Manual

Baseband Signal Generator and Fading Simulator

R&S® AMU 200A

1402.4090.02

Printed in Germany

ROHDE&SCHWARZ
Test and Measurement Division

Dear Customer,

throughout this manual, the Baseband Signal Generator and Fading Simulator R&S® AMU 200A is abbreviated as R&S AMU.

Tabbed Divider Overview

**CD-ROM including complete operating manual and compiled online help
(provided in the file inside pocket)**

Data Sheet

**Safety Instructions
Certificate of Quality
EU Certificate of Conformity
Support-Center Address
List of R&S Representatives**

User documentation for Baseband Signal Generator and Fading Simulator R&S AMU 200A

Tabbed Divider

CE

Certificate No.: 2007-04

This is to certify that:

Equipment type	Stock No.	Designation
AMU200A	1402.4090.02	Baseband Signal Generator
AMU-B9	1402.8809.02	Baseband Generator
AMU-B10	1402.5300.02	Baseband Generator
AMU-B11	1402.5400.02	Baseband Generator
AMU-B13	1402.5500.02	Basisband Grundmodul
AMU-B14	1402.5600.02	Fading Simulator
AMU-B15	1402.5700.02	Fading Simulator Extension
AMU-B16	1402.5800.02	Differential I/Q Outputs
AMU-B18	1402.6006.02	Digital I/Q Output
AMU-B81	1402.6858.02	Rear Panel Connectors

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN 61010-1 : 2001
EN 61326 : 1997 + A1 : 1998 + A2 : 2001 + A3 : 2003
EN 55011 : 1998 + A1 : 1999 + A2 : 2002, Klasse B
EN 61000-3-2 : 2000 + A2 : 2005
EN 61000-3-3 : 1995 + A1 : 2001

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 2007

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

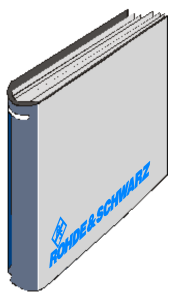
Munich, 2007-02-19

Central Quality Management MF-QZ / Radde

Contents of User Documentation for the Baseband Signal Generator and Fading Simulator R&S AMU 200A

The user documentation describes the Baseband Signal Generator and Fading Simulator R&S AMU 200A and all options. It includes a printed Quick Start Guide and a CD-ROM with the complete operating and service manual in printable pdf-format.
The R&S AMU is equipped with a context-sensitive online help that offers a help page for each instrument function.

Quick Start Guide

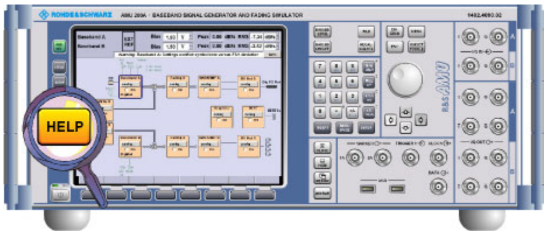


The present quick start guide describes everything that is needed to put the instrument into operation and to get familiar with the generator. The quick start guide gives an introduction to remote control and manual control via external monitor, mouse and keyboard.

The quick start guide is subdivided into the data sheet plus 3 chapters plus index:

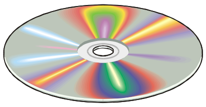
The data sheet	informs about specifications and characteristics of the instrument.
Chapter 1	Describes the control elements and connectors on the front and rear panel as well as all procedures required for putting the instrument into operation.
Chapter 2	Gives an introduction the operating concept and typical applications of the R&S AMU.
Chapter 3	Describes key operating modes, the structure of the graphical interface and the principles of manual control.
Index	Contains an index of the quick start guide.

Help System



The help system is embedded in the instrument, offering quick, context-sensitive reference to the information needed for operation and programming. The help contains the complete user documentation for the Signal Generator including the contents of the present quick start guide.
The help files (*.chm) are also available on the CD-ROM and can be used as a standalone help.

Documentation CD-ROM

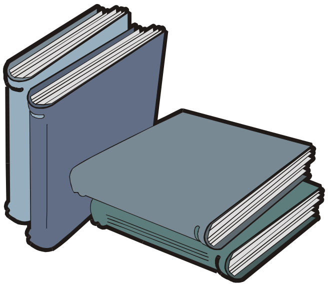


The CD-ROM provides the complete user documentation for the Signal Generator:

- The online help system (*.chm).
- The complete operating manual and service manual in printable form (*.pdf).
- The data sheet (brochure and specifications) in printable form.
- Links to different useful sites in the R&S internet.

Note: *Please use the ADOBE® Acrobat® Reader for PDF files and the browser Internet Explorer® ≥ 4.0 for the HTML help.*

Optional Documentation



The printed version of the operating and service manual provides the contents of the quick start manual plus the complete reference and the service information for the Signal Generator. This manual can be ordered as an option (stock no. 1402.5222.32 (English - A4 format) or 1402.5222.39 (English - letter format)); see ordering information in the data sheet.

Note: *The CD-ROM contains the *.pdf version of the manuals.*

Operating Manual

The operating manual contains comprehensive information about the instrument functions and remote control, in addition to the chapters of the quick start guide. It includes information about maintenance of the instrument and about error detection listing the error messages which may be output by the instrument. It is subdivided into 10 chapters:

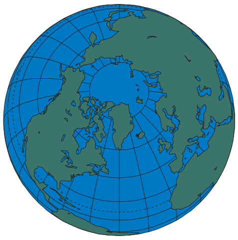
The data sheet	informs about specifications and characteristics of the instrument.
Chapter 1	Describes the control elements and connectors on the front and rear panel as well as all procedures required for putting the instrument into operation.
Chapter 2	Gives an introduction to the operating concept and typical applications of the R&S AMU.
Chapter 3	Describes key operating modes, the structure of the graphical interface and the principles of manual control.

Chapter 4	Forms a reference for manual control of the R&S AMU and contains a detailed description of all instrument functions and their application. The chapter also lists the remote control command corresponding to each instrument function.
Chapter 5	Describes the basics for programming the R&S AMU, command processing and the status reporting system.
Chapter 6	Lists all the remote-control commands defined for the instrument.
Chapter 7	-
Chapter 8	Describes preventive maintenance and the characteristics of the instrument's interfaces.
Chapter 9	Gives the status messages and a list of error messages that the R&S AMU may generate.
Chapter 10	Contains an index of the operating manual.
Annex	Describes all Digital Standards supported by the R&S AMU. Contains the remote-control commands and indices of each standard.

Service Manual Instrument

The service manual - instrument informs on how to check compliance with rated specifications, on instrument function, repair, troubleshooting and fault elimination. It contains all information required for the maintenance of R&S AMU by exchanging modules. In addition it describes how to perform a firmware update and how to install options.

Internet Site



The Rohde & Schwarz internet site: http://www.rohde-schwarz.com/product/amu200A.html provides the most up to date information on the R&S AMU. Additonally firmware updates including the associated release notes, instrument drivers current data sheets and application notes are provided for download on the internet site.

The current operating manual at a time is available as printable PDF file in the download area.

Contents - Chapter 1 "Putting into Operation"

1 Putting into Operation

Introduction - Putting into Operation

Chapter 1, "Putting into Operation" explains the control elements and connectors of the R&S AMU 200A Baseband Signal Generator and Fading Simulator with the aid of the front and rear views and describes how to put the instrument into operation. It also describes the connection of peripherals such as keyboard, mouse and monitor. A detailed description of the device interfaces is given in chapter, "*Maintenance and Remote Control Interfaces*". Specifications of interfaces can be seen in the data sheet.

Chapter 2, "*Getting Started*" gives an overview of generator functions and introduces the operating concept. Detailed operating instructions and an overview of menus follow in chapter 3, "*Manual Operation*".

The complete manual on the CD-ROM in printable pdf-format provides chapters 4 to 9: Menus and instrument functions are described in detail in chapter 4, "*Instrument Functions*", basics of remote control of the instrument in chapter 5, "*Remote Control - Basics*" and commands for remote control in chapter 6 "*Remote Control - Commands*". Chapter, "*Error Messages*" contains a list of possible status and error messages.

Legend for Front Panel View

This section gives an overview of the control elements and the connectors on the front panel of the R&S AMU. Each element/connector is briefly described and a reference is given to the chapters containing detailed information. Connectors designated for one of the two paths are labeled with the accordant letter A or B (path A, path B). Not especially labeled connectors are affected to both paths.

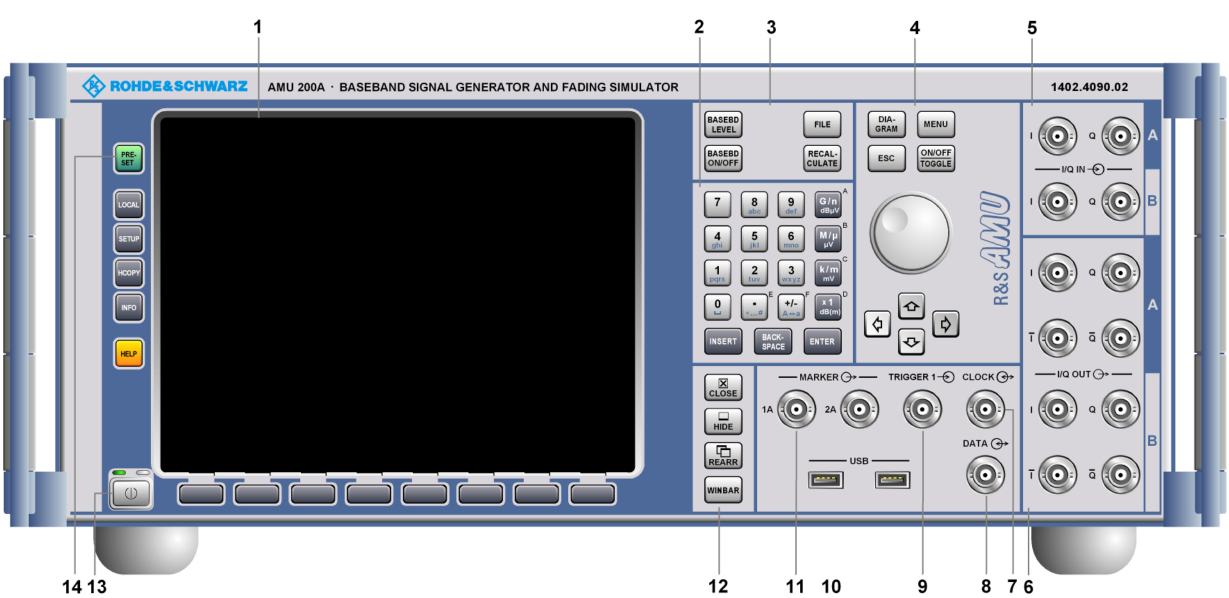
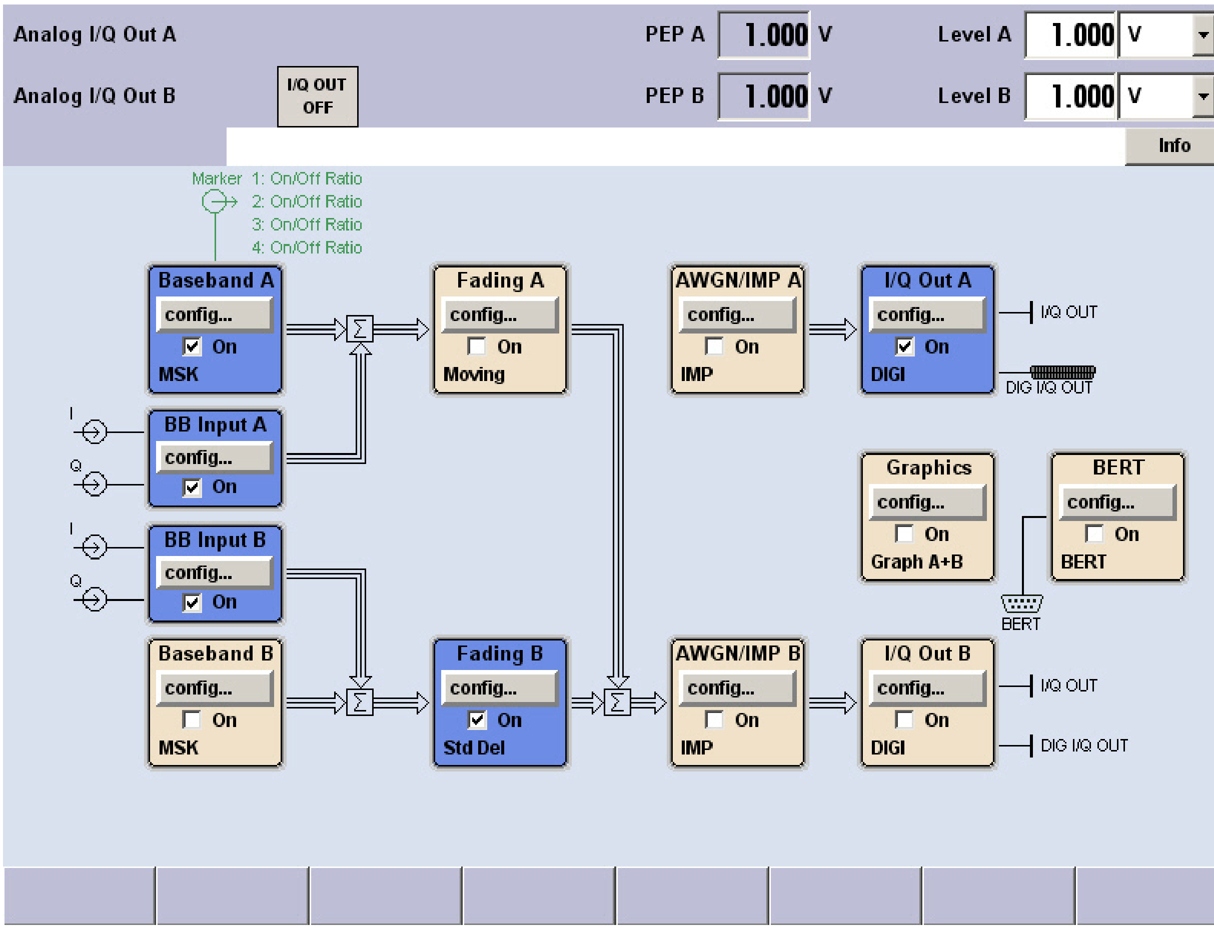


Figure 1-1 Front panel view

1 Display



Display	The display shows all main settings and states of the instrument. The display is divided into three sections: – the **status bar** with the main system parameters, level settings and an info line, – the **block diagram** with the current configuration, – the **winbar** with labeled soft keys.	See chapter 3, section "*Display*"
Status bar	The status bar – gives a survey of the current state of the system. – coveres information on level settings containing peak envelope power (PEP). – enables the user to set the main parameters directly. – shows brief error messages in the info line. ***Note:*** *Detailed information on a message can be called with the* INFO *key.*	See chapter 3, section "*Display*"

Block diagram	The block diagram shows the current configuration and the signal flow in the generator with the aid of function blocks containing an on/off switch. Clicking the function block opens a list of associated setting menus. Active menus, info windows and graphs are displayed on top of the block diagram. ***Note:*** *Anytime the block diagram can be displayed in the foreground with the DIAGRAM key.*	See chapter 3, section "*Display*"
Winbar	Open menus are indicated by a labelled button in the winbar. The buttons determine the softkey functions for front-panel control. When a button or softkey is pressed, the associated menu is displayed either in the foreground or minimized in the winbar. If required, the winbar is covered by a row of buttons to which menu-specific functions of the active menu are assigned. ***Note:*** *By pressing the WINBAR button, the winbar can be displayed in the foreground again. This allows the user to toggle between the button and the softkey functions.*	See chapter 3, section "*Display*"

2 Keypad for data entry

Keys for data entry

0...9 Entry of numeric values

. Entry of decimal point

+/– Entry of sign

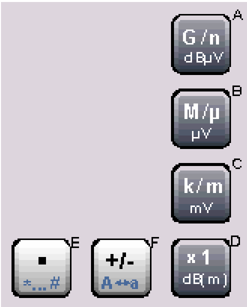
abc Entry of letters

_ Entry of a space

***... #** Entry of special characters

A ↔ a Switchover between uppercase and lowercase letters

See chapter 3, section "*Setting Parameters*"

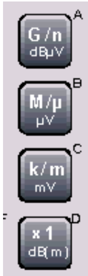


Keys for data entry

A, B, C, D, E, F
Entry of hexadecimal values. The letters assigned to the keys are automatically active when an entry field with a hexadecimal value is active.

