:DM:CLISt:DELete <Filename>

The command deletes the specified control list from the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are deleted. The file extension may be omitted. Only files with the file extension `*.dm_iqc` will be deleted.

Setting parameters:
<Filename> <list name>

Example: `BB:DM:CLIS:DEL 'c_list3'`
deletes control list c_list3.

Usage: Setting only

Manual operation: See "Select Control List..." on page 67
See "Select Control List" on page 75

[:SOURce<hw>]:BB:DM:CLISt:POINts?

The command queries the number of lines (2 bytes) in the currently selected list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: `BB:DM:CLIS:SEL "c_list1"`
selects control list c_list1.
`BB:DM:CLIS:POIN?`
queries the number of lines in the control list.
Response: `20`
the control list consists of 20 lines.

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:SELect <Filename>

The command selects the control list in the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are selected. If a control list with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.dm_iqc` will be selected or created.

Parameters:

<Filename> <list name>

Example: `BB:DM:CLIS:SEL 'c_list1'`
selects control list `c_list1`.

Manual operation: See "Select Control List..." on page 67
See "Select Control List" on page 75
See "Functions for handling of control lists" on page 216

[:SOURce<hw>]:BB:DM:DLISt:DATA <Data>
[:SOURce<hw>]:BB:DM:DLISt:DATA? [<Start>[, <Count>]]

The **Setting** command sends the bit data to the data list selected with the command `:BB:DM:DLISt:SELect`. Any existing content in the data list is overwritten. This command only writes data into the data section of the file.

This command sends the bit data to the selected data list, which is overwritten.

The **query** reads out the data part of the data list. If the query is expanded by using the two parameters <start> and <length>, the list is read out in smaller sections. Start and Length are expressed in bits. Without the parameters, the total length is always read out starting from address 1. The command `:FORMat ASCii | PACKed` can be used to select the data format. The byte sequence is defined in the IEC bus standard (read/write most significant byte first). `*RST` has no effect on data lists.

Parameters:

<Data> integer

Query parameters:

<Start> integer

Range: 1 to 2147483647

<Count> integer

Range: 1 to 2147483647

Example: `BB:DM:DLIS:SEL 'dlist1'`
Selects data list dlist1. If the file does not yet exist, it is created.
`BB:DM:DLIS:DATA 1,1,1,0,0,0,1,1,0,1...`
Sends the specified data to file dlist1. Any data already present is overwritten.

Example: `BB:DM:DLIS:SEL 'dlist1'`
Selects data list dlist1.
`FORM ASCI`
Selects ASCII data transmission format.
`BB:DM:DLIS:DATA? 2048,1024`
Queries the data starting at bit 2048 for 1024 bits.

[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend <Bits>

The command appends the bit data onto the end of the existing data in the selected data list. This means that existing content in the data list is not overwritten. By this means very long data lists can be built up piecemeal. The data format is as specified in command `SOURce:BB:DM:DLISt:DATA`.

The command cannot be used with an empty data list, such as one that has just been created, for example. In this case the command `SOURce:BB:DM:DLISt:DATA` must first be used to enter modulation data in the list.

`*RST` has no effect on data lists.

Setting parameters:

<Bits> 0 | 1 {,0 | 1 } | block data

Example: `BB:DM:DLIS:SEL ' d_list2'`
selects data list `d_list2`.
`FORM ASC`
selects ASCII data transmission format.
`BB:DM:DLIS:DATA:APP 1,1,1,0,0,0,1,1,0,1...`
adds the specified numeric data to the existing data in data list `d_list2`.

Usage: Setting only

[:SOURce<hw>]:BB:DM:DLISt:DELete <Filename>

The command deletes the specified data list. from the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are deleted. The file extension may be omitted. Only files with the file extension `*.dm_iqd` will be deleted.

Setting parameters:

<Filename> string

Example: `BB:DM:DLIS:DEL ' d_list2'`
deletes data list d_list2.

Usage: Setting only

Manual operation: See "Select Data List..." on page 67
See "Select Data List" on page 74

[:SOURce<hw>]:BB:DM:DLISt:POINts <Points>

The command 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: `BB:DM:DLIS:POIN 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 will be ignored.

[:SOURce<hw>]:BB:DM:DLISt:SELect <Select>

The command selects the data list in the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are selected. If a data list with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.dm_iqd` will be selected or created.

The modulation data in this data list is used when the data source is selected using the command `SOURce:BB:DM:SOURce DLISt`.

Parameters:

<Select> <list name>

Example: `BB:DM:DLIS:SEL 'd_list2'`
selects data list `d_list2`.

Manual operation: See "Data Source" on page 67
See "Select Data List..." on page 67
See "Select Data List" on page 74
See "Functions for handling of data lists" on page 216

[:SOURce<hw>]:BB:DM:FLISt:DELete <Filename>

Deletes the secified user filter file. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.vaf`*.vaf will be deleted.

Setting parameters:
<Filename> string

Example: `BB:DM:FILT:TYPE USER`
selects the User filter type.
`MMEM:CDIR 'D:\user\Filter_List'`
sets the default directory for the user-defined filters.
`BB:DM:FLIS:DEL user_filter3`
deletes the user-defined filter.

Usage: Setting only

Manual operation: See "Load User Filter" on page 72

[:SOURce<hw>]:BB:DM:FLISt:POINts?

Queries the user filter list length.

Return values:
<Points> integer
Range: 0 to INT_MAX
*RST: 0

Example: `BB:DM:FILT:TYPE USER`
selects the User filter type.
`BB:DM:FLIS:POIN?`
queries the list length.

Usage: Query only

[:SOURce<hw>]:BB:DM:FLISt:SELect <Filename>

Selects the user-defined filter (`*.vaf`).

The directory applicable to the following command is defined with the command `MMEM:CDIRectory`. To access the files in this directory, only the file name is required, without the path and the file extension.

Parameters:
<Filename> string

Example: `BB:DM:FILT:TYPE USER`
selects the User filter type.
`MMEM:CDIR 'D:\user\Filter_List'`
sets the default directory for the user-defined filters.
`BB:DM:FLIS:SEL user_filter3`
selects the user-defined filter.

Manual operation: See "Load User Filter" on page 72

[:SOURce<hw>]:BB:DM:MLISt:DELete <Filename>

Deletes the secified user mapping file. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.vam` will be deleted.

Setting parameters:
<Filename> string

Example: `BB:DM:FORM USER`
selects the User modulation type.
`MMEM:CDIR 'D:\user\mapping_List'`
sets the default directory for the user mapping lists.
`BB:DM:MLIS:DEL user_mapping3`
deletes the user mapping list.

Usage: Setting only

Manual operation: See "Load User Mapping" on page 69

[:SOURce<hw>]:BB:DM:MLISt:POINts?

Queries the user modulation mapping list length.

Return values:
<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: `BB:DM:FORM USER`
selects the User modulation type.
`BB:DM:MLIS:POIN?`
queries the list length.