See chapter 3, section "*Setting Parameters*"

2 Keypad for data entry



Keys for data entry

The unit keys can select **a unit** and thus determine the absolute value or **change the unit**, i.e. trigger a recalculation without changing the absolute value.

Their function depends on the time at which they are pressed during parameter entry:

Selecting the unit

If a unit key is pressed immediately after a numeric value has been entered, it terminates the entry and determines the multiplication factor for the respective basic unit (e.g. the k/m mV key determines the unit kHz after frequency entry). For level entries, the unit indicated on the unit key is used (e.g. the k/m mV key determines the unit mV after level entry).

Changing the unit

If a numeric entry is terminated with ENTER (e.g. by clicking on the rotary knob) and not with a unit key, the unit displayed in the unit field of the parameter in the menu is assigned. If the unit key is pressed later, the unit is changed but not the value. The value is recalculated to suit the new unit (e.g. the display changes from 1000 to 1 when Hz is changed to kHz). The new unit then is indicated in the value field of the menu.

See chapter 3, section "*Selecting a Unit - Setting Parameters*"

2 Keypad for data entry

Keys for data entry

Assignment

G/n Giga/nano

dBµV inactive

M/µ Mega/micro

µV µV for levels

k/m kilo/milli

Mv mV for levels

x1 basic unit (x1)

dB(m) V for levels

same function as ENTER key for unit-free values

Note:
The unit key G/n selects the exponent Giga or nano of the unit. The unit key x1 confirms the entries in the base unit and values without a unit. The units dbµV and dBm are inactive.

See chapter 3, section "*Selecting a Unit - Setting Parameters*"

Keys for data entry

INSERT

Toggels between insert and overwrite mode.

BACKSPACE

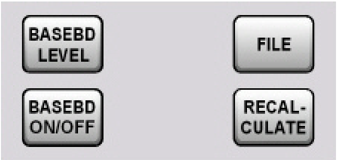
Deletes the character to the left of the cursor.

ENTER

– Calls the next menu level.
– Activates the editing mode for highlighted numeric and alphanumeric parameters.
– Terminates a data entry; the new value is set.
In case of numeric parameters, the unit indicated next to the value in the menu applies.
– Switches highlighted status parameters on and off (on/off state).
– Confirms (OK) and closes message windows.

See chapter 3, section "*Setting Parameters*"

3 Keys for setting parameters



Keys for setting parameters

BASEBD LEVEL

Activates the baseband level entry.
In the two-path mode, the baseband level entry field that was active last is activated. Pressing the key again activates the baseband level entry for the second path.

FILE

Activates a menu for storing or loading the settings of the instrument. Pressing the key again closes the dialog.

BASEBD ON/OFF

Switches the Baseband signal on and off.
In the two-path mode, the BASEBD ON/OFF key switches all signals off. A second stroke restores the status that was active before the last switch-off.
I/Q OUT OFF is displayed in the status bar.

RECALCULATE

Starts the recalculation of the instrument settings. If time-consuming calculations are required, the active signal generation is automatically switched off and the calculation is interrupted to allow the user to make further settings. Calculation is restarted by a keystroke and the signal generation is switched on again after the calculation is completed.

See chapter 3, section "*Setting Parameters*"

4 Keys for settings and navigation in the display

Keys for settings in the display

DIAGRAM

Brings the block diagram to the foreground. Active menus are minimized. Active menus are indicated by the buttons in the menu bar.

MENU

Calls the menu tree.

ESC

– Calls the next higher selection level. This opens up the following functions:

– Closes the active menu if the cursor is in the top-level menu (parameter selection).
If settings in this menu require acknowledgement by means of an **Accept** button, a query is displayed asking whether the changes made should be cancelled.

– Switches between different entry fields of a menu.

– Quits the editing mode and restores the previous value. This function is only available in the editing mode, i.e. only before an entry is confirmed or selected with Enter.

– Cancels queries in message windows.

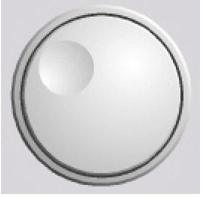
– Shifts the entry cursor from the frequency or level display to the previously active menu or to the previously highlighted block in the block diagram if no menu is active.

ON/OFF TOGGLE

– Switches highlighted elements or a function block on and off.

– Switches between two or more settings, e.g. items of selection lists. At the end of a list, the cursor is set on the first entry again.

See chapter 3, section "*Setting Parameters*"



Keys for settings and navigation in the display

Rotary knob

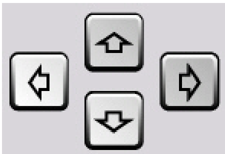
– Varies the value at a cursor position.

– Moves the entry cursor in the block diagram or menu.

– Moves the cursor in tables and selection lists.

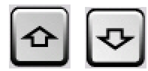
– Clicking on the rotary knob (= Enter) terminates entries. In this case the entry mode is terminated and the value set.

See chapter 3, section "*Setting Parameters*"

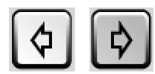


Keys for settings and navigation in the display

Arrow keys



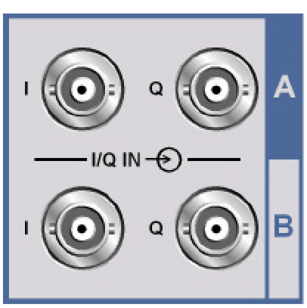
– Vary the entry value
– Highlight a selected list item in the editing mode
– Highlight parameters in menus and tables (up/down)



– Move the cursor in the entry fields (editing mode)
– Highlight parameters in menus and tables (left/right)

See chapter 3, section "*Setting Parameters*"

5 I/Q IN – Input path A and path B



I/Q IN

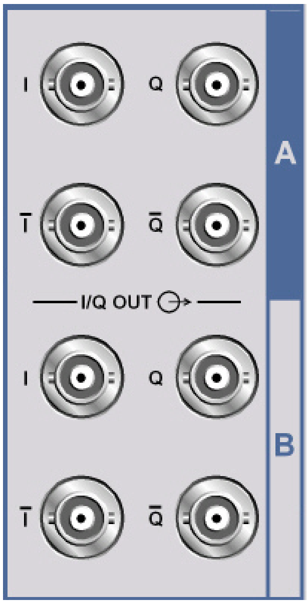
Input for external analog baseband signal (option R&S AMU-B17, Baseband Input).

See data sheet

and chapter 4, sections "*Data and Signal Sources in Baseband*"

and "*Baseband Input Settings Menu*"

6 I/Q OUT – Output path A and B



I/Q OUT

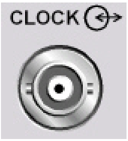
Direct output or differential (non-inverting) output of the analog I/Q signal (option R&S AMU-B16 for differential output).

See data sheet

and chapter 4, sections "*Data and Signal Sources in Baseband*"

and "*Baseband Input Settings Menu*"

7 CLOCK – Clock input and output



CLOCK

– Input for external clock signal (bit or symbol clock, multiple of symbol clock) for synchronizing the external data signal in case of multivalent modulation. The active edge can be set (path A only).

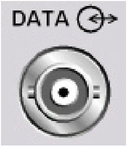
– Output for clock signal (bit or symbol clock) in the internal mode (path A only).

See data sheet

and chapter 4, sections "*Data and Signal Sources in Baseband*"

and "*Baseband Input Settings Menu*"

8 DATA – Data input and output



DATA

– Input for external serial data signal in case of digital modulation (path A only)

– Output for serial data signal in case of digital modulation (path A only)

See data sheet

and chapter 4, sections "*Data and Signal Sources in Baseband*"

and "*Baseband Input Settings Menu*"

9 TRIGGER1 – Trigger input

TRIGGER 1 Input for external triggering of digital modulations, standards and ARB. (switchable to path A or/and path B).

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

10 USB – Female USB connectors Type A

USB

– USB (universal serial bus) interfaces of type A (host)
– Connection of peripherals such as mouse, keyboard and printer
– Connection of memory stick for file transmission
– Firmware update

Note:
Further USB interfaces are available:
2 USB interfaces type A (USB1.1 and USB 2.0) on the rear panel and
1 USB interface of type B (device USB for transmission and remote control) on the rear panel.

See chapter 1, section "*Connecting a Mouse*"

and chapter 8, section "*USB Connection (USB and USB IN)*"

11 MARKER 1A and MARKER 2A – Trigger inputs and outputs

MARKER 1A/2A

Output 1 and 2 for triggering and control of external devices with user-definable marker signals.

Marker signals 1 to 3 are permanently assigned to the outputs; marker signal 4 can be routed to one of the four USER outputs.

Path A

Marker 1, 2:
BNC connectors MARKER 1A/2A on the front panel or on the rear panel.

Marker 3:
MARKER 3A pin of the AUX I/O connector on the rear panel.

Marker 4:
BNC connector USER 1 or USER 2/3/4 pins of the AUX I/O connector on the rear panel.

Path B

Marker 1, 2:
BNC connectors MARKER 1B/2B on the rear panel.

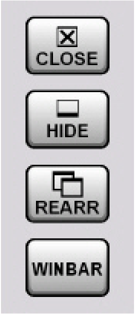
Marker 3:
MARKER 3B pin of the AUX I/O connector on the rear panel.

Marker 4:
BNC connector USER 1 or USER 2/3/4 pins of the AUX I/O connector on the rear panel.

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

12 Keys for setting the display



Keys for menu operation

CLOSE

– Closes the currently active menu.

– If the entry mode is active, changes are cancelled.

If settings in this menu require acknowledgement by means of an **Accept** button, a query is displayed asking whether the changes made should be cancelled.

HIDE

Minimizes the active open menu. The associated button in the winbar remains visible.

REARR

Automatic rearrangement of open menus.

WINBAR

Toggles between display and blanking of the winbar.

Note:

*The **winbar** is the bar at the bottom of the display. The winbar indicates open menus by a labeled button. When a button is clicked using the rotary knob, the associated menu is displayed either in the foreground or minimized in the winbar.*
*The **winbar** can be called with the* WINBAR *key.*

See chapter 3, section "*Menu Operation*"

13 Switch

The **ON/STANDBY switch** switches the instrument from the standby mode to the operating mode, provided that the **Power switch** at the instruments´ rear panel is switched on.

The yellow LED at the top right of the switch indicates the **STANDBY** mode;
the green LED at the top left indicates that the instrument is ready for operation (**ON**).

See chapter 1, section "*Switching On*"

CAUTION

Danger of shock hazard!

The instrument is still power-supplied while it is in standby mode.

14 Keys for general instrument settings

PRESET

Sets the instrument to a defined state.

LOCAL

Switches from REMOTE control to LOCAL (manual) control.

SETUP

Opens the setup menu for configuring presetting.

HCOPY

Opens the print menu for configuring and starting printing.

INFO

Activates the display of status messages, error messages and warnings.

HELP

Activates the context-sensitive help display.

See chapter 4, section "*General Instrument Settings*"

Legend for Rear Panel View

This section gives an overview of connectors on the rear panel of the R&S AMU. Each connector is briefly described and a reference is given to the chapters containing detailed information. For technical data of the connectors refer to the data sheet.

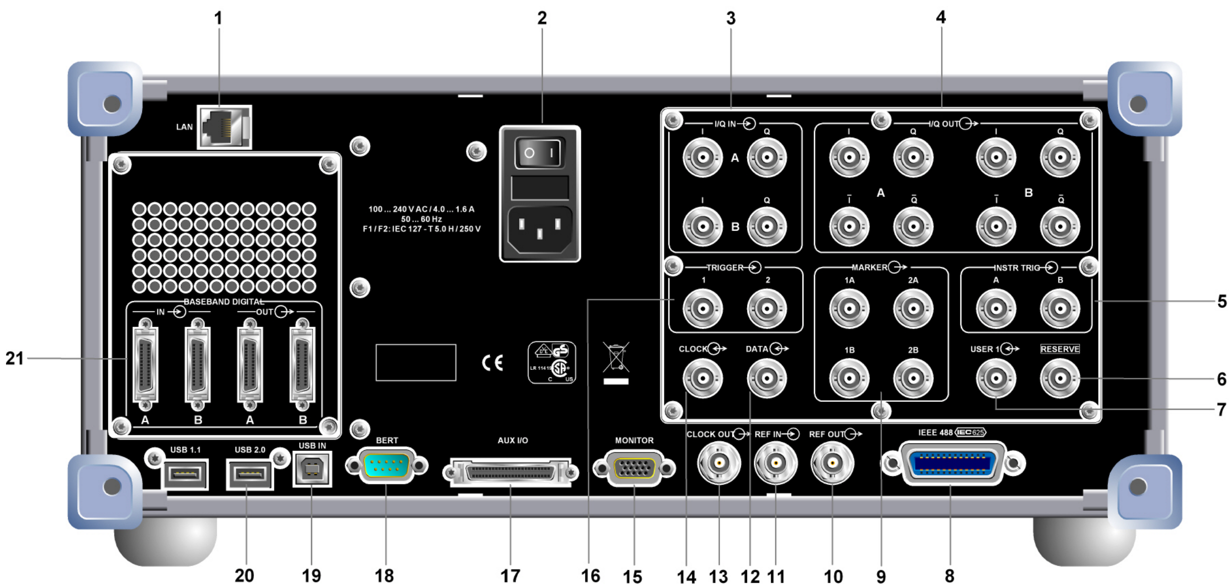
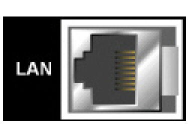


Fig. 1-2 Rear panel view

1 LAN interface

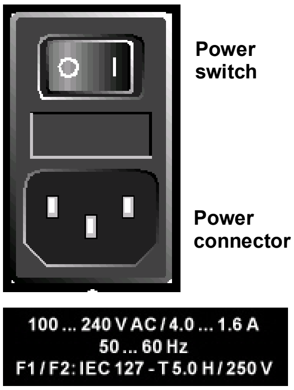


LAN Ethernet interface for

- Integrating the R&S AMU in a network
- Remote control of the R&S AMU
- Input of external asynchronous data
- Manual remote control of the R&S AMU
- Firmware update

See data sheet and chapter 1, section "*Connecting the R&S AMU to a Network (LAN)*", chapter 8, section "*LAN Connector*" and chapter 5, section "*Remote Control via LAN Interface*"

2 AC supply



Power switch

After pressing the power switch at the rear of the instrument to position **I**, the instrument is either in operating (ON) mode or ready for operation (STANDBY). The current mode depends on the position of the **ON/STANDBY** switch at the instruments´ front panel.

AC power connector

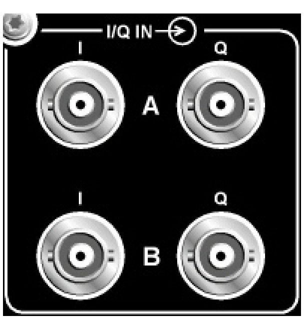
When the R&S AMU is connected to the AC supply, it automatically sets itself to the correct range for the applied voltage (range: see type label). There is no need to set the voltage manually.