Usage: Query only

[:SOURce<hw>]:BB:DM:MLISt:SELect <Filename>

Selects the user mapping list in the default directory. The default directory is set using command MMEM:CDIRectory. A path can also be specified, in which case the files in the specified directory are selected. If a user mapping list with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension *.vam will be selected or created.

Parameters:

<Filename> string

Example: BB:DM:MLIS:SEL 'c_list1'
selects the user mapping list c_list1.

Manual operation: See "Load User Mapping" on page 69

[:SOURce<hw>]:BB:DM:SETTing:CATalog?

Reads out the files with Custom Digital Modulation settings in the default directory. The default directory is set using command MMEM:CDIRectory. Only files with the file extension *.dm will be listed.

Return values:

<Catalog> string

Example: MMEM:CDIR 'D:\user\dig_mod'
sets the default directory.
BB:DM:SETT:CAT?
reads out all the files with Custom Digital Modulation settings in the default directory.
Response: 'DM_1'
the file DM_1 with Custom Digital Modulation settings is available.

Usage: Query only

Manual operation: See "Save/Recall" on page 64

[:SOURce<hw>]:BB:DM:SETTing:DELete <Filename>

This command deletes the selected file with Custom Digital Modulation settings. The directory is set using command MMEM:CDIRectory. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension *.dm will be deleted.

Setting parameters:

<Filename> string

Example: BB:DM:STAN:ULIS:DEL 'DM_1'
deletes file DM_1.

Usage: Setting only

Manual operation: See "Save/Recall" on page 64

[:SOURce<hw>]:BB:DM:SETTing:LOAD <Filename>

This command loads the selected file with Custom Digital Modulation settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.dm` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:DM:STAN:ULIS:LOAD 'DM_1'`
loads file `DM_1`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 64

[:SOURce<hw>]:BB:DM:SETTing:STORe <Filename>

This command stores the current Custom Digital Modulation settings into the selected file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. User Standards are stored as files with the specific file extensions `*.dm`.

Setting parameters:

<Filename> string

Example: `BB:DM:STAN:ULIS:STOR 'DM_QAM'`
stores the current Custom Digital Modulation settings into file `DM_QAM`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 64

[:SOURce<hw>]:BB:DM:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

<Fast> 0 | 1 | OFF | ON

*RST: 1

[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog?

Reads out the files with Digital Standard settings in the default directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.dm_stu` will be listed.

Return values:

<Catalog> string

Example: `MMEM:CDIR 'D:\user\dig_mod'`
sets the default directory.
`BB:DM:STAN:ULIS:CAT?`
reads out all the files with Digital Standard settings in the default directory.
Response: `'DM_QAM'`
the file `DM_QAM` with Digital Standard settings is available.

Usage: Query only

[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete <Filename>

Deletes the selected file with Digital Standard settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.dm_stu` will be deleted.

Setting parameters:

<Filename> string

Example: `BB:DM:STAN:ULIS:DEL 'DM_QAM'`
deletes file 'DM_QAM'.

Usage: Setting only

[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD <Filename>

Loads the selected file with Digital Standard settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.dm_stu` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:DM:STAN:ULIS:LOAD 'DM_QAM'`
loads file 'DM_QAM'.

Usage: Setting only

[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe <Filename>

Stores the current Digital Standard settings into the selected file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. User Standards are stored as files with the specific file extensions `*.dm_stu`.

Setting parameters:

<Filename> string

Example: `BB:DM:STAN:ULIS:STOR 'DM_QAM'`
stores the current Digital Standard settings into file 'DM_QAM'.

Usage: Setting only

11.10 SOURce:BB:IMPort subsystem

The `IMPort` subsystem contains the commands for importing IQ signal data files via TCP/IP into R&S WinIQSIM2.

11.10.1 General commands

[:SOURce<hw>]:BB:IMPort:PRESet

Sets the default settings for IQ data import.

Example: `SOURce1:BB:IMPort:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 138

[:SOURce<hw>]:BB:IMPort:SERVer:ID?

Queries the connected import server. If no import server is connected, a message "not connected" is displayed.

Return values:

<Id> string

Example: `BB:IMP:SERV?`
queries the connected import server.

Usage: Query only

Manual operation: See "Server ID" on page 139

[:SOURce<hw>]:BB:IMPort:SERVer:LOCal[:STATe] <State>

Acivates/deactivates the local host as the server from where the IQ data streams will be dowloaded. If activated, the field for entering a remote host is filled with the entry "localhost" automatically and cannot be edited.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: `BB:IMP:SERV:LOC:STAT ON`
sets the localhost as the connected server.

Manual operation: See "Use Local Server" on page 139

[:SOURce<hw>]:BB:IMPort:SERVer:NAME <Name>

The command enters the name (IP address) of the connected server. To enter the name in this field, the check box "Use Local Server" has to be unchecked.

Parameters:

<Name> string

Example: `BB:IMP:SERV:NAME 12.34.45.78`
enters the IP address of the connected server.

Manual operation: See "Server Name" on page 139

[:SOURce<hw>]:BB:IMPort:SERVer:PORT <Port>

Sets the port number for the server connection.

Parameters:

<Port> integer
Range: 0 to 65536
*RST: 1000

Example: `BB:IMP:SERV:PORT 1000`
sets port 1000 for the server connection.

Manual operation: See "Port Number" on page 139

[:SOURce<hw>]:BB:IMPort:SERVer:TTOut <TTout>

Sets the duration after which the transmission is aborted in case of a server timeout.

Parameters:

<TTout> integer

Range: 10 to 10000
*RST: 20

Example: `BB:IMP:SERV:TTO 20`
sets the transmission timeout to 20 seconds.

Manual operation: See "Transmission Timeout (s)" on page 139

[:SOURce<hw>]:BB:IMPort:SETTing:CATalog?

Reads out the files with import settings in the default directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.import` will be listed.

Return values:

<Catalog> string

Example: `MMEM:CDIR 'D:\user\/user/waveform'`
sets the default directory to D:\user\/user/waveform.
`BB:IMP:SETT:CAT?`
reads out all the files with import settings in the default directory.
Response: 'import_1', 'import_2'
the files `import_1` and `import_2` with import settings are available.

Usage: Query only

Manual operation: See "Save/Recall" on page 139

[:SOURce<hw>]:BB:IMPort:SETTing:DELete <Filename>

Deletes the selected file with import settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.import` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:IMP:SETT:DEL 'import_1'`
deletes file `import_1`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 139

[:SOURce<hw>]:BB:IMPort:SETTing:LOAD <Filename>

Loads the selected file with import settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.import` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:IMP:SETT:LOAD 'import_1'`
loads file `import_1`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 139

[:SOURce<hw>]:BB:IMPort:SETTing:STORe <Filename>

Stores the current import settings into the selected file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Import settings are stored as files with the specific file extensions `*.import`.