See data sheet

and chapter 1, section "*Connecting the R&S AMU to the AC Supply"*

and "*Switching On"*

3 I/Q IN - Signal input



I/Q IN

Input for external analog baseband signal (option R&S AMU-B17, Baseband Input).

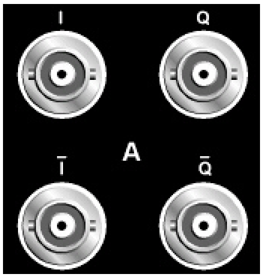
Rear panel connectors for path A and path B (option R&S AMU-B81). This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.).

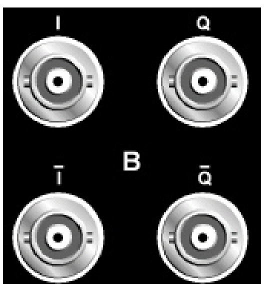
See data sheet

and chapter 4, sections "*Data and Signal Sources in Baseband"*

and "*Baseband Input Settings Menu*"

4 I/Q OUT- Signal output





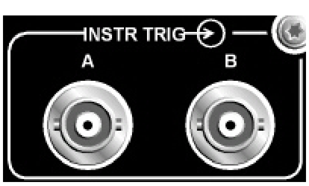
I/Q OUT

Direct output or differential (non-inverting) output of the analog I/Q signal (option R&S AMU-B16 for differential output).
Rear panel connectors for path A and path B (option R&S AMU-B81) . This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.).

See data sheet

and chapter 4, section "*Impairment of Digital I/Q Signal*"

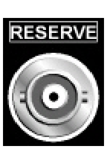
5 INSTR TRIG - Instrument triggering



INSTR TRIG A/B

BNC connectors reserved for future extensions.

6 RESERVE



RESERVE

BNC connectors reserved for future extensions.

7 USER1 - USER connector

USER 1

Input/output for configurable signals for triggering and control.

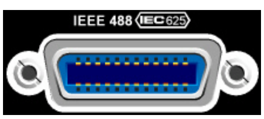
The following signals can be applied to the connector:

– Marker 4 (path A/B)
– Clock Out (path B, bit or symbol)
– CW mode Out (path A/B)
– No signal (blank) marker (path A/B)

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

8 IEEE 488 - IEC/IEEE bus connector



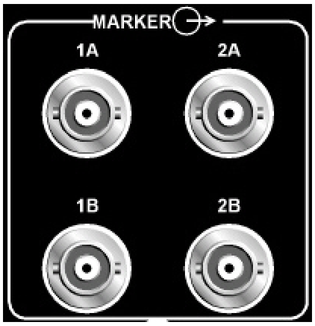
IEC 625/IEEE 488

IEC bus (IEEE 488) interface for remote control of the R&S AMU.

See data sheet

and chapter 8, section "*IEC/IEEE Bus Interface"*

9 Marker 1A/2A, 1B/2B – Marker Outputs



MARKER 1A/2A, 1B/2B

Output 1 and 2 for triggering and control of external devices with user-definable marker signals.

Rear panel connectors for path A and path B (option R&S AMU-B81). This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.).

Marker signals 1 to 3 are permanently assigned to the outputs; marker signal 4 can be routed to one of the four USER outputs.

Path A

Marker 1, 2:
BNC connectors MARKER 1A/2A on the front panel or on the rear panel.

Marker 3:
MARKER 3A pin of the AUX I/O connector on the rear panel.

Marker 4:
BNC connector USER 1 or USER 2/3/4 pins of the AUX I/O connector on the rear panel.

Path B

Marker 1, 2:
BNC connectors MARKER 1B/2B on the rear panel.

Marker 3:
MARKER 3B pin of the AUX I/O connector on the rear panel.

Marker 4:
BNC connector USER 1 or USER 2/3/4 pins of the AUX I/O connector on the rear panel.

MARKER 1A and 2A outputs are intended for future upgrades (option R&S AMU-B81).

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

10 REF OUT – Reference signal output

REF OUT

Output of the internal analog reference signal.

See data sheet

and chapter 4, section "*Setup Reference Oscillator*"

11 REF IN – Reference signal input

REF IN

Input for an external analog reference signal (the external reference is used for both paths).

See data sheet

and chapter 4, section "*Setup menu*"

12 DATA – Data input and output

DATA

– Input for external serial data signal in case of digital modulation (path A only)

– Output for serial data signal in case of digital modulation (path A only)

Rear panel connector for path A and path B (option R&S AMU-B81). This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.)

See data sheet

and chapter 1, section "*Setting up the Instrument or Installing it in a 19" Rack*"

13 CLOCK OUT – Clock signal output

CLOCK OUT

Output for the internal clock signal (bit or symbol) of path A, the internal clock signal of path B can be output at one of the USER interfaces.

See data sheet

and chapter 4, section "*Data and Signal Sources in Baseband*"

14 CLOCK – Clock signal input and output

CLOCK

– Input for external clock signal (bit or symbol clock, multiple of symbol clock) for synchronizing the external data signal in case of multivalent modulation. The active edge can be set (path A only).

– Output for clock signal (bit or symbol clock) in the internal mode (path A only).

Rear panel connectors for path A and path B (option R&S AMU-B81). This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.)

See data sheet

and chapter 4, section "*Data and Signal Sources in Baseband*"

and "*Baseband Input Settings Menu*"

15 Monitor

MONITOR

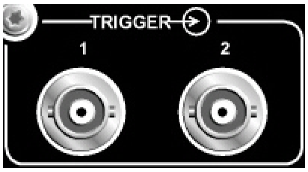
Connector for external monitor

See data sheet

and chapter 1, section "*Connecting an External Monitor*"

and chapter 8, section "*Monitor Connector (MONITOR)*"

16 TRIGGER – Trigger input



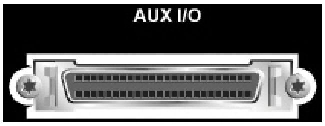
TRIGGER 1/2

– Input for external triggering of digital modulations, standards and ARB (switchable to path A and/or path B).

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

17 AUX I/O – Data interface



AUX I/O

Parallel input/output for data signals as well as settable trigger and control signals of the baseband.

Note:

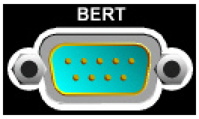
The assignment of the AUX I/O interface, the USER pins and the arbitrary assignment of pins to path A or to path B can be configured in the **Setup** *menu under:*
Environment - USER Marker / AUX I/O Settings*.*

An adapter of the AUX I/O interface to coaxial BNC connectors is available as an accessory (R&S SMU-Z5, see data sheet).

See data sheet

and chapter 4, section "*Global Trigger/Clock/Input Settings – Setup – Environment*"

18 BERT – Bit error rate tester



BERT (**B**it **E**rror **R**ate **T**ester) input

Input for data, clock and control signals for bit and block error rate measurements, level 0.0128..1.998V. See chapter 8 for pin assignment.

See data sheet

and chapter 4, section "*Bit and Block Error Rate Measurements - BERT Block"*

and chapter 8, section "*BERT Connector*"

19 USB IN – USB interface type B

USB

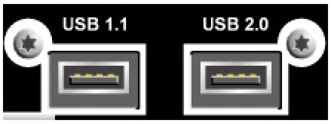
(universal serial bus) interface of type B (device USB). This port is reserved for future extensions.

Note:

Further USB interfaces are available:
2 USB interfaces type A (master USB) on the front panel and
2 USB interfaces type A (USB1.1 and USB 2.0) on the rear panel.

See chapter 8, section "*USB Connection (USB and USB IN)"*

20 USB 1.1/2.0 – USB interfaces Type A



USB

(universal serial bus) interfaces of type A (host USB 1.1 and USB 2.0).

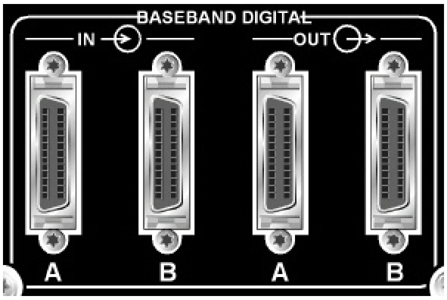
– Connection of peripherals such as mouse, keyboard, printer
– Connection of memory stick for file transmission
– Firmware update

Note:
Further USB interfaces are available:
2 USB interfaces type A (master USB) on the front panel and
1 USB interface of type B (device USB) on the rear panel.

See chapter 1, section "*Connecting a Mouse*"

and chapter 8, section "*USB Connection (USB and USB IN)*"

21 Baseband Digital IN/OUT – Digital interface



BASEBAND DIGITAL IN/OUT

– Input for external digital I/Q signal (BBIN) in case of digital modulation (option R&S AMU-B17, Baseband Input (digital/analog)).
– Output of the digital I/Q signal (BBOUT) (option R&S AMU-B18 Digital I/Q Out).

Note:
A further digital I/Q signal input requires a second option R&S AMU-B17, Baseband Input (digital/analog). Respectively, two-path instruments require a second option for digital I/Q output (option R&S AMU-B18, Digital I/Q Out).
A cable for the connection to the digital interface BBIN/BBOUT is available.
The associated cable has the order number ***14526-EZHB-xxx-0QC****.*
xxx stands for the length in meters. For example, a cable of this type having a length of two meters is available under R&S part number 1402.4990.00.

Putting into Operation

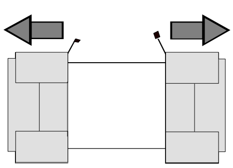
The following section describes the procedure for putting the instrument into operation. It contains general safety instructions for instrument operation.

The installation of options and the firmware update are described in chapter 4 of the Service Manual (supplied with the instrument on the CD-ROM).

CAUTION

Instrument damage caused by disregarding the precautions!
Make sure to follow the instructions of the following sections in order not to endanger to people or to avoid damage to the instrument. This is of particular importance when you use the instrument for the first time. Also observe the general "*Safety Instructions*" of this manual.

Unpacking the Instrument



Remove protective covers

– Remove the instrument from its packaging and check the equipment for completeness using the delivery note and the accessory lists for the separate items.

– Remove the two protective covers from the front and rear panel of the R&S AMU and carefully check the instrument for damage.

– If there is damage, immediately contact the carrier who delivered the instrument. In this case, make sure not to discard the box and packing material.

– Keep the box and packing material until you have verified that the contents are complete and until the R&S AMU has been tested electrically and mechanically.

– The original packaging is also useful for transporting or shipping the R&S AMU later on. Keep at least the two protective covers to prevent control elements and connectors from being damaged.

Setting up the Instrument or Installing it in a 19" Rack

The instrument is designed for indoors use. It can either be set up independently or mounted in a 19" rack.

Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders (refer to data sheet for Order No.). The mounting instructions are supplied with the adapter. With the option R&S AMU-B81 (Rear panel connectors, factory-fitted) the front panel inputs and outputs are relocated to the rear panel.

CAUTION

Risk of overheating!
To less airflow for cooling may cause overheating of the instrument.

Prior to putting the instrument into operation always check for space between the ventilation holes and the rack casing to get sufficient air supply in the rack.

Safety Instructions

General Precautions

CAUTION

Instrument damage caused by disregarding the following precautions!
Any non-compliance with the following precautions may cause damage to the instrument. Prior to putting the instrument into operation, check the following:

– The covers of the housing are in place and screwed on.

– Vents are not obstructed. Make sure that the air can escape freely through the vents at the rear and at the sides. The minimum distance to the wall should therefore be at least 10 cm.

The signal levels at the inputs do not exceed permissible limits.

The outputs of the instrument are not overloaded or incorrectly connected.

– The instrument should only be operated in horizontal position on an even surface.

– The ambient temperature must not exceed the range specified in the data sheet.

Please also observe the instructions in the following sections and the general safety instructions at the beginning of this manual.

Protection against Electrostatics

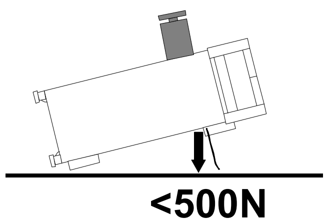
To avoid damaging the electronic components of the EUT due to electrostatic discharge produced by contact, the use of appropriate protective measures is recommended.

Setting up the Instrument

WARNING

Safe operation with support feet!

- Stacked **instruments** may slip off.
  Secure stacked instruments against slipping (e.g. by locking the feet to the top of the front-panel frame).
  The feet must be fully folded in or folded out. Only then a stable position of the instrument and reliable operation can be ensured. The uniform pressure on the folded-out feet must not exceed 500 N (weight of instrument and of equipment stacked on top).
- When the instrument with expanded feet, the feet might collapse and fold in.
  Do not shift the instrument with the feet out.



Cleaning the Outside and Storing

What is necessary is essentially the cleaning of the instrument.

ATTENTION

Instrument damage caused by cleaning agents!

Cleaning agents contain substances that may damage the instrument, e.g. solvent-containing cleaning agents may damage the front panel labeling or plastic parts.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument is suitably cleaned using a soft, line-free dust cloth.

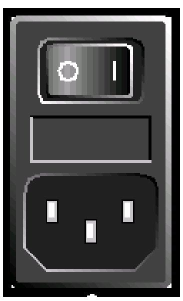
EMC Safety Precautions

To avoid electromagnetic interference (EMI) only suitable, double shielded signal and control cables must be used. Lines have to be terminated with 50 Ω. Outputs like REF IN/OUT , CLOCK IN/OUT TRIG/NEXT and MARKER connectors, as well as USB devices must be used to keep within permissible EMI limits.

Connecting the R&S AMU to the AC Supply

The AC supply connector is at the rear panel of the unit. When the R&S AMU is connected to the AC supply, it automatically sets itself to the correct range for the applied voltage (range: see type label on the rear panel). There is no need to set the voltage manually or change fuses for connecting.

Power Fuses



Fuse holder

The R&S AMU is fully fused by two fuses IEC127-T5H/250 V. The fuses are accommodated in the pull out fuse holder next to the power connector.
Before replacing the fuses, disconnect the power cord from the R&S AMU. The fuse box is locked mechanically as long as a power connector is plugged in.

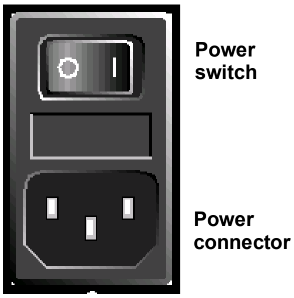
DANGER

Shock hazard!

For Fuse replacement, ensure that the instrument is switched off and disconnected from the power supply by removing the plug from the AC and DC Power connector.

Fuse replacement
Replace fuses only with type and rating specified on the rear panel.
Use two screwdrivers simultaneously to lift the fuse holder below the power connector and pull it out.

Switching On



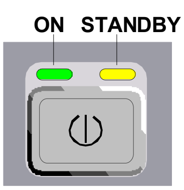
– Connect the R&S AMU to the AC supply by means of the supplied power cable.

Since the instrument is in compliance with the safety class EN61010-1, it only should be connected to a socket with a protective earthing contact.

– Press the **Power switch** at the rear of the instrument to position **I**.

After power-up, the instrument is either in operating (ON) mode or ready for operation (STANDBY). The current mode depends on the position of the **ON/STANDBY** switch at the instruments´ front panel (see description below).

Note:
The power switch may remain on for any period of time. Switching off is required only if the instrument ought to be isolated from the AC supply completely.



– Press the **ON/STANDBY switch** on the front panel.
The green LED at the top left of the switch indicates that the instrument is ready for operation (**ON**).

The instrument is ready for operation.
All modules inside the instrument are supplied with power.

Note:
*The yellow LED at the top right of the switch indicates the **STANDBY** mode.*

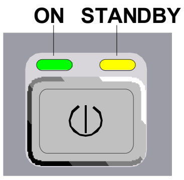
Start Display and Booting the R&S AMU

After the instrument is switched-on, the installed BIOS version and the processor characteristics are indicated for a few seconds in the start display.

The booting of the Windows XP operating system and the firmware of the instrument are executed in rotation. During the booting of the instrument firmware, a selftest is performed. After booting is completed, the block diagram of the R&S AMU is displayed and the instrument is ready to be operated. The settings that were active before the last switch-off are established unless another start setting has explicitly been selected in the **File** menu.

Note:
If the software stops unexpectedly, the instrument can be shut down by pressing the STANDBY key for approx. 5 s.

Switching Off



– Press the **ON/STANDBY switch** on the front panel.
The R&S AMU stores the current settings on the hard disk before it shuts down the Windows operating system. Then the AC supply is switched to the **STANDBY** mode.

The yellow LED must be on.
Only the AC supply is powered and the oven-controlled crystal oscillator is kept at operating temperature.

CAUTION

Danger of shock hazard!

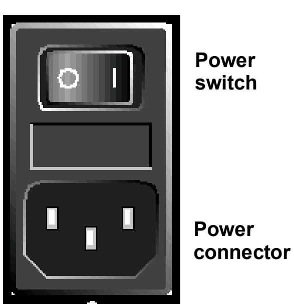
The instrument is still power-supplied while it is in standby mode.
It is recommended:

– **first** to switch the instrument to **STANDBY** mode

– before completely disconnecting it from the AC supply.

If the power is disconnected before the instrument is switched to the standby mode, all current settings will be lost.

Do the following steps only if the instrument is completely disconnected from the AC supply:



– Press the main power switch at the rear of the instrument to position **O**.
None of the front-panel LEDs should be on.

Note:
*Make sure that the instrument is set to **STANDBY mode** before switching off the power. If the power switch is set to O before the instrument is switched to the standby mode, all current settings will be lost.*

Function Check

The R&S AMU automatically monitors the main functions when the instrument is switched on and continuously during operation.

If a fault is detected, ERROR is displayed in the info line together with a brief error description.

For in-depth identification of the error, press the INFO key. In response, a description of the error(s) is displayed (see chapter 9, "*Error Messages*").

In addition to the automatic monitoring of the instrument functions, the following features ensure the successful operation of the R&S AMU.

- **Internal Adjustments**
  Adjustments can be performed in the **Setup-System-Internal Adjustments** menu. Thus a maximum level accuracy can be obtained, for instance.
- **Test points**
  Internal test points can be queried by the user and the results can be displayed. See chapter 4, section "*Test Point... - Setup-Test*".

Default Settings

The instrument is set to a defined state with the PRESET key.

Reference frequency	internal, adjustment off
Offsets	0
Digital modulations	switched off
IEC/IEEE bus address	not changed

With PRESET, all parameters and switch states are preset, including those of deactivated operating modes.

Presettings beyond those in the above list can be seen from the *RST values of the associated IEC/IEEE bus commands.

Windows XP

CAUTION

Functions of the instrument may be impaired!

Using not specifically authorized software may impair instrument functions.

Drivers and programs used in the instrument under Windows XP have been adapted to the R&S AMU. Existing software **must only be modified** with update software released by Rohde & Schwarz. Likewise, **only programs authorized by Rohde & Schwarz** for use on the instrument **must be executed**.

The following program packages have been successfully tested for compatibility with the measurement instrument software:

- Windows XP Remote Desktop
- Symantec Norton AntiVirus – Virus-protection software

The R&S AMU is equipped with the Windows XP operating system. The configuration of the operating system is optimally adapted to the R&S AMU functions in the factory. Changes in the system setup are required if peripherals like keyboard and printer are connected or if the network configuration does not comply with the default settings (see section "*Connecting the R&S AMU to a Network (LAN)*").

After power-up of the R&S AMU, the operating system boots and the instrument firmware is started automatically without a password query (auto login).

Note:

Auto login is performed with the user name and the password "instrument". The standard user has administrator rights so that printer and network installations are possible.

The operating system only can be accessed if an external keyboard and/or a mouse is connected. Windows XP provides an on-screen keyboard that can be operated using a mouse, thus enabling operation by mouse only. An external keyboard is recommened for extensive entries.

System settings under Windows XP can be made in the **Start - Control Panel** menu (for required settings refer to the Windows XP manual and to the hardware description).
The Windows XP start menu opens by pressing the **Windows** key, which is located next to the Ctrl key or by pressing the CTRL-ESC keys in combination, which are located on the external/on-screen keyboard. In this menu the Windows XP programs can be called. Additionally some of the programs are placed as symbols in the windows task bar and can be directly called by double-clicking the associated symbol. The Windows XP desktop including the task bar is displayed by moving the mouse to the bottom of the display.

The instrument display containing the block diagram, the status bar (header) and the winbar is displayed in the foreground by double-clicking the **Block Diagram**, **Status Bar** and **Task Bar** buttons in the Windows task bar.

The R&S AMU does not contain a disk drive. Data is exchanged using a memory stick connected to a USB interface. An unused disk drive letter is automatically assigned to the memory stick. Data can be transferred in the Windows Explorer.

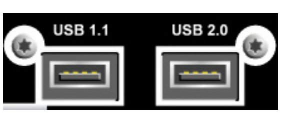
Energy saving mode:
An energy saving mode is a default setting in the R&S AMU. The hard disk switches to power-save mode if it is not accessed for 30 minutes. The energy-saving mode is exited by accessing the hard disk anew.

Connecting an External Keyboard

A commercial, external keyboard with an USB interface can be connected to the R&S AMU. A keyboard simplifies the entry of list items, comments, file names, etc. and is the prerequisite for a convenient operation of Windows XP.

USB interfaces

(front panel)



(rear panel)

Connection

– Plug in the keyboard to one of the USB interfaces of type A, either on the front panel or on the rear panel of the instrument.

The keyboard is detected automatically shortly after connection.
US keyboard assignment is the default setting.

Note:

*The keyboard assignment and special settings such as the refresh rate or language can be changed in the **Start - Control Panel – Keyboard** and the **Regional and Language Options** menu of Windows XP. The menu can be accessed by pressing the **Windows** key on the external keyboard.*

*A keyboard emulation menu can be executed in the Window XP operating system **START - Programs - Accessories - Accessibility - On-Screen Keyboard**. With the On-Screen Keyboard it is possible to manually operate the instrument using the mouse only.*

Connecting a Mouse

A commercial, external mouse with an USB port can be connected to the R&S AMU. A mouse simplifies the control of the block diagram and of associated menus. Using the on-screen keyboard (keyboard emulation) a mouse is required for operating in Windows XP.

USB interfaces

(front panel)

(rear panel)

Connection

– Plug in the mouse to one of the USB interfaces of type A, either on the front panel or on the rear panel of the instrument.

The mouse is detected automatically shortly after connection.

Note:

Special settings like mouse cursor, speed, etc., can be done done in the ***Start - Control Panel – Mouse*** *menu of Windows XP.*
The menu can be accessed by pressing the Windows key on the external keyboard.

Connecting an External Monitor

CAUTION

Overvoltage hazard!
Connecting a monitor while the instrument is switched on the monitor and instrument may be impaired.
A monitor **must not be connected** until the instrument is **switched off** (standby).
Do not modify the screen driver (Display type) and the display configuration since this will impair instrument operation.

An external monitor with an analog interface can be connected to the R&S AMU.

(rear panel)

Connection

– Switch off the instrument (STANDBY mode) before connecting an external monitor (see also section "*Switching Off*")

The yellow LED must be on.

– Plug in the monitor connector to the *MONITOR connector"* on the rear panel of the instrument.

– Switch on the instrument (ON mode) to start the R&S AMU.

The external monitor is detected automatically.
The entire display of the R&S AMU, containing the status bar, the block diagram and the winbar is displayed on the monitor additionally.

Further settings are not required.

Note:
The MONITOR interface is described in chapter 8, section "Maintenance and Interfaces"

Connecting the R&S AMU to a Network (LAN)

The R&S AMU is equipped with a network interface and can be connected to an Ethernet LAN (local area network).

Provided that the appropriate rights have been assigned by the network administrator and the Windows XP firewall configuration is adapted accordingly, files can be transmitted by using the network. Also network recources, e.g. network folders can be used. Additionally the instrument can be remote-controlled and manually controlled in the network.

Manual network control means that the user can operate the R&S AMU from any remote PC in the network via the **Remote Desktop** connection which is provided for Windows PCs or via the **Ultr@VNC** connection which is provided for Linux/Unix and Windows PCs. For instance, the user can control one or more R&S AMU instruments from a desk that is part of a test assembly located in another section of the building.

Remote control of the instrument via the LAN interface is described in chapter 5, section "*Remote Control via LAN Interface*". A firmware update via the LAN interface is described in chapter 2 of the Service Manual (on CD-ROM).

Connection to the Network

CAUTION

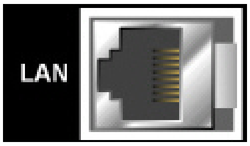
Risk of network errors!

Connecting errors may affect the entire network.

We recommend coordinating the connection of the instrument to the network with the network administrator.

Do not connect or disconnect the network cable until the instrument is **switched off** (standby). Only then the network connection can be reliably detected and impairments to instrument operation can be avoided.

LAN interface



(rear panel)

Connection

The instrument is connected to the LAN with the aid of a commercial cross-over RJ-45 cable suitable for a 10/100Mbps connection.

– Connect the instrument to the LAN interface on the rear panel of the instrument.

Note:

The LAN interface is described in chapter 8, "Maintenance and Interfaces".

Configuring the R&S AMU for Network Operation

The network interface functions with 10/100Mbps Ethernet IEEE 802.3u. The TCP/IP network protocol and the associated network services are preconfigured.

For data exchange in a LAN, each connected PC or instrument must be accessible via an IP address or via an unambiguous computer name. In addition, network access of the different users is organized by the assignment of access rights.
Access rights determine which of the available network resources, e.g. data logging systems, are available to the R&S AMU.

The Window XP operating system is protected by an activated firewall per default. The configuration of the firewall has to be adapted according to the required network communication needs.

Networks using DHCP
The R&S AMU is preconfigured for networks using DHCP (dynamic host configuration protocol). In these networks, an available IP address is automatically assigned to the R&S AMU. The generator is identified by an unambiguous computer name in the factory. This computer name can be queried and changed in the **Start - My Computer** menu of Windows XP (see "*Query Computer Name*").

Networks using fixed IP addresses
In networks using fixed IP addresses, the addresses are mostly assigned by the network administrator. A fixed IP address must be entered in the **Start - Control Panel** menu of Windows XP (see "*Entering the IP Address"*).

Point-to-Point Connection
To build a simple network – just an LAN connection between the R&S AMU and a controller without integration into a larger network – an IP address has to be assigned to the R&S AMU and the controller. For such purposes, the IP addresses 192.168.xxx.yyy are available .The value range for xxx and yyy is 1...254, the value for the subnet mask is always 255.255.255.0.
For this type of connection, a commercial cross-over RJ-45 cable is used.

User name and pass word
The user "**instrument**" is assigned to the R&S AMU. The user name is used for auto-login when the instrument is started and for manual remote control. The password is **"instrument"**. By assigning the respective rights, the network administrator decides which directories and resources in the network can be accessed by the R&S AMU.

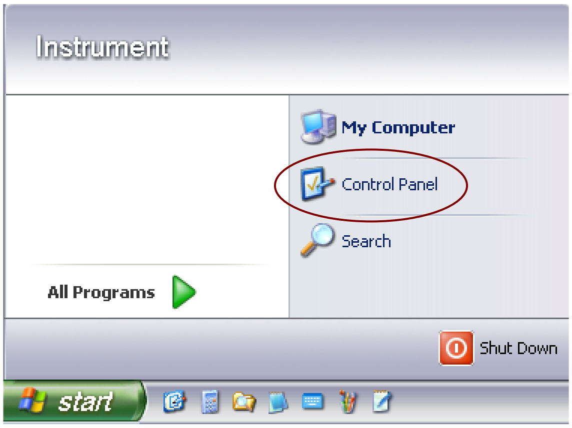
Preparations

The configuration of the R&S AMU for networking is performed in the Windows XP menus. The operating system can be accessed only if an external keyboard and/or a mouse are connected. Operating by mouse without using an external keyboard is possible only by using on-screen keyboard. To ensure all devices will be recognizied **Switch off** the instrument (STANDBY mode) before connecting the external devices (see also "*Switching Off"*).

1. Switch off the the instrument
2. Connect the external keyboard and/or the mouse to the USB interface.
3. Switch on the instrument

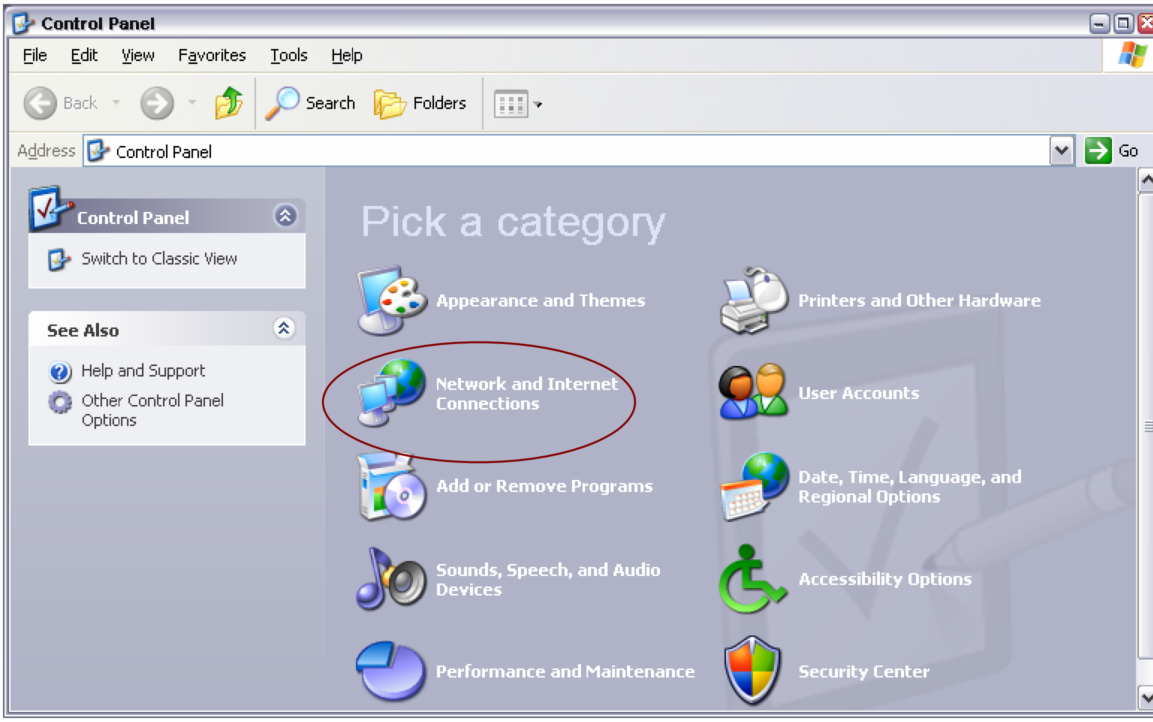
Entering the IP Address

1. Open the start menu (either by pressing the **Windows** key (on the keyboard next to the CTRL key) or by moving the mouse to the bottom of the display and subsequent clicking on **Start**).