Setting parameters:

<Filename> string

Example: `BB:IMP:SETT:STOR 'import_1'`
stores the current import settings into file `import_1`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 139

[:SOURce<hw>]:BB:IMPort:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

<Fast> 1 | ON | 0 | OFF
*RST: 1

[:SOURce<hw>]:BB:IMPort:SRATe:VARiation?

Queries the sample rate variation.

Return values:

<Variation> float

Range: 400 to 40E6
Increment: 0.001
*RST: 20E6

Example: `BB:IMPort:SRATe:VARiation?`

Usage: Query only

Manual operation: See "Sample Rate Variation" on page 141

[:SOURce<hw>]:BB:IMPort:STATe <State>

Enables/disables the import of IQ data.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `BB:IMP:STAT ON`
enables the import of IQ data.

Manual operation: See "State" on page 138

11.10.2 Filter/clipping settings

[:SOURce<hw>]:BB:IMPort:CLIPping:LEVel <Level>

Sets the limit for level clipping. This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

Level clipping is activated with the command `SOUR:BB:IMP:CLIP:STAT ON`.

Parameters:

<Level> integer

Range: 1 to 100
*RST: 100
Default unit: PCT

Example: `BB:IMP:CLIP:LEV 80PCT`
sets the limit for level clipping to 80% of the maximum level.
`BB:IMP:CLIP:STAT ON`
activates level clipping.

Manual operation: See "Clipping Level" on page 143

[:SOURce<hw>]:BB:IMPort:CLIPping:MODE <Mode>

The command sets the method for level clipping (Clipping).

Parameters:

<Mode> VECTor | SCALar

VECTor
The reference level is the amplitude | i+jq |.

SCALar
The reference level is the absolute maximum of the I and Q values.

*RST: VECTor

Example: `BB:IMP:CLIP:MODE SCAL`
selects the absolute maximum of all the I and Q values as the reference level.
`BB:IMP:CLIP:LEV 80PCT`
sets the limit for level clipping to 80% of this maximum level.
`BB:IMP:CLIP:STAT ON`
activates level clipping.

Manual operation: See "Clipping Mode" on page 143

[:SOURce<hw>]:BB:IMPort:CLIPping:STATe <State>

Activates level clipping (Clipping). The value is defined with the command `[SOURce]:BB:IMPort:CLIPping:LEVel`, the mode of calculation with the command `[SOURce]:BB:IMPort:CLIPping:MODE`.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `BB:IMP:CLIP:STAT ON`
activates level clipping.

Manual operation: See "Clipping State" on page 142

[:SOURce<hw>]:BB:IMPort:FILTer:ILENgth <ILength>

Sets the impulse length (number of filter tabs).

Parameters:

<ILength> integer

Range: 1 to 128
*RST: 40

Example: `BB:IMP:FILT:ILEN 10`
sets the number of filter tabs to 10.

Manual operation: See "Impulse Length" on page 141

[:SOURce<hw>]:BB:IMPort:FILTer:ILENgth:AUTO <Auto>

Acivates/deactivates the impulse length state. If activated, the most sensible parameter values are selected. The value depends on the coherence check.

Parameters:

<Auto> 1 | ON | 0 | OFF

*RST: 1

Example: `BB:IMP:FILT:ILEN:AUTO ON`
the most sensible parameters are selected automatically.

Manual operation: See "Impulse Length" on page 141

[:SOURce<hw>]:BB:IMPort:FILTer:OSAMpling <OSampling>

Sets the upsampling factor.

Parameters:

<OSampling> integer

Range: 1 to 32
*RST: 2

Example: `BB:IMP:FILT:OSAM 32`
sets the upsampling factor to 32.

Manual operation: See "Oversampling" on page 142

[:SOURce<hw>]:BB:IMPort:FILTer:OSAMpling:AUTO <Auto>

Acivates/deactivates the upsampling factor state. If activated, the most sensible parameter values are selected. The value depends on the coherence check. If deactivated, the values can be changed manually.

Parameters:

<Auto> 1 | ON | 0 | OFF

*RST: 1

Example: `BB:IMP:FILT:OSAM:AUTO ON`
the most sensible parameters are selected automatically.

Manual operation: See "Oversampling" on page 142

[:SOURce<hw>]:BB:IMPort:FILTer:TYPE <Type>

Selects the filter type.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LPASSEVM

*RST: GAUSs (if layer mode OFDM), COSine (if layer mode CCK or PBCC)

Example: `BB:IMP:FILT:TYPE COS`
selects the Cosine filter type.

Manual operation: See "Filter" on page 141

[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:COSine <Cosine>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:GAUSs <Gauss>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:LPASs <LPass>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:LPASSEVM <LPassEvm>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:PGAuss <PGauss>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:RCOSine <RCosine>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:SPHase <SPhase>
[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:APCO25 <Apco25>

Sets the corresponding filter parameter.

Parameters:

<Apco25> float

Range: 0.05 to 0.99
Increment: 0.01
*RST: 0.2

Example: `BB:IMP:FILT:PAR:APCO25 0.2`
sets the roll-off factor to 0.2 for filter type APCO25.

Manual operation: See "Roll Off Factor or BxT" on page 141

[:SOURce<hw>]:BB:IMPort:FILTer:PARameter:COSine:COFS <Cofs>

Sets the "cut of frequency shift" value for the Cosine filter type.

Parameters:

<Cofs> float

Range: -1 to 1
Increment: 0.01
*RST: -0.1

Example: `BB:IMP:FILT:PAR:COS:COFS 0.04`
the "cut of frequency shift" value is set to 0.04.

Manual operation: See "Cut Off Frequency Shift" on page 141

11.10.3 Marker settings

[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:MODE <Mode>

The command defines the signal for the selected marker output.

Parameters:

<Mode> RESTart | PULSe | PATTern | RATio

RESTart
A brief marker signal is generated at the start of the waveform.

PULSe
A pulsed marker signal is generated. The pulse frequency (= symbol rate/divider) is defined with the `SOUR:IMP:TRIG:OUTP:PULSe:DIVider` command and can be queried with the `SOUR:BB:IMP:TRIG:OUTP:PULSe:FREQuency` command.

PATTern
A marker signal is generated with the aid of a user-definable bit pattern. The bit pattern is entered with the command `SOURce:BB:IMP:TRIGger:OUTPut:PATTern`. The bit pattern is a maximum of 32 bits long.

RATio
A regular marker signal corresponding to the Time Off / Time On specifications in the commands `SOURce:BB:IMP:TRIGger:OUTPut:OFFT` and `SOURce:BB:IMP:TRIGger:OUTPut:ONT` is generated.

*RST: RESTart

Example: `BB:IMP:TRIG:OUTP2:MODE PULS`
selects the pulsed marker signal on output MARKER 2.

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of symbols in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:IMPort:TRIGger:OUTPut:MODE RATio` on the marker outputs is OFF.