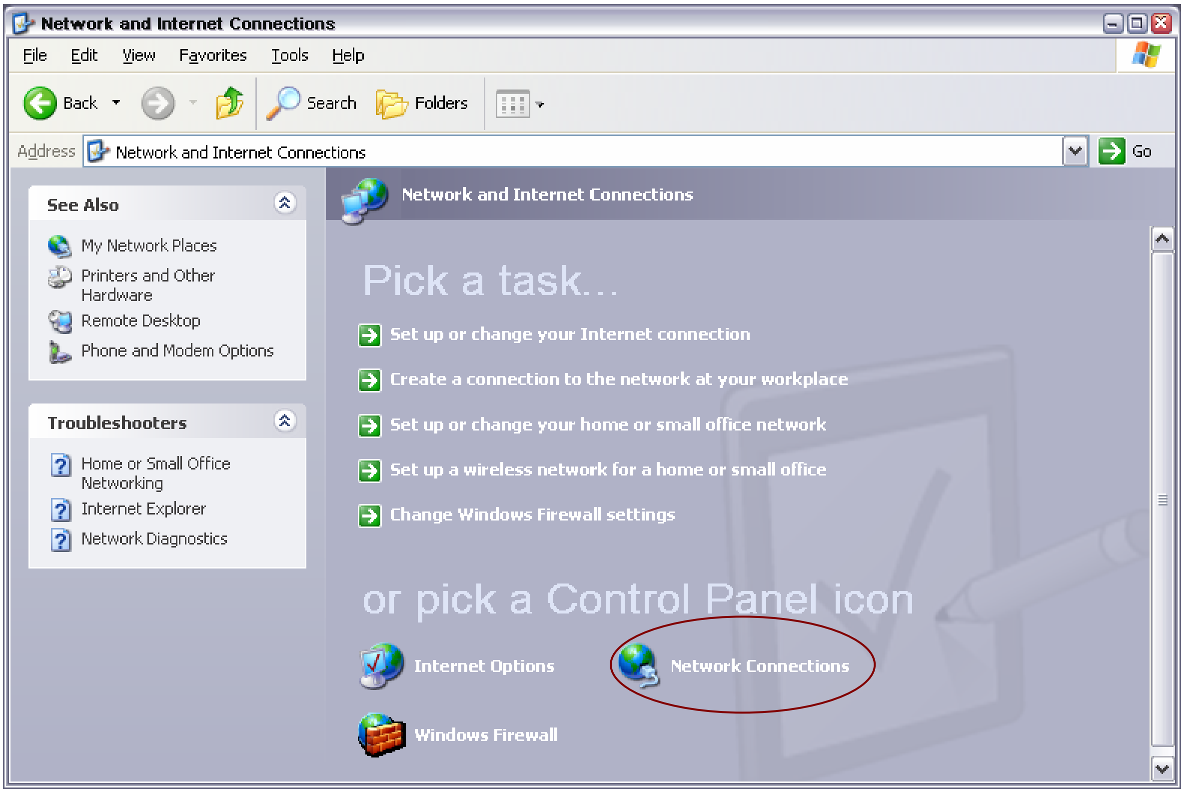
2. Click on **Control Panel**

The **Control Panel window** is displayed.



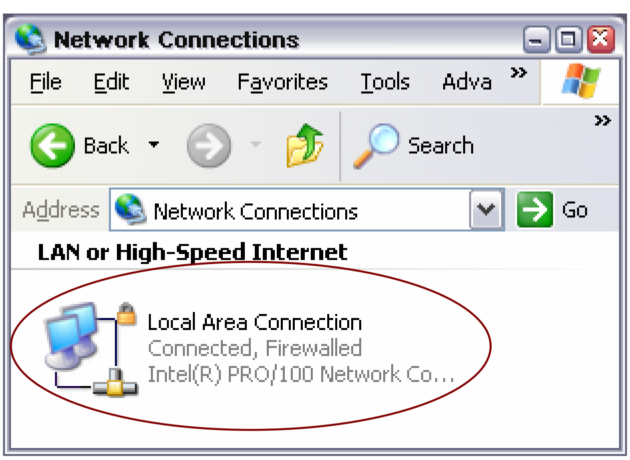
3. Click on **Network and Internet Connections**.

   The **Network and Internet Connections window** is displayed.



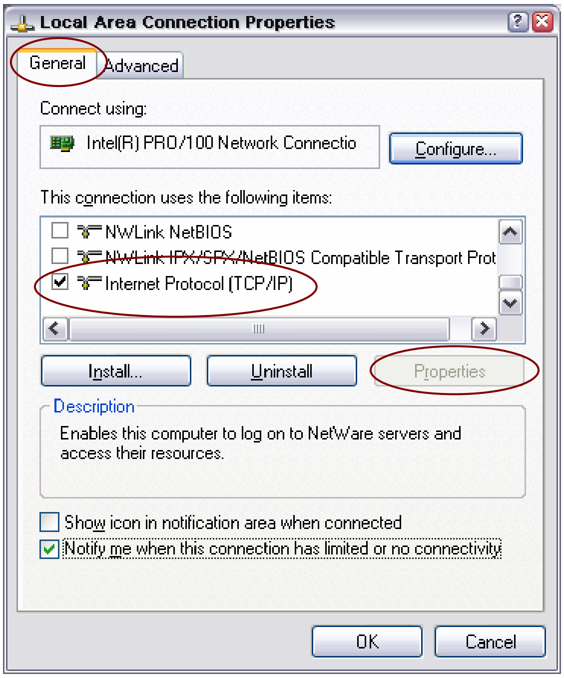
4. Click on **Network Connections** in the menu of "**pick a Control Panel icon**".

   The **Network Connections window** is displayed



5. Click on **LAN Area Connection** in the **Network Connections** menu.

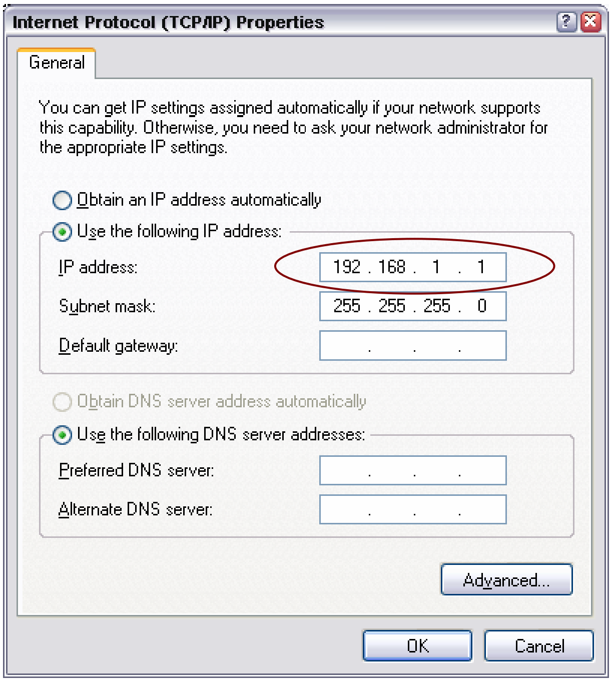
   The **Local Area Connection Properties window** is displayed



6. On the **General tab**, select **Internet Protocol (TCP/IP)** in the field **„This connection uses the following items:”**

7. Click on the **Properties** button.

   The **Internet Protocol TCP/IP) Properties window** is displayed
   Default setting is “**Obtain an IP address automatically** (DHCP = dynamic host configuration protocol)”.

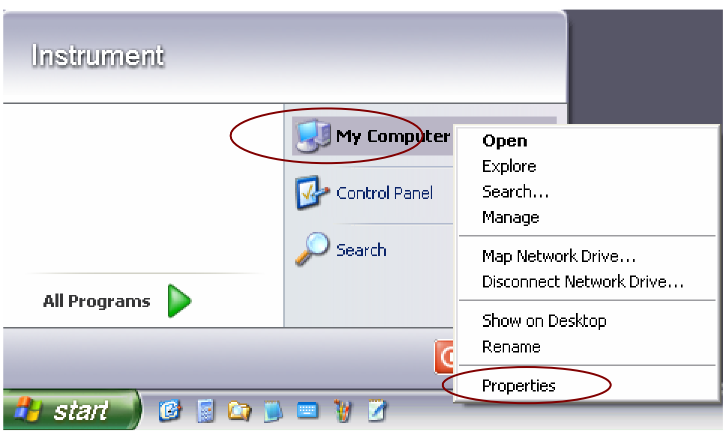


8. Enter the IP address in the field "**Use the following IP address:**" (the IP address can be queried from the network administrator).

9. Confirm the entry in all following menus with **OK**.

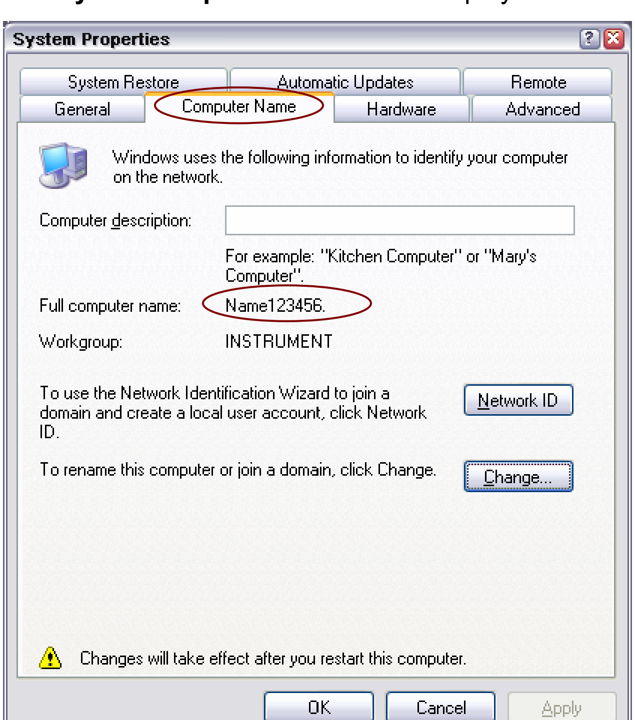
Query Computer Name

1. Open the start menu (either by pressing the **Windows** key (on the keyboard next to the CTRL key) or by moving the mouse to the bottom of the display and subsequent clicking on **Start**).
2. Select **My Computer**
3. Open the context menu by pressing the right mouse key.



4. Click on **Properties**

The **System Properties window** is displayed



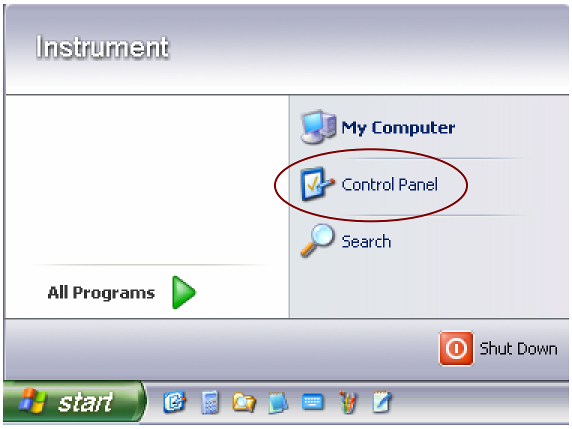
5. Select the **Computer Name** tab.
   The computer name is displayed under **“Full Computer Name:”**.
   The name can be changed in the submenu “**Change”**.

Configuring Internet Connection Firewall

The Windows XP Firewall suppresses all network communication which is not initialized by the controller itself or which is defined as unwanted. It protects the controller from an attack of hostile users and programs. On the R&S AMU, the Internet Connection Firewall (ICF) is activated for all network connections per default to enhance protection of the instrument.

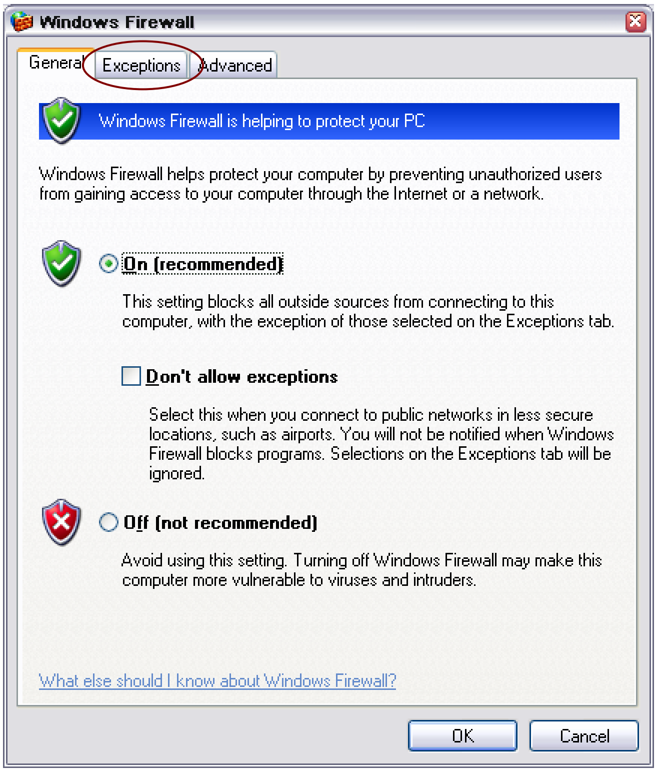
To enable data transfer with other controllers in a local network, file and printer sharing must be specifically permitted.

1. Open the start menu (either by pressing the **Windows** key (on the keyboard next to the CTRL key) or by moving the mouse to the bottom of the display and subsequent clicking on **Start**).

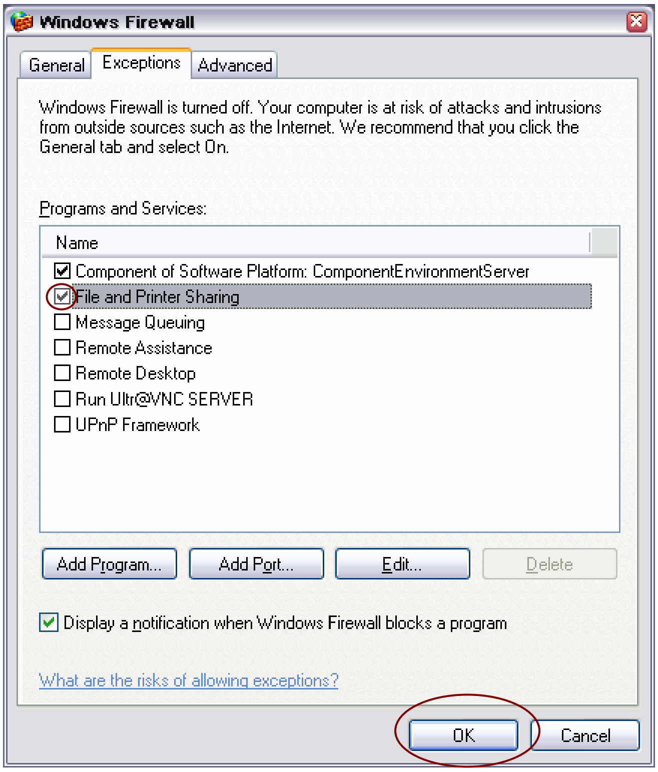


2. Select **Control Panel** and open the context menu by pressing the right mouse key.
3. Click on **Switch to Classic View**
4. Select the **Windows Firewall**

The **Windows Firewall window** is displayed.



5. Select tab **Exceptions**.



6. Activate the check box **“File and Printer Sharing”**.
7. Confirm the entry in all following menus with **OK**.

Accessing Directories in the Network

The access to network drives depends on the access rights and whether the drives in question have been enabled. The complete integration of the R&S AMU into a large network with the necessary allocation of rights is highly complex and normally performed by a network administrator.
However, the hard disk of a computer also connected to the network can be accessed from the R&S AMU relatively easily. The only precondition for this is that the desired directory the R&S AMU should have access is enabled on the remote computer. Subsequently, this directory is accessed from the R&S AMU using a Windows XP® search function.
This procedure is also of importance for a point-to-point connection, for instance in order to start a firmware update for which the files have been stored on the hard disk of the remote computer.

Note:
The computer and the R&S AMU must both be equipped with a computer name and an IP address (see section "Configuring the R&S AMU for Network Operation")

Enabling the desired directory on the remote computer

Note:
The menu name may deviate from the name specified in the operating sequence, depending on the language and on the operating system used on the computer.

1. Open the **Windows explorer** on the remote computer.
2. Select the directory to be enabled.
3. Open the context menu by pressing the right mouse key.
4. Click on **Properties**.
5. In the **Sharing** tab, activate the checkbox “**Share this folder”**.
6. Write down the name of the computer (see section "*Query Computer Name*").

Accessing the enabled directory on the R&S AMU

1. Open the Start menu.
2. In the **Search** menu, select **Computers or People**
3. Select **A Computer on the Network**.
4. Enter the computer name in the input window of the query **Which Computer you are looking for?**
5. Start the search by pressing the enter key.

The computer and its name appears in the results list.

6. Click on the computer's name to display the enabled directory.

The files in this directory can be used in the R&S AMU.

Note:
If a user name and a password are requested when you click on the computer, the login name and password used on the computer must be entered.

Manual Remote Control via an External Controller

The R&S AMU can be manually controlled from an external PC via a network link. This allows a convenient operation of the R&S AMU from the desktop although the instrument is integrated in a rack somewhere else.

Manual remote control in contrast to **remote control** does not use remote-control commands but a separate software which is installed on the external PC. After its start, the software simulates the user interface of the R&S AMU. The instrument can thus be manually operated from the PC as on the unit itself.

A precondition for manual remote control is a connection between R&S AMU and PC via a LAN network and the installation of the software on the PC and on the R&S AMU.
Two free-of-charge programs are available for setting up the connection for manual remote control:
The Windows program **Remote Desktop Connection** for PCs with Window operating system and the program **Ultr@VNC** for PCs with Linux/Unix or Windows operating system.

After the connection is established, the R&S AMU screen with the block diagram is displayed on the external PC and the R&S AMU can be manually remote-controlled from the external PC. The individual functions are operated using the mouse and keyboard. Specific instrument functions can be executed using specific key combinations on the keyboard or a front panel key emulation that can be operated with the mouse (see chapter 3, section "*Legend of Front-Panel Controls*").

Installation of the remote-control software and establishing the connection between external PC and R&S AMU is described in the following.

Configuration for Manual Remote Control via Windows Remote Desktop Connection

The instrument is operated with the aid of the Windows program **Remote Desktop Connection** which is provided by Microsoft in the download area of the Internet (http://www.microsoft.com). Manual remote control is described in chapter 3, "*Manual Operation*".

Manual remote control of the R&S AMU is possible under the following conditions:

- The Windows 95 operating system or higher and the **Remote Desktop Connection** program are installed on the external PC and
  a LAN interface is configured for the network.
- The R&S AMU and PC are linked via a LAN.
- The **Remote Desktop Connection** is enabled on the R&S AMU
- R&S AMU data (IP address or computer name of R&S AMU in the network) is entered in the **Remote Desktop Connection** program of the external PC.
- Login on the external computer for the R&S AMU was carried out with the correct user name (remote) and the correct password (remote).

CAUTION

Risk of unauthorized access!

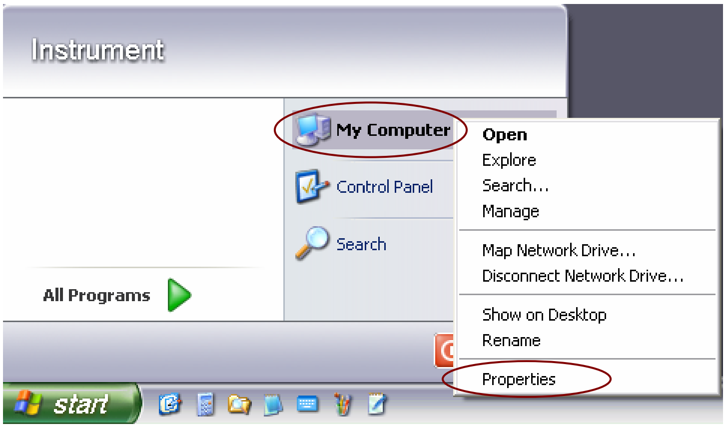
After activation of the remote desktop, any user on the network who knows the computer name and login data can access this R&S AMU. Even after cutting it, the connection is still enabled and the R&S AMU can be accessed any time.

To disable the connection, the **remote desktop must be deactivated** on the R&S AMU.

Enable Remote Desktop Connection on R&S AMU

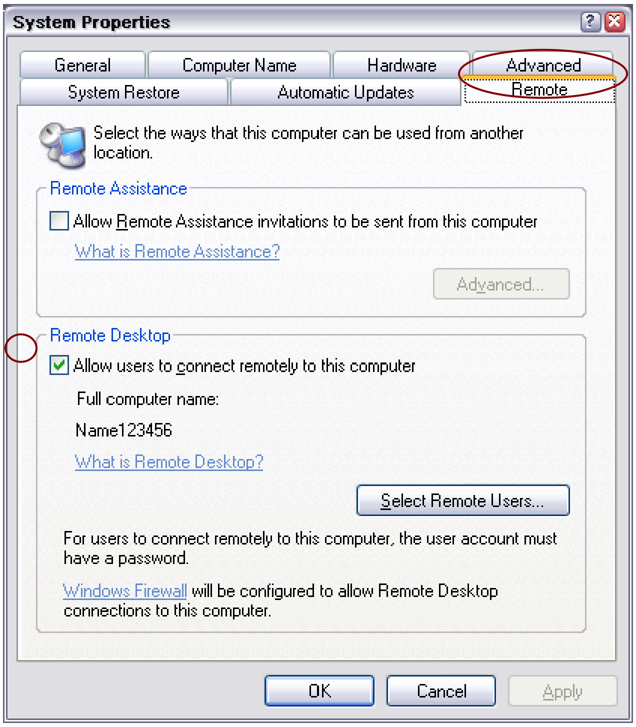
The configuration is performed in the Windows XP menus. The operating system can be accessed only if an external keyboard and/or mouse are connected. Operating by mouse without using an external keyboard is possible only by using the on-screen keyboard.
To ensure all devices will be recognizied **Switch off** the instrument (STANDBY mode) before connecting the external devices (see also "*Switching Off*").

1. Switch off the instrument
2. Connect the external keyboard and /or the mouse to the USB interface.
3. Switch on the instrument
4. Open the start menu with the **Windows** key, select **My Computer** and open the context menu by pressing the right mouse key.



5. Click on **Properties**.

The **System Properties window** is displayed



6. Select the **Remote** tab.
7. Activate check box: "**Allow users to connect remotely to this computer**"

The computer name is displayed under **"Full Computer Name:"**.
The name can be changed in the submenu "**Change"**.

Note:
When activating/locking the Remote Desktop, the associated firewall settings are automatically enabled/disabled.

Install Remote Desktop and Establish Connection on the Windows PC

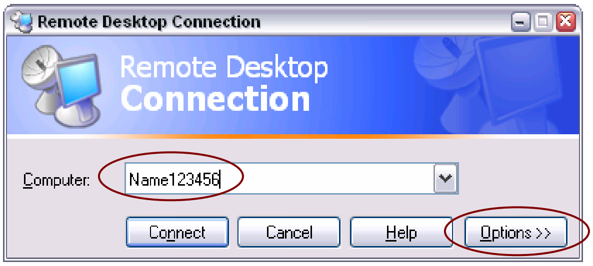
The **Remote Desktop Connection** program of Microsoft is available on the Internet for the Windows 95™ operating system and its successors as a free-of-charge download. Following the instructions on the Internet, it can be loaded onto any external PC. For the Windows XP operating system, the program is available on the installation CD-ROM.

1. Install **Remote Desktop Connection** program if required

Note:
Prior to the first use, the instrument and user ID of the R&S AMU must be entered on the external PC. The instrument ID, i.e. the computer name of the R&S AMU, identifies the R&S AMU in the network. A computer name is assigned to each R&S AMU in the factory, which can be used for manual remote control. The query for the computer name is described in section "Query Computer Name".
*The user ID is required for accessing the R&S AMU. On the R&S AMU "**instrument**" the user name and password are preset. No entry need to be made in the **Domain** field.*

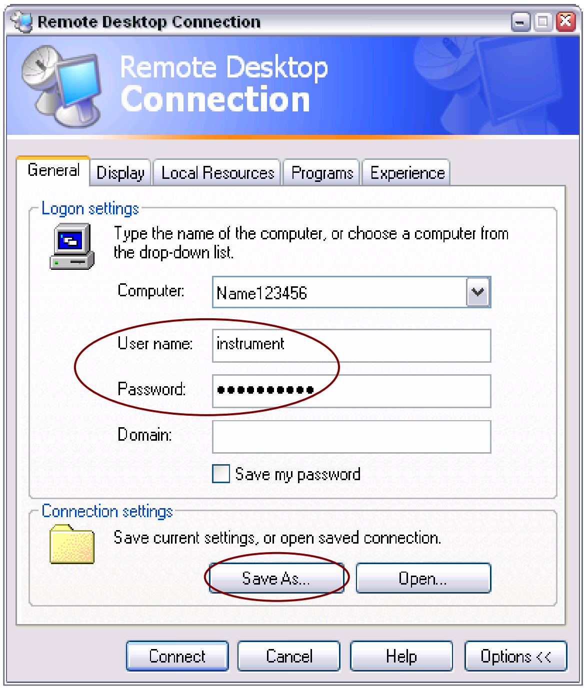
2. Start the program in the **Start - All Programs - Accessories - Communications** window.

   The **Remote Desktop Connection window** is displayed



3. Enter the computer name
4. Click on **Options** for entering the instruments ID

   The **Remote Desktop Connection window** (General tab) is displayed

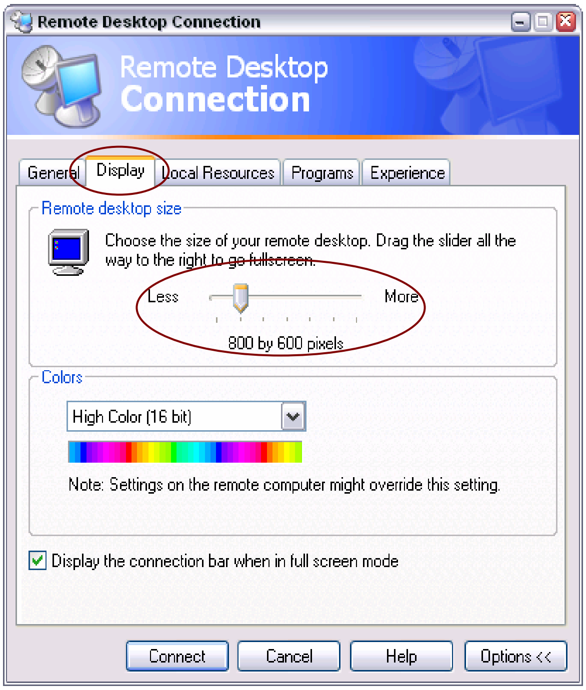


5. On the **General** tab, insert the **User name** and **Password** of the R&S AMU.
6. The Login data can be stored with the **Save As** button, e.g. as default.rdp file.

Note:
*If the connection settings are are stored as a **default.rdp** file, the login data are offered as default value by starting the program. In case the connection settings are stored in another file, the R&S AMU link is available in a selection list, opened with the button of the **Computer:** entry field*

7. Select **Display** tab.

The **Remote Desktop Connection window** (Display tab) is displayed



8. Select **800 x 600** by using the slide "**Remote desktop size"**.
9. Confirm the connection with **Connect**.

   The connection for desktop remoting is established.

After the connection is established, the screen with the block diagram is displayed and the R&S AMU can be manually remote-controlled from the external PC.
The individual functions are operated using the mouse and keyboard. Specific instrument functions can be executed using specific key combinations on the keyboard or the front panel key emulation that can be operated with the mouse (see table in chapter 3, section "*Legend of Front-Panel Controls*").

The device firmware of the R&S AMU is disabled when the connection is set up. **Direct control on the R&S AMU is not possible while manual remote control is active.** The access of an external PC is indicated by the logon screen of Windows XP which identifies the accessing user.

If several R&S AMU instruments are to be manually remote-controlled from one PC, a separate **Remote Desktop Control** window must be opened for each R&S AMU. This is possible by starting the program on the external PC several times.

Cut Manual Remote Control Connection via Remote Desktop

The connection can be cut either on the R&S AMU or on the external PC. Cutting the connection does not disable it. It can be established again any time.

Cutting the connection on the R&S AMU (requires an external keyboard and a mouse):

1. Click on **Disconnect** in the remote-control message menu of the R&S AMU

   The connection is cut, a message on the external PC informs about the disconnection.

Cutting the connection on the external PC:

1. Open the start menu.
2. Click on **Disconnect** in the lower right-hand corner of menu

Disable Manual Remote Control Connection via Remote Desktop

The connection can be disabled by deactivating the Remote Desktop on the R&S AMU .

1. Open the start menu, select **My Computer** and open the context menu by pressing the right mouse key.
2. Click on **Properties** and select the **Remote** tab in the menu.
3. Deactivate the check box **Allow users to connect remotely to this computer** and close the window with the **OK** button.

   The connection is disabled, it is no longer possible to access the R&S AMU for manual remote control via **Remote Desktop**.

Configuration for Manual Remote Control via Ultr@VNC

The instrument is operated with the aid of the program **Ultr@VNC**. The program is included in operating system Linux/Unix. It is available as a free-of-charge download on the internet for operating system Window XP (http://ultravnc.sourceforge.net/download.htm)

Manual remote control of the R&S AMU is possible under the following conditions:

- The external PC with Linux/Unix or Windows operating system (Windows 95 or higher) is equipped with a LAN interface which is configured for the network.
- The R&S AMU and PC are linked via a LAN.
- The **Ultr@VNC** program is installed and enabled on the R&S AMU, and an user-specific password for the **VNC** connection is defined. Communication on the network via **Ultr@VNC** program is enabled in the firewall.
- PC with Linux/Unix operating system
  R&S AMU IP address is entered in the **address line** of the internet browser of the external PC and the user-specific password for the **VNC** connection is entered in the request panel.

- PC with Windows operating system
  The **Ultr@VNC Viewer** program component is installed on the external PC
  R&S AMU IP address and the user-specific password for the **VNC** connection are entered in the **VNC Viewer** panel.

CAUTION

Risk of unauthorized access!
After enabling the VNC connection, any user on the network who knows the password and IP address of the I/Q modulation generator can access this R&S AMU. Even after cutting it, the connection is still enabled and the R&S AMU can be accessed any time. To disable the connection, the **VNC program on the R&S AMU must be uninstalled or the VNC server service disabled**.

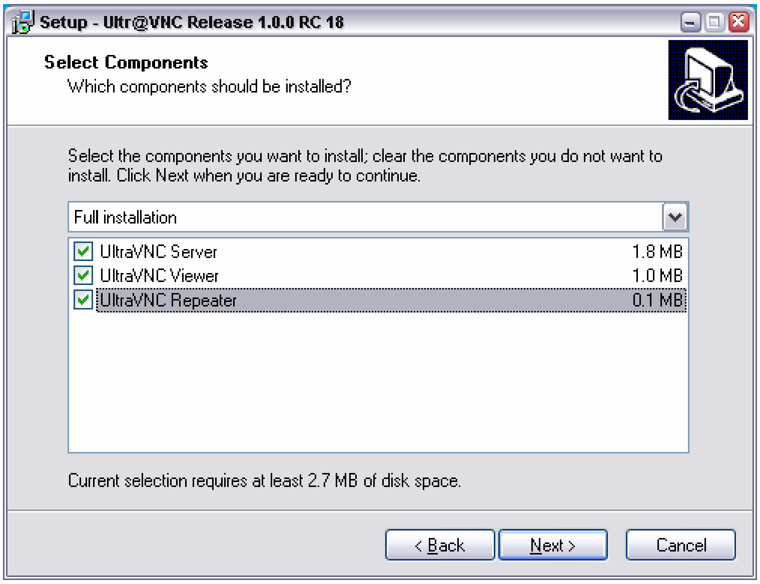
To enhance security, also **communication on the network via Ultr@VNC** program **should be disabled** in the firewall.