Parameters:

<OffTime> integer

Range: 1 to 16777215
Increment: 1
*RST: 1

Example: `BB:IMP:TRIG:OUTP2:OFFT 20`
sets an OFF time of 20 symbols for marker signal 2.

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PATTern <Pattern>

The command defines the bit pattern used to generate the marker signal in the setting `SOURce:BB:IMP:TRIGger:OUTPut:MODE PATTern`. 0 is marker off, 1 is marker on.

Parameters:

<Pattern> integer

Range: #B0,1 to #B111
*RST: #B0,1

Example: `BB:IMP:TRIG:OUTP2:PATT #B000000011111111,15`
sets a bit pattern.
`BB:IMP:TRIG:OUTP2:MODE PATT`
activates the marker signal according to a bit pattern on output MARKER 2.

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for the Pulse marker mode (`SOUR:BB:IMP:TRIG:OUTP:MODE PULSe`). The resulting pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: `BB:IMP:TRIG:OUTP2:PULS:DIV 2`
sets the divider to 2 for the marker signal on output MARKER 2.
`BB:IMP:TRIG:OUTP2:FREQ?`
queries the resulting pulse frequency of the marker signal.
Response:
`66 000`
the resulting pulse frequency is 66 kHz.

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:IMPort:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal in the setting `SOURce:BB:IMP:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider.

Return values:

<Frequency> float

Range: 0 to max
Increment: 0.001
*RST: 10E6

Example: `BB:IMP:TRIG:OUTP2:PULS:DIV 2`
sets the divider marker signal on output MARKER 2 to the value 2.
`BB:IMP:TRIG:OUTP2:MODE PULS`
enables the pulsed marker signal.
`BB:IMP:TRIG:OUTP2:PULS:FREQ?`
queries the pulse frequency of the marker signal.
Response:
`33 000`
the resulting pulse frequency is 33 kHz.

Usage: Query only

Manual operation: See "Marker Mode" on page 144

11.11 SOURce:BB:MCCW subsystem

This subsystem contains the commands for setting the Multi Carrier CW signals.

11.11.1 Suffixes

SOURce<hw>

For one-path instruments, the keyword SOURce is optional and can be omitted.

The numeric suffix to `SOURce` distinguishes between signal generation for path A and path B in the case of two-path instruments:

- `SOURce[1]` = path A
  The keyword `SOURce` is optional and can be omitted
- `SOURce2` = path B
  The keyword `SOURce` is mandatory, i.e. the command must contain the keyword with suffix 2.

OUTPut<ch>

The numeric suffix to `OUTPut` distinguishes between the available markers.

11.11.2 General settings and carrier setup settings

[:SOURce<hw>]:BB:MCCW:STATe <State>

Activates the multi carrier CW signal generation and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: `SOURce1:BB:MCCW:STATe ON`

Manual operation: See "State" on page 99

[:SOURce<hw>]:BB:MCCW:PRESet

Sets the multi carrier signal parameters to their default values (`*RST` values specified for the commands).

Not affected is the state set with the command `SOURce<hw>:BB:MCCW:STATe`

Example: `SOURce1:BB:MCCW:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 100

[:SOURce<hw>]:BB:MCCW:CARRier:COUNt <Count>

Sets the number of carriers in the Multi Carrier CW signal. The total bandwidth is calculated as (Number of carriers - 1) * Carrier spacing and must not exceed the system bandwidth of the instrument (see data sheet).

The carrier spacing (`:BB:MCCW:CARRier:SPACing`) is reduced if the total bandwidth is not respected when entering the number of carriers.

The number of carriers entered therefore defines the maximum carrier spacing (`:BB:MCCW:CARRier:SPACing`).

Parameters:

<Count> integer

Range: 1 to 160001
*RST: 64

Example: `BB:MCCW:CARR:COUN 10`
sets 10 CW carriers for the multi carrier signal.

Manual operation: See "Number of Carriers" on page 100

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe <Phas0[,Phas1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe? [<Start>[, <Count>]]

Sets the start phase of the carrier with the aid of a value list. The first value in the list is assigned to the carrier with index 0, the second value to the carrier with index 1, etc. The maximum length corresponds to the maximum number of multi carriers. There is no need to enter all the values every time. Values not set by the value list are set with the default values provided they have already been explicitly set by a previous command. If this is the case, the values continue to apply until overwritten.

Setting parameters:

<Phas0[,Phas1..]> float

Range: 0 to 360
Increment: 0.01
*RST: 0
Default unit: DEG

Query parameters:

<Start> integer

Range: 0 to lastCarrier

<Count> integer

Range: 1 to lastCarrier

Return values:

<Phas[,Phas..]> float

Example: `BB:MCCW:CARR:LIST:PHAS 1,20,30,40,50,60`

sets a start phase for carriers 0, 1, 2, 3 and 4.

`BB:MCCW:CARR:LIST:PHAS? 2,3`

queries the phase of carrier 1, 2 and 3.

Response: `20,30,40`

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer <Pow0[,Pow1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer? <Start>, <Count>

Sets the power of the carrier with the aid of a value list. The first value in the list is assigned to the carrier with index 0, the second value to the carrier with index 1, etc. The maximum length corresponds to the maximum number of multi carriers. There is no need to enter all the values every time. Values not set by the value list are set with the default values provided they have already been explicitly set by a previous command. If this is the case, the values continue to apply until overwritten.

Setting parameters:

<Pow0[,Pow1..]> float

Increment: 0.01

Query parameters:

<Start> integer

Range: 0 to lastCarrier

<Count> integer

Range: 1 to lastCarrier

Return values:

<Pow[,Pow..]> float

Example: `BB:MCCW:CARR:LIST:POW -65 dB, -30 dB, -50 dB,...`

sets the power of carrier 0 to -65 dB, carrier 1 to -30 dB and so on.

`BB:MCCW:CARR:LIST:POW? 2,3`

queries the power of carrier 1 and 2.

Response: `-30,-50`

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe <Stat0[,Stat1..]>]
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe? <Start>, <Count>

Switches the carrier on or off with the aid of a value list. The first value in the list is assigned to the carrier with index 0, the second value to the carrier with index 1, etc. The maximum length corresponds to the maximum number of multi carriers. There is no need to enter all the values every time. Values not set by the value list are set with the default values provided they have already been explicitly set by a previous command. If this is the case, the values continue to apply until overwritten.

Setting parameters:

<Stat0[,Stat1..]> ON | OFF[,ON | OFF,...]

Query parameters:

<Start> integer
Range: 0 to lastCarrier

<Count> integer
Range: 1 to lastCarrier

Return values:

<State[,State..]> select

Example: `BB:MCCW:CARR:LIST:STAT 1,0,1,1,0,0....`
switches carrier 0 on, carrier 1 off, etc.
`BB:MCCW:CARR:LIST:STAT? 2,4`
queries the states of carrier 2, 3, 4 and 5.
Response: `0,1,1,0`

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CARRier:PHASe <CarrierIndex>, <Phase>

Sets the start phase of the selected carrier.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:MCCW:CFACtor:MODE OFF`).