Install and Enable VNC Connection on R&S AMU

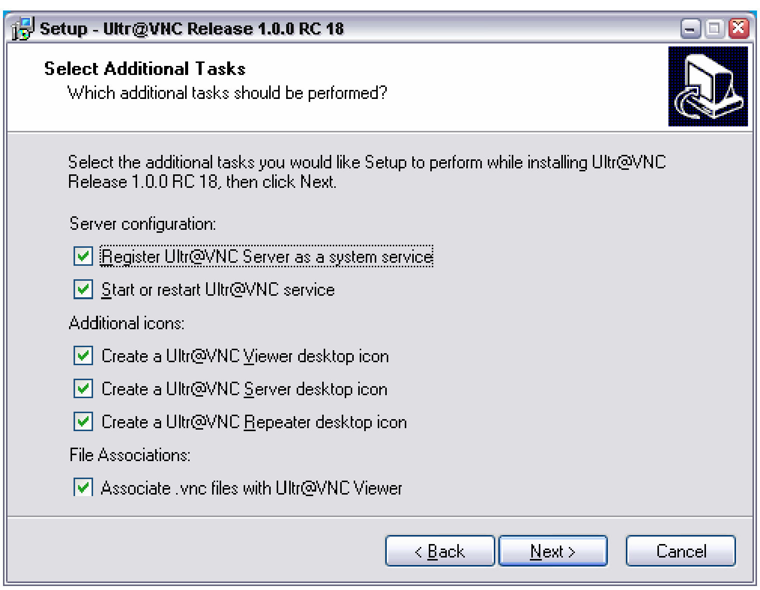
The **Ultr@VNC** program is available on the Internet as a free-of-charge download. Following the instructions on the Internet, it can be copied onto the R&S AMU.

1. Download the program from the internet and copy it to a directory that can be accessed by the R&S AMU.
2. Switch off the instrument.
3. Connect a mouse and a keyboard.
4. Switch on the instrument.
5. Shut down the firmware using the ALT-F4 key combination.
6. Start the installation by double clicking on the setup file (Ultr@VNC_100_RC18_setup.exe / whereas 18 denotes the version number).
   The setup wizard leads through the installation. In the following only those panels are described in which defined settings are required for the R&S AMU.

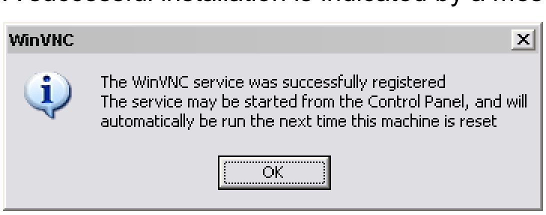
– Select installation of all components



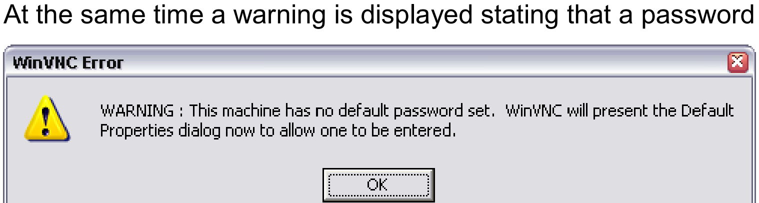
– Select all entries in the Additional Task Panel



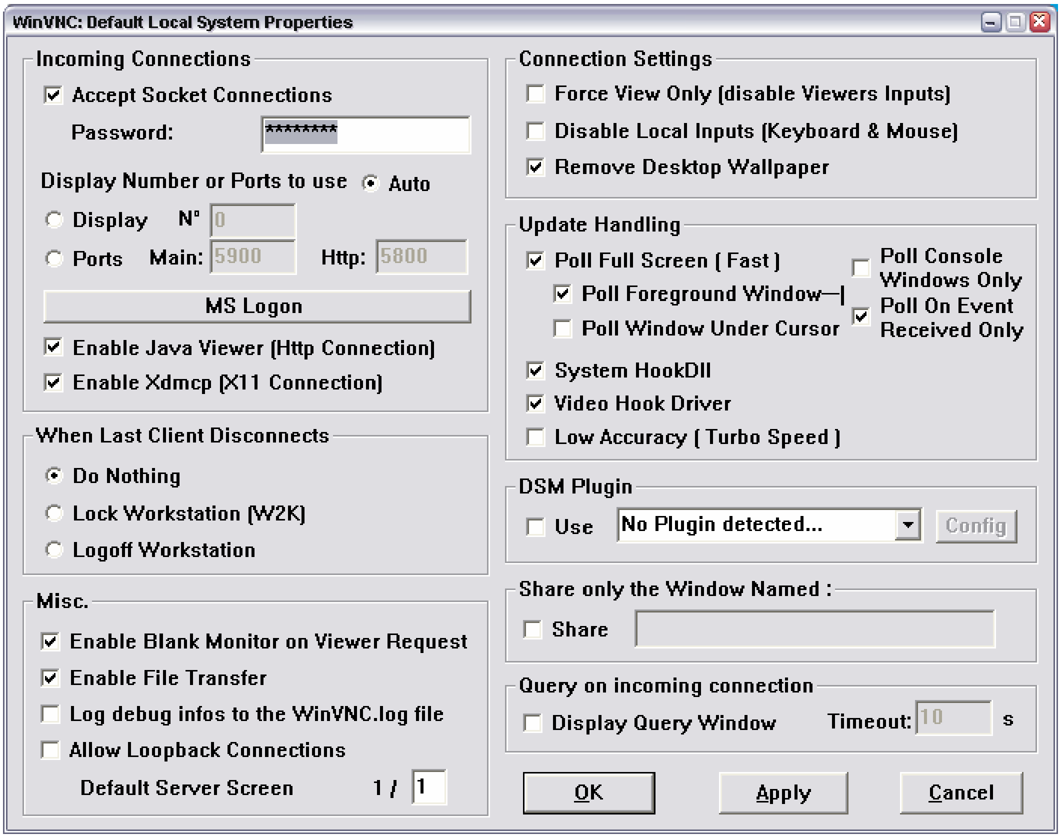
– A successful installation is indicated by a message



– At the same time a warning is displayed stating that a password must be set.



– After clicking on **OK** in the warning panel the **Default Local System Properties** panel opens. A password with a length of at least five digits must be entered. This password is used on the remote PC to access the R&S AMU. Other settings may be changed according to the user-specific security requirements.



7. After the installation the VNC connection must be enabled in the ICF firewall (see following section).

After the installation the program always is automatically started together with the operating system.

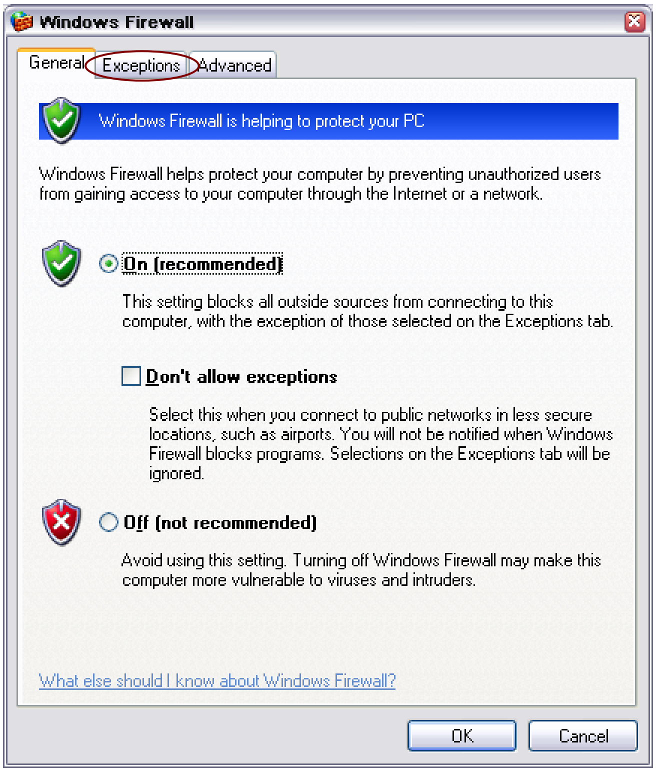
An icon  is placed on the right side of the Windows XP task bar (notification area). On mouse over, the IP address of the R&S AMU is indicated. This IP address and the user-defined password are the prerequisites to enable manual remote control on the PC.
A cut connection is indicated by changed color of the icon. Cutting the connection does not disable it. It can be established again any time.

Configuring Internet Connection Firewall for VNC Connection

To enable manual remote control by other controllers in a local network via VNC connection, the connection must be specifically permitted in the firewall.

1. Open the start menu, select **Control Panel** and open the context menu by pressing the right mouse key.
2. Click on **Switch to Classic View**
3. Select the **Windows Firewall**

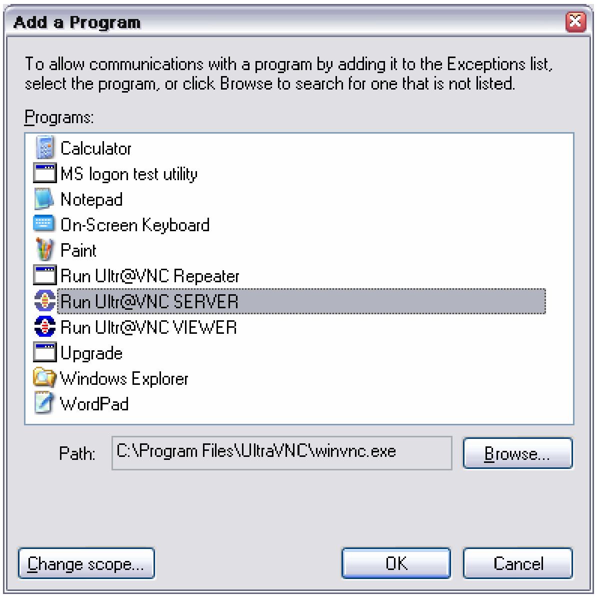
The **Windows Firewall window** (General tab) is displayed.



Select tab **Exceptions**.

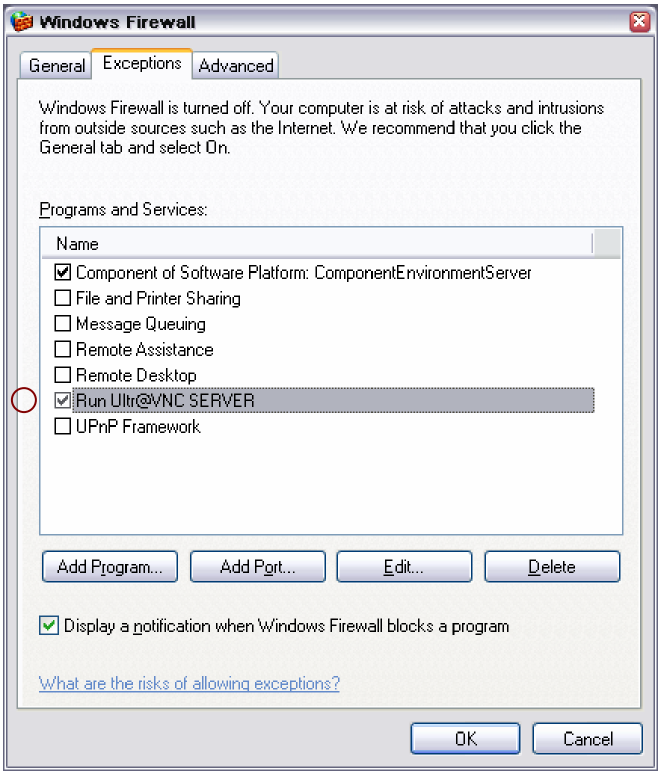
4. Call sub menu **Add Program...**

The **Add a Program window** is displayed.



5. Select **Run Ultr@VNC SERVER** and click on **OK**.

The **Windows Firewall window** (Exceptions tab) is displayed.



6. Activate check box **Run Ultr@VNC SERVER** in the **Exceptions** tab.
7. Confirm the entry with **OK**.

Establish Manual Remote Control on the Linux/Unix PC

The **VNC** program is available per default for Linux/Unix operating systems. Only three steps are necessary to establish the connection to the R&S AMU:

1. Start the internet browser on the PC.
2. Enter the following address:

   vnc://"IP-address of R&S AMU", e.g. vnc://192.168.1.1

   After Enter, the password for the remote **VNC** connection is requested
3. Enter the password defined in the **Default Local System Properties** panel of the **Ultr@VNC** program of R&S AMU. The connection is established when the **Log On** button is pressed.

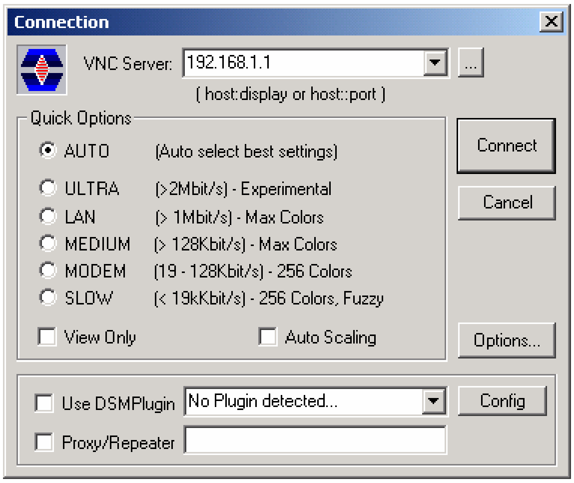
   After the connection is established, the current screen with the block diagram is displayed and the R&S AMU can be manually remote-controlled from the external PC. The individual functions are operated using the mouse and keyboard. Specific instrument functions can be executed using specific key combinations on the keyboard (see table in chapter 3, section "*Legend of Front-Panel Controls*"). In contrast to Remote Control Desktop, **direct control on the R&S AMU is possible while manual remote control is established**, it can be performed alternately with the manual remote control.

Install VNC Viewer and Establish VNC Connection on the Windows PC

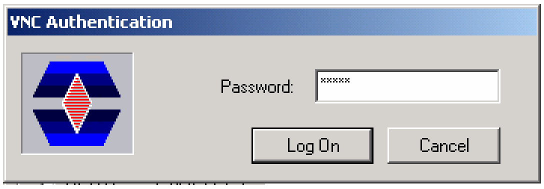
The **Ultr@VNC** program is available on the Internet as a free-of-charge download.
Following the instructions on the Internet, the program can be copied onto the external Windows PC.
Only the program component **VNC Viewer** is required.

Note:
*The **VNC Viewer** program is included in the download for the installation of the Ultr@VNC program on the R&S AMU if **Full installation** was selected in the **Select Component** panel. In this case, the program ultr@vncviewer.exe can be copied to the Windows PC.*

1. Install **VNC Viewer** program component on the PC.
2. Start **VNC Viewer** program component on the PC.



3. Enter IP address of R&S AMU in input line **VNC Server.**
4. Initialize the connection by pressing the **Connect** button.
   A message requesting the password appears.



5. Enter the **VNC** password defined in the **Default Local System Properties** panel of the **Ultr@VNC** program of R&S AMU. The connection is established when the **Log On** button is pressed.