Parameters:

<CarrierIndex> integer
Range: 0 to lastCarrier

<Phase> float
Sets the start phase of the selected carrier.
Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:MCCW:CARR:PHAS 15,90`
sets a start phase of 90 DEG for carrier 15.

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CARRier:POWer <CarrierIndex>, <Power>

Sets the power of the selected carrier.

Parameters:

<CarrierIndex> integer

Range: 0 to lastCarrier

<Power> float

Sets the power of the selected carrier.

Range: -80 to 0
Increment: 0.01
*RST: 0

Example: `BB:MCCW:CARR:POW 15, -50 dB`
sets the power of carrier 15 to -50 dB.

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CARRier:SPACing <Spacing>

The command sets the carrier spacing.

The carriers are generated symmetrically around the center carrier. The total bandwidth is calculated as ("Number of carriers" - 1) * "Carrier spacing" and must not exceed the system bandwidth of the instrument (see data sheet).

The maximum carrier spacing that can be set is dependent on the chosen number of carriers

The maximum carrier spacing is automatically reduced so that the maximum total bandwidth is not exceeded on entering the number of carriers (`:BB:MCCW:CARRier:COUNt`).

Parameters:

<Spacing> float

Range: 0 to 120E6
Increment: 0.01
*RST: 10E3

Example: `BB:MCCW:CARR:SPAC 10 MHz`
sets a carrier spacing of 10 MHz.

Manual operation: See "Carrier Spacing" on page 100

[:SOURce<hw>]:BB:MCCW:CARRier:STATe <CarrierIndex>, <State>

Switches the selected carrier on or off.

The counting in remote control differs from the numbers in the carrier table. Index 0 corresponds to number 1 (first line) in the table. Therefore, switching the state of the channel via remote control always switches the state of <channel index> + 1 in the table.

Parameters:

<CarrierIndex> integer

Range: 0 to lastCarrier

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:MCCW:CARR:STAT 15, ON`
switches carrier 16 on.

Manual operation: See "Carrier Table" on page 103

[:SOURce<hw>]:BB:MCCW:CFACtor <CFactor>

Sets the desired crest factor for the multi carrier signal on selection of the command `SOUR:BB:MCCW:CFAC:MODE SLOW`.

Parameters:

<CFactor> float

Range: 0 to 30
Increment: 0.01
*RST: 3

Example: `BB:MCCW:CFAC:MODE SLOW`
sets the Target Crest optimization mode.
`BB:MCCW:CFAC 10 dB`
sets the desired crest factor to 10 dB.

Manual operation: See "Desired Crest Factor" on page 101

[:SOURce<hw>]:BB:MCCW:CFACtor:ACTual?

Queries the actual Crest Factor for `BB:MCCW:CFAC:MODE SLOW`.

Return values:

<Actual> float

Range: 0 to 100
Increment: 0.01
*RST: 3

Example: `SOUR:BB:MCCW:CFAC:MODE SLOW`
`BB:MCCW:CFAC:ACT?`
Response: `3`

Usage: Query only

[:SOURce<hw>]:BB:MCCW:CFACtor:MODE <Mode>

Sets the mode by which automatic settings will minimize the crest factor or hold it at a chosen value.

Parameters:

<Mode> OFF | CHIRp | SLOW

OFF
Crest factor optimization is switched off. The carrier PHASE setting has an effect.

CHIRp
The crest factor is very rapidly optimized to < 3 dB for multi carrier signals so that all carriers are switched on and have the same amplitude. The computation time is independent of the number of carriers. In other carrier configurations the achievable crest factor is worse.

SLOW
The crest factor entered using `SOURceBB:MCCW:CFACtor` is maintained for all carrier configurations by means of automatic settings. The computation time depends on the number of carriers and on the crest factor that has been set. Computation time increases only when the number of carriers exceeds 256 and the crest factor is above 4 dB.

*RST: CHIRp

Example: `BB:MCCW:CFAC:MODE OFF`
switches off automatic crest factor optimization.
The setting `SOURBB:MCCW:CARR:PHAS` has an effect.

Manual operation: See "Optimize Crest Factor Mode" on page 101

[:SOURce<hw>]:BB:MCCW:CLOCk?

Queries the output clock rate. The output clock rate depends on the number of carriers an the selected carrier spacing.

Return values:

<Clock> float

Range: 0 to Max
Increment: 1E-3
*RST: 0

Example: `BB:MCCW:CLOC?`
queries the output clock rate.
Response: `256 000 000`
the output clock rate is 256 MHz.

Usage: Query only

Manual operation: See "Clock Frequency" on page 100

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute

Adopts the settings for the carrier range which has been defined using the `:BB:MCCW:EDIT:CARR:...` commands.

Example: `BB:MCCW:EDIT:CARR:STAR 4`
the carrier range starts at carrier 4.
`BB:MCCW:EDIT:CARR:STOP 400`
the carrier range stops at carrier 400.
`BB:MCCW:EDIT:CARR:STAT ON`
sets all the carriers in the carrier range to ON.
`BB:MCCW:EDIT:CARR:EXEC`
adopts the settings for all the carriers in the carrier range.
`BB:MCCW:STAT`
starts generation of the multi carrier signal. Carriers 4 to 400 are in the ON state.

Usage: Event

Manual operation: See "Accept" on page 103

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP <Step>

Sets the step width by which the start phases of the carriers in the defined carrier range will be incremented.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:MCCW:CFACtor:MODE OFF`).

Parameters:

<Step> float

Range: -359.99 to 359.99
Increment: 0.01
*RST: 0

Example: `BB:MCCW:EDIT:CARR:PHAS 90 DEG`
sets a start phase of 90° for the carriers in the carrier range.
`BB:MCCW:EDIT:CARR:PHAS:STEP 1 DEG`
the start phase is incremented by 1° for each carrier, i.e. the first carrier has a start phase of 90°, the second a start phase of 91°, etc.

Manual operation: See "Phase Step" on page 103

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt] <Start>

Sets the start phase for the individual carriers in the defined carrier range. If the command `:BB:MCCW:EDIT:CARR:PHAS:STEP` is used to define a step width, the phase entered here applies only to the starting carrier. The phases of the remaining carriers are stepped up or down by the phase value specified in the `:BB:MCCW:EDIT:CARR:PHAS:STEP` command.

The phase settings are only valid if optimization of the crest factor is disabled (`SOURce:BB:MCCW:CFACtor:MODE OFF`).

Parameters:

<Start> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0

Example: `BB:MCCW: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 103

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP <Step>

Sets the step width by which the starting power of the carriers in the defined carrier range will be incremented.