After the connection is established, the current screen with the block diagram is displayed and the R&S AMU can be manually remote-controlled from the external PC. The individual functions are operated using the mouse and keyboard. Specific instrument functions can be executed using specific key combinations on the keyboard (see table in chapter 3, section "*Legend of Front-Panel Controls*"). In contrast to Remote Control Desktop, **direct control on the R&S AMU is possible while manual remote control is established**, it can be performed alternately with the manual remote control.

Cut Manual Remote Control Connection via Ultr@VNC

The connection can be cut either on the R&S AMU or on the external PC. Cutting the connection does not disable it. It can be established again any time.

Cutting the connection on the R&S AMU (requires an external keyboard and a mouse):

1. Open the start menu with the **Windows** key or the CTRL + ESC key combination.
2. Right-click on the **VNC** icon on the task bar. The context menu opens.
3. Select **Kill all clients**.

The connection is cut, a message on the external PC informs the user about the disconnection. The **VNC** icon changes its color.

Cutting the connection on the external Linux/Unix PC:

1. Either close the internet browser or
   close the R&S AMU window.

The connection is disabled, the **VNC** icon on the task bar off the R&S AMU changes its color.

Cutting the connection on the external Windows PC:

1. Close the **VNC Viewer** program

The connection is cut, the **VNC** icon on the task bar off the R&S AMU changes its color.

Disable Manual Remote Control Connection via Ultr@VNC

The connection can be disabled by removing the program on the R&S AMU or by deactivating the **VNC Server** service in the Control Panel.

Removing the VNC program:

1. Open the start menu with the **Windows** key or the CTRL + ESC key combination.
2. Open the **Control Panel** menu
3. Select **Add or Remove Programs**
4. Remove the **VNC** program.

The connection is disabled, the **VNC** icon on the task bar of the R&S AMU disappears.

Deactivating the VNC Server service:

1. Open the start menu with the **Windows** key or the CTRL + ESC key combination.
2. Open the Control Panel menu
3. Select **Services**
4. Deactivate the **VNC Server** service.

The connection is disabled, the **VNC** icon on the task bar of the R&S AMU disappears.

Contents - Chapter 2 "Getting Started"

2 Getting Started

Introduction - Getting Started

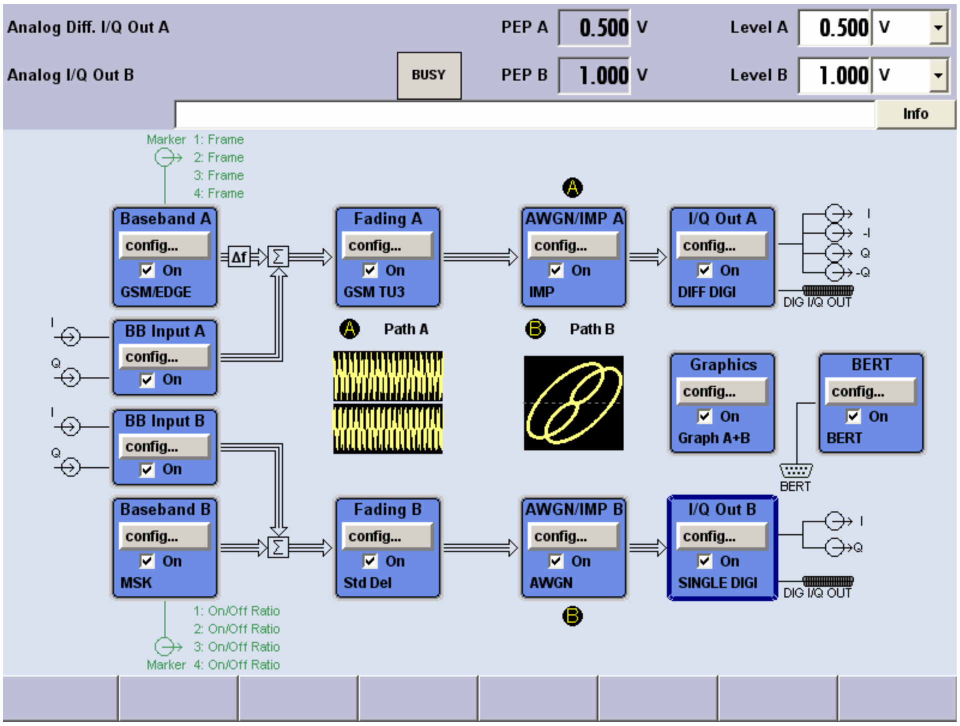
The R&S AMU 200A Baseband Signal Generator and Fading Simulator uses internal and/or external baseband signal sources and simulates various interfering signals in the baseband, e.g. fading, noise and I/Q impairment.
Digital signals can be generated internally in accordance with several digital standards or user defined signal characteristics. Analog or digital baseband signals can be fed into the signal path. The signals are generated in realtime or with the aid of the Arbitray Waveform Generator. The digital data streams can be output directly and are converted to analog I/Q baseband output signals.

The R&S AMU may contain two paths, the first being called path A and the second path B. The signals generated in different basebands blocks can be routed from path A to path B and vice versa and can be added. Each baseband path enables independent output of the modulated signals (analog in/out, digital in/out, analog differential out).

A graphical user interface ensures fast and easy operation. The architecture of the R&S AMU and the signal flow are shown in a block diagram on the R&S AMU display. In the diagram, signal processing is performed from left to right:

- Baseband signal generation, including external I/Q signal application
- Fading
- I/Q Impairment and AWGN Generation
- I/Q Signal output.

The block diagram in the figure below shows a fully equipped two-path R&S AMU

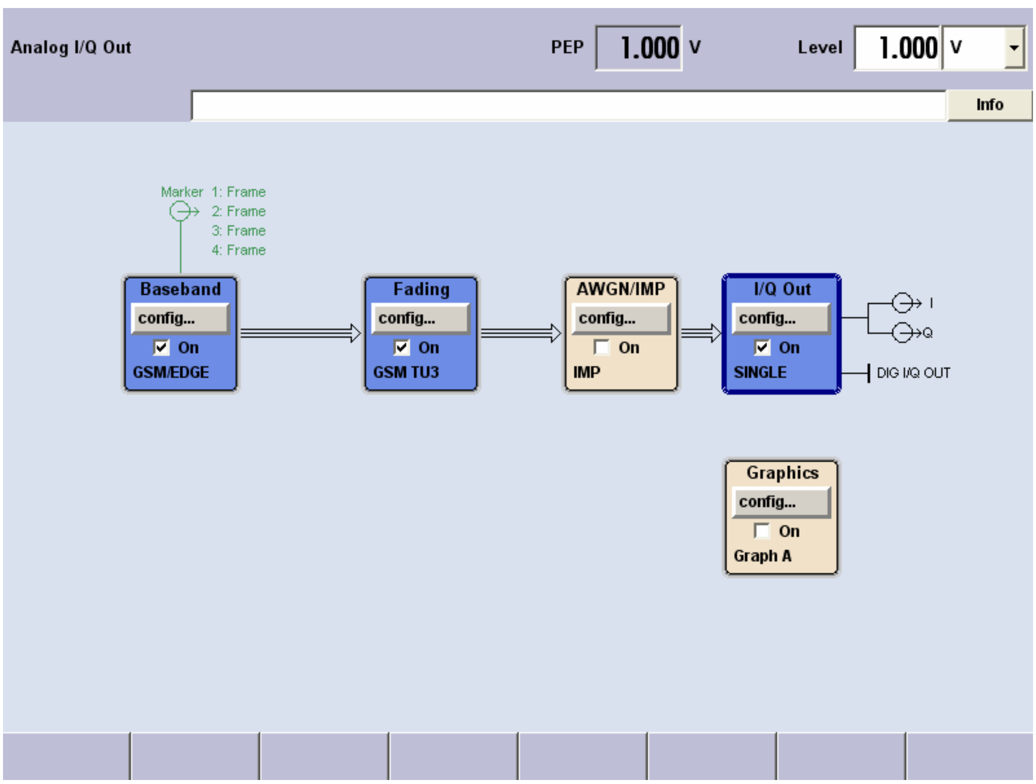


Block diagram of a fully equipped R&S AMU

For more detailed information on options, refer to the R&S AMU data sheet (available on the R&S AMU Homepage on the Internet; http://www.rohde-schwarz.com/products/amu).

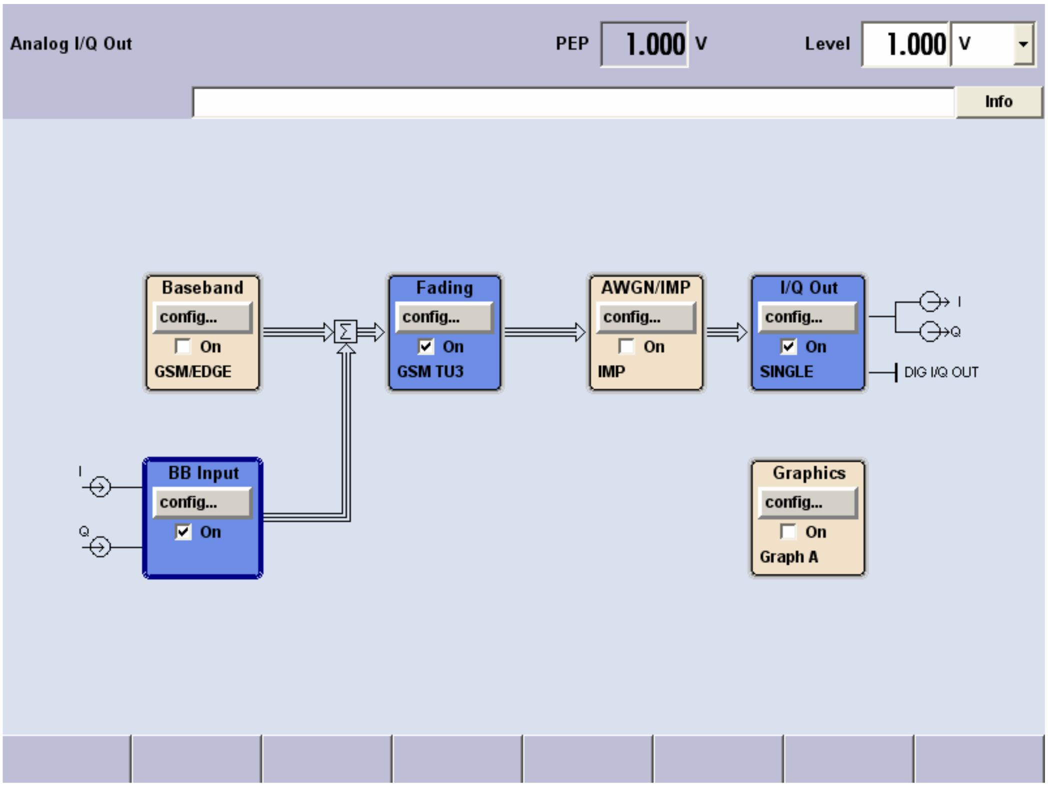
In the R&S AMU, a digitally modulated signal can be generated in several ways:

1. The **I/Q signal is generated internally** in the R&S AMU. In this case the instrument must be equipped with at least one baseband generator (option R&S AMU-B9/B10/B11) and at least one baseband main module (option R&S AMU-B13). One or two baseband generators can be installed. The signals produced by the two generators can be added (possibly with frequency offset). Fading scenarios can be created with the aid of a fading module (option R&S AMU-B14, Fading Simulator and option R&S AMU-B15, Fading Simulator Extension). A digital/analog converter converts the internal digital baseband signals into analog I/Q output signals. The output of the analog signal can be single ended or differential (option R&S AMU-B16 ; Differential I/Q Output). For the digital signal output a baseband digital I/Q output (option R&S AMU-B18, Baseband Digital I/Q Output) is available.



Operation of the R&S AMU with I/Q signals generated by the internal baseband generator

2. The **I/Q signal is generated by an external instrument and coupled in via the baseband input module** (option R&S AMU-B17, Baseband I/Q Input (digital/analog)). With the baseband input module analog or digital signals can be fed into the R&S AMU. The frequency of the signals can be shifted, and if options are installed for internal baseband generation, the external and the internal baseband signals can be added with variable level ratio. If the R&S AMU is equipped with a fading simulator (option R&S AMU-B14, Fading Simulator and option R&S AMU-B15, Fading Simulator Extension), the signals can be faded. The fading module can also process external I/Q signals.



Operation of the R&S AMU with external I/Q signals applied to the R&S AMU

Modules of the R&S AMU

The R&S AMU is a fully digital two-path baseband signal generator. A completely equipped instrument covers hardware modules for

- generating I/Q signals,
- simulating interfering signals as noise and I/Q impairment,
- fading,
- the output of analog and digital I/Q signals.

Baseband generator (option R&S AMU-B9/B10/B11):
In case an internally I/Q signal has to be generated in the R&S AMU, the instrument must be equipped with at least one baseband generator. A baseband generator contains modules for real time signal generation and an arbitrary waveform generator (ARB). One or two baseband generators, like

R&S AMU-B9	Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime)
R&S AMU-B10	Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime)
R&S AMU-B11	Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime)

can be fitted in an R&S AMU and operated separately. Signals from the baseband generators can be routed from path A to path B and vice versa, and can be added (possibly with frequency offset).
Software options providing various digital standards are available. Option R&S AMU-K40, for instance, generates signals to GSM/EDGE standard, option R&S AMU-K42 signals to 3GPP FDD standard. For more detailed information on available options, refer to the R&S AMU data sheet and the R&S AMU configuration guide (available at R&S AMU homepage on the internet).

Note:
*If two baseband generators are fitted and two signals of the same standard (e.g. GSM/EDGE) are to be output simultaneously, two appropriate software options must be installed (in this case option R&S AMU-K40). If only one option R&S AMU-K40 is installed and GSM/EDGE is selected in the first baseband generator, the second baseband generator is disabled for GSM/EDGE. A software option is not tied to a specific baseband generator. In our example, **either** the first **or** the second baseband generator can output a GSM/EDGE signal.*

Baseband input module (option R&S AMU-B17):
With the aid of this module, externally generated analog or digital I/Q signals can be fed into the R&S AMU.
For two-path instruments, the external signal can be connected to baseband path A or path B. For one-path instruments, the baseband input module is permanently linked to path A.
Up to two baseband input modules can be applied. In two-path instruments the signal of the first baseband module can be routed to path A, path B or to both paths. The signal of the second baseband input module is firmly connected to path B.
External and internal baseband signals can be added with variable level ratio. The I/Q signals can be further processed: e.g. the frequency of the signals can be shifted, noise can be added and they can also be faded.

Fading module (option R&S AMU-B14): This module enables fading effects to be produced on baseband signals in real time. Up to 20 fading paths (40 fading paths with option R&S AMU-B15) can be created simultaneously.
Software option R&S AMU-K71 comprises the 3GPP dynamic fading configurations moving propagation and birth-death propagation as well as the fine delay fading configurations offering enhanced delay resolution.

Note:

At least one fading simulator, option R&S AMU-B14 must be installed.
*If both options **R&S AMU-B14 and the R&S AMU-B15** are installed (signal path A and B), dynamic fading and enhanced resolution can be used either on signal path A or B **with one option R&S AMU-K71** option.*
*If dynamic fading and enhanced resolution is to be used on signal paths **A and B simultaneously**, **two options R&S AMU-K71** must be installed.*

Baseband main module (option R&S AMU-B13): The module converts the digital signal to an analog I/Q signal and routes it to the I/Q output.
The baseband main module also offers digital I/Q impairment functions. The I/Q signal can be deliberately corrupted, e.g. for testing the performance of a receiver's baseband section.
This module can be installed twice (for path A and path B).
All frequency and time settings are coupled to the internal reference frequency.

Additional White Gaussian Noise (option R&S AMU-K62): Additive white noise, which may be required for channel capacity