Parameters:

<Step> float

Range: -80 to 80
Increment: 0.01
*RST: 0

Example: `BB:MCCW:EDIT:CARR:POW -80dB`
sets a power of -80 dB for the carriers in the carrier range.
`BB:MCCW:EDIT:CARR:POW:STEP 1 dB`
the power phase is incremented by dB for each carrier, i.e. the first carrier has -80 dB, the second -79 dB, etc.

Manual operation: See "Power Step" on page 103

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt] <Start>

Sets the power for the individual carriers in the defined carrier range. If the command `:BB:MCCW:EDIT:CARR:POW:STEP` is used to define a step width, the power entered here applies only to the starting carrier. The power of the remaining carriers is stepped up or down by the power specified in the `:BB:MCCW:EDIT:CARR:POW:STEP` command.

Parameters:

<Start> float

Range: -80 to 0
Increment: 0.01
*RST: 0

Example: `BB:MCCW:EDIT:CARR:POW -50 dB`
sets the power of the carrier to -50 dB.

Manual operation: See "Power Start" on page 102

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt <Start>

Selects the first carrier in the carrier range to which the settings with the `:BB:MCCW:EDIT:CARR:...` commands shall apply.

Parameters:

<Start> integer

Range: 0 to 8191
*RST: 0

Example: `BB:MCCW:EDIT:CARR:STAR 4`
the carrier range starts at carrier 4.

Manual operation: See "Carrier Start/Stop" on page 102

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe <State>

Switches all the carriers in the selected carrier range on or off.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: `BB:MCCW:EDIT:CARR:STAT ON`
sets all the carriers in the carrier range to ON.

Manual operation: See "Carrier State" on page 102

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP <Stop>

Selects the last carrier in the carrier range to which the settings with the `:BB:MCCW:EDIT:CARR:...` commands shall apply.

Parameters:

<Stop> integer

Range: 0 to 8191
*RST: 0

Example: `BB:MCCW:EDIT:CARR:STOP 40`
the carrier range stops at carrier 40.

Manual operation: See "Carrier Start/Stop" on page 102

11.11.3 Marker settings

This section lists the remote control commands, necessary to configure the markers.

The marker delay settings are available for R&S SMx and R&S AMU instruments only.

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

Parameters:

<Mode> RESTart | PULSe | PATTern | RATio

RESTart
A brief marker signal is generated at the start of the waveform.

PULSe
A pulsed marker signal is generated. The pulse frequency (= sample rate/divider) is defined with the `SOUR:BB:MCCW:TRIG:OUTP:PULSe:DIVider` command and can be queried with the `SOUR:BB:MCCW:TRIG:OUTP:PULSe:FREQuency?` command.

PATTern
A marker signal is generated with the aid of a user-definable bit pattern. The bit pattern is entered with the aid of command `SOURce:BB:MCCW:TRIGger:OUTPut:PATTern`. The bit pattern is a maximum of 32 bits long.

RATio
A regular marker signal corresponding to the Time Off / Time On specifications in the commands `SOURce:BB:MCCW:TRIGger:OUTPut:OFFT` and `SOURce:BB:MCCW:TRIGger:OUTPut:ONT` is generated.

*RST: RESTart

Example: `BB:MCCW:TRIG:OUTP2:MODE PULS`
selects the pulsed marker signal on output MARKER 2.

Manual operation: See "Marker Mode" on page 105

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime <OffTime>
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime <OnTime>

Sets the number of samples in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:MCCW:TRIGger:OUTPut:MODE RATio` on the marker outputs is ON.

Parameters:

<OnTime> integer

Range: 1 to 16777215
*RST: 1

Example: `BB:MCCW:TRIG:OUTP2:ONT 20`
sets an ON time of 20 samples for marker 2.

Manual operation: See "Marker Mode" on page 105

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Sets the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric
0 is marker off, 1 is marker on.
*RST: #H2

<BitCount> integer
Range: 1 to 64
*RST: 2

Example:
```
BB:MCCW:TRIG:OUTP2:MODE PATT
BB:MCCW:TRIG:OUTP2:PATT #HE0F52,20
```

Manual operation: See "Marker Mode" on page 105

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for Pulse marker mode (`SOUR:BB:MCCW:TRIG:OUTP:MODE PULSe`). The resulting pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer
Range: 2 to 1024
*RST: 2

Example: `BB:MCCW:TRIG:OUTP2:PULS:DIV 2`
sets the divider for the marker signal on output MARKER 2 to the value 2.
`BB:MCCW:TRIG:OUTP2:FREQ?`
queries the resulting pulse frequency of the marker signal
`Response: 66 000`
the resulting pulse frequency is 66 kHz.

Manual operation: See "Marker Mode" on page 105

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal in the setting `SOUR:BB:MCCW:TRIG:OUTP:MODE PULS`. The pulse frequency is derived by dividing the symbol rate by the divider. The divider is defined with command `SOUR:BB:MCCW:TRIG:OUTP:PULS:DIV`.

Return values:

<Frequency> float

Increment: 1E-3

Example:
`BB:MCCW:TRIG:OUTP2:PULS:DIV 4`
sets the divider for the marker signal on output MARKER 2 to the value 4.
`BB:MCCW:TRIG:OUTP2:MODE PULS`
enables the pulsed marker signal
`BB:MCCW:TRIG:OUTP2:PULS:FREQ?`
queries the pulse frequency for the marker signal.
`Response: "33 000"`
the resulting pulse frequency is 33 kHz.

Usage: Query only

Manual operation: See "Marker Mode" on page 105

11.12 SOURce:BB:PROGress subsystem general commands

In the R&S WinIQSIM2, some calculation processes may take longer time. While operating the instrument manually, you can observe the status of an initiated process by the busy indicator. The following commands fulfill the same task in the remote control operation.

Example: Querying the status of the Create Waveform file process

The following is an example on how to use these commands to retrieve information about how many percent of the initiated process are completed.

```
:SOURce1:BB:EUTRa:SETTing:TMOD:DL "E-TM1_1__15MHz"
:SOURce1:BB:EUTRa:SLENgth 100
:SOURce1:BB:PROGress:MCODer?
// 100 (task compleated)
:SOURce1:BB:EUTRa:STATe ON
:BB:PROGress:MCODer?
// 67 (task in progress)
:SOURce1:BB:EUTRa:WAVeform:CREate
:SOURce1:BB:PROGress:MCODer?
// 25 (task in progress)
// :SOURce1:BB:PROGress:MCODer:DM:FILTer?
// 100
```

[:SOURce<hw>]:BB:PROGress:MCODer?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?

Queries the status of an initiated process, like for example the calculation of a signal in accordance to a digital standard, or the calculation of a multi carrier or multi segment waveform file.

Return values:

<WSegment> integer

Indicates the task progress in percent

Range: 0 to 100
*RST: 100

Example: see Example "Querying the status of the Create Waveform file process" on page 389

Usage: Query only

[:SOURce<hw>]:BB:PROGress:MCODer:DM:FILTer?

Queries the status of an applied offline filtering, like for example during the calculation of a waveform and a multi carrier waveform file.

Return values:

<Filter> integer

Indicates the task progress in percent

Range: 0 to 100
*RST: 100

Example: see Example "Querying the status of the Create Waveform file process" on page 389

Usage: Query only

11.13 STATus subsystem

This system contains the commands for the status reporting system. See also Chapter 10.2, "Status reporting system", on page 236 for detailed information.

*RST on page 260 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 WinIQSIM2 cause the status registers to be changed.
  Setting values: A decimal value in the range 0 to 32767 (=2^{15}-1)

:STATus:OPERation:CONDition?

Quieries the content of the CONDition part of the STATus:OPERation register.

This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out because it indicates the current hardware status.

Return values:

<Condition> string

Example: `:STATus:OPERation:CONDition?`

Usage: Query only

:STATus:OPERation:ENABle <Enable>

Sets the bits of the ENABle part of the STATus:OPERation register. This setting determines which events of the Status-Event part are forwarded to the sum bit in the status byte. These events can be used for a service request.

Parameters:

<Enable> string

Example: `:STAT:OPER:ENAB 32767`

all events are forwarded to the sum bit of the status byte.

:STATus:OPERation[:EVENt] < >

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 398.

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

11.14 SYSTem subsystem

The `SYSTem` subsystem contains a series of commands for general functions which do not directly affect signal generation.

:SYSTem:COMMunicate:SOCKet:PORT <ScpiEthPort>

Sets the port number for remote control via socket communication.

Parameters:

<ScpiEthPort> integer

Range: 1000 to 65535
*RST: n.a. (factory preset: 5025)

Example:
```
SYSTem:COMMunicate:SOCKet:PORT 5030
// specifies the socket port number.
```

Manual operation: See "SCPI Port" on page 236

: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 WinIQSIM2 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: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 "Static Notifications / Error History" on page 229

: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: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[: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 / Error History" on page 229

:SYSTem:ERRor:HISTory:CLEar

Clears the error history.

Example:
```
SYSTem:ERRor:HISTory:ClEar
// Deletes the history entries.
```

Usage: Event

Manual operation: See "Clear History" on page 229

: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:
```
SYSTem:ERRor:STATic?
// Returns all static errors that are collected in the error queue.
```

Usage: Query only

Manual operation: See "Static Notifications / Error History" on page 229

:SYSTem:MMEMory:PATH:USER?

Queries the user directory, that means the directory the R&S WinIQSIM2 stores user files on.

Return values:
<PathUser> string

Example:
```
SYSTem:MMEMory:PATH:USER?
Response: "'D:\user\"
```

Usage: Query only

:SYSTem:NINFormation?

Queries the oldest information message ("Error History > Level > Info") in the error/ event queue.

Return values:
<NextInfo> string

Example:
```
:SYSTem:NINFormation?
// queries the oldest entry in the info message queue.
Response: 90,"Info;=== Instrument startup... ==="
// Information message containing error number 90, that states, that the
```

Usage: Query only

:SYSTem:OSYStem?

Queries the operating system of the instrument.

Return values:
<OperSystem> string

Example:
```
SYSTem:OSYStem?
Response: "Linux"
```

Usage: Query only

:SYSTem:RCL <Pathname>

Selects and uploads a `*.savrcltxt` file with previously saved R&S WinIQSIM2 settings from the default or a specified directory.

Setting parameters:
<Pathname> string

Example:
```
SYSTem:RCL "D:\user\temp\Test"
// loads the "Test.savrcltxt" file from the directory D:\user\temp\.
```

Usage: Setting only

:SYSTem:SAV <Pathname>

Saves the current R&S WinIQSIM2 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 WinIQSIM2 assigns the extension (`*.savrcltxt`) automatically.

Setting parameters:

<Pathname> string

Example:
```
SYSTem:SAV "D:\user\temp\Test"
// saves the file "Test.savrcltxt" in the directory D:\user\temp\.
```

Usage: Setting only

:SYSTem:SERRor?

Returns a list of all currently listed errors. The list corresponds to the notifications in manual control.

Return values:

<StaticErrors> string

Example:
```
SYSTem:SERRor?
// queries all errors existing in the error queue.
Response: -221, 'Settings conflict', 153, 'Input voltage out of range'
// the two returned errors have occurred since the error queue was last q
```

Usage: Query only

: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?
// INSTruments:NAME "SMW-123456"
// INSTruments:SELect:ARB 2
// TRANsmit:DESTination INST
// TRANsmit:DESTination:IFILe "var/user/waveform/LTE_E_TM1_1_10MHz.wv"
// TRANsmit:COMMent "LTE_TestCase_ETM1_1_10_Waveform"
// TRANsmit:AUTO:PATH A
// TRANsmit:AUTO: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: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: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.

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

12 Troubleshooting and notifications

12.1 Notifications

Notifications inform on inconsistencies of a configuration or process, and point out deviations, deficiencies or imperfection of functions that initiate an event in R&S WinIQSIM2. The signal generation software distinguishes the notifications according to the significance of the events by different icons.

Some events require that you first fix the deviation to make sure that the signal generation software operates correctly.

R&S WinIQSIM2 displays a notification in the "Info" line on the screen, and saves all accumulated notifications in a history list, with specific error code and description. An event also initiates an entry in the event/error queue of the status reporting system. In remote control mode, you can query the notifications with the command `:SYSTem:ERRor:ALL?` on page 396.

See the following sections:

- Chapter 10.2, "Status reporting system", on page 236
- Chapter 9.3, "Querying notifications", on page 227

12.1.1 Volatile notifications

Volatile notifications report automatic settings (e.g. switching off incompatible types of modulation) or on entries that are not accepted by the software (e.g. range violations). After a short time, the notification disappears, but you can find it in the history dialog. Usually, the volatile notifications do not require any user action.

Remote command:

- `:SYSTem:ERRor:ALL?` or
- `:SYSTem:ERRor:CODE[:NEXT]?`

12.1.2 Permanent notifications

Permanent notifications are displayed if an error occurs that impairs further operation. The error signaled by a permanent message must be eliminated before the correct operation can be continued.

The notification remains in the "Info" line until you have fixed the error. After elimination, the message disappears, but you can find it in the history dialog.

Remote command:`:SYSTem:ERRor:STATic?`

12.2 SCPI notifications

The SCPI notifications are similar for all SCPI applications. SCPI notifications have negative error codes (numbers). For detailed information, see the documentation of the SCPI standard.

12.3 Device-specific notifications

The following table contains all notifications that can appear in for the signal generation software in alphabetical order, with a description of the error and remedy, if possible. Positive error codes denote device-specific errors.

The device-specific error notifications set bit 3 in the ESR register.

The index provides a list of the error notifications sorted according to their error codes.

Error Code	Error	Description	Remedy
140	This modulation forces other modulations off	A modulation has been switched on which cannot be used at the same time as an already active modulation. The previous modulation has been switched off. Example: Enabling modulation GSM/ EDGE switches any active digital modulation off.	
241	No current list	There is no list selected. To execute the required operation, a list has to be selected in the related menu. If no list is available, a new list must be created.	
242	Unknown list type specified	The list type selected is not valid for the required operation. For instance, the file extension for waveform list files is *.wv. It is not possible to enter another file extension when selecting a list.	Check the selected list type.
261	Waveform Protected	The selected waveform file cannot be transferred to a controller. The waveform is produced with simulation software R&S WinIQSIM2 and is protected.	
460	Cannot open file	The selected file cannot be opened.	Check the path and filename.
461	Cannot write file	The file cannot be written.	Check if the file is read only.
462	Cannot read file	The file cannot be read.	Check if the file contents are compatible with the file type.

Error Code	Error	Description	Remedy
463	Filename missing	The required operation cannot be executed because the filename is not specified.	Enter a filename when creating a list.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension. For instance, the file extension for waveform list files is `*.wv`. It is not possible to enter another file extension when storing a list.
465	File contains invalid data	The selected file contains data that is not valid for the file type. The file extension determines the data that is valid for this file type. If the file extension is changed, the file type and the file data are invalid. Example: the extension of a waveform file (= `*.wv`) was changed to `*.txt`	Check the file extension.

12.4 Resolving network connection failures

Several issues can cause failures in the network connection. 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 WinIQSIM2 PC and certain switches or routers available on the market
- Invalidity of the assigned IP address

Possible solutions

NOTICE

Risk of network failure

Connecting to the network can cause network failure. Errors can affect the entire network.

- Check the network infrastructure. Exchange connecting cables if obvious damage is visible.
- Observe the link status LED next to the LAN connector.
  If a link failure is detected, connect the computer to a different network port or to a different network device.
- Check whether the IP address of the computer is within the network's address range.

IP addresses that are set manually can be invalid.

12.5 Obtaining technical support

If problems occur, R&S WinIQSIM2 generates error messages which usually are sufficient for you to detect the cause of an error and find a remedy. Error message types are described in Chapter 12.1, "Notifications", on page 402.

In addition, our customer support assists you in solving any problems with R&S WinIQSIM2. We find solutions more quickly and efficiently if you provide us with the following information:

- **Software options** via "File > Setup > Software/Option" provide information on the status of R&S WinIQSIM2 software components installed on your computer.
- **System messages:** displayed in the "Info" line provide information on any errors that have occurred.

Collect the error information and contact your Rohde & Schwarz Customer Support Center for technical support, see http://www.customersupport@rohde-schwarz.com.

Annex

A Extensions for user files

The following table lists all available file extensions for user files.

Table A-1: List of the automatically assigned file extensions in the instrument

Function/Digital Standard	List type	Contents	File suffix
Instrument State	Settings	Instrument settings	`*.savrcl`
Import Settings	Settings	Settings	`*.import`
"Arbitrary Wave-form Generator"	Waveform	ARB waveforms ARB multi segment waveforms	`*.wv`
	Waveform	ARB multi carrier settings	`*.arb_multcarr`
	Configuration data	Configuration file for creation of multisegment ARB waveforms	`*.inf_mswv`
	Play List	ARB Sequencing List	`*.wvs`
"DM"	Data List	Digital modulation data	`*.dm_iqd` `*.tdm`
	Control List	Data to control digital modulation	`*.dm_iqc`
	Settings	Digital modulation settings	`*.dm`
	User Standard	Digital modulation user standard	`*.dm_stu`
	User Mapping	Digital modulation user mapping	`*.vam`
	User Filter	Digital modulation user filter	`*.vaf`
"GSM/EDGE"	Settings	GSM/EDGE settings	`*.gsm`
	Slot	User-defined slot data	`*.gsm_slu`
	Frame	User-defined frame data	`*.gsm_fu`
	Slot	Higher symbol rate slot	`*.gsm_hslu`
	Frame	Higher symbol rate frame	`*.gsm_hfu`
"Bluetooth"	Bluetooth Set-tings	Complete setting of the Bluetooth menu	`*.bto`
"TETRA"	TETRA Set-tings	Complete setting of the TETRA menu	`*.tetra`
"3GPP FDD"	Settings	Complete setting of the 3GPP (FDD) menu	`*.3g`
	Settings	Channel coding enhanced DPCH channels (downlink)	`*.3g_ccod_dl_s`
	Settings	Channel coding enhanced DPDCH channels (uplink)	`*.3g_ccod_ul`
"CDMA2000"	Settings	Complete setting of the CDMA2000 menu	`*.cdma2k`

Function/Digital Standard	List type	Contents	File suffix
"TD-SCDMA2000"	Settings	Complete setting of the TD-SCDMA2000 menu	*.tdscdma
	Settings	Test Model for TD-SCDMA2000	*.tdtmd
1xEV-DO	Settings	Complete setting of the 1xEV-DO menu	*.evdo
"IEEE 802.11 WLAN"	Settings	Complete setting of the IEEE 802.11 WLAN menu	*.wlan
"IEEE 802.11 n WLAN"	Settings	Complete setting of the IEEE 802.11n WLAN menu	*.wlann
	Settings	Beamforming data	*.bmf
"IEEE 802.16 WiMAX"	Settings	Complete setting of the IEEE 802.16 WiMAX menu	*.wimax
"EUTRA/LTE"	Settings	Complete setting of the EUTRA/LTE menu	*.eutra
	Settings	TDD Settings	*.lte_tdd
	Settings	User-defined IQ-File	*.iqw
"GNSS"	Settings	Complete setting of the GNSS menu	*.gps *.galileo *.glonas
	Settings	Almanac Settings	*.txt *.alm *.al3 *.agl
	Settings	Waypoints File	*.txt
	Settings	Generated Almanac File	*rs_al *.rs_yuma
	Settings	Ionospheric File	*.rs_ion
	Settings	Navigation Data	*.rs_nav
	Settings	UTC File	*.rs_utc *.rs_acq
"DVB"	Settings	Complete setting of the DVB menu	*.dvb
	Settings	DVB Transport Stream	*.gts *.ts *.trp
"DAB/T-DMB"	Settings	Complete setting of the DAB/T-DMB menu	*.dab
	Settings	DAB ETI Files	*.eti *.xeti
NFC	Settings	Complete setting of the NFC menu	*.nfc

Glossary: Publications and references

Symbols

1GP115: Rohde & Schwarz application note 1GP115 "Generating WLAN IEEE 802.11ax Signals"

1MA279: Rohde & Schwarz application note 1MA279 "Doherty, Balanced, Push-Pull & Spatial Amplifier Performance Enhancement"

1MA296: Rohde & Schwarz application note 1MA296 "Narrowband Internet of Things Measurements"

1MA299: Rohde & Schwarz application note 1MA299 "Linearity Measurements on RFFE Components"

List of commands

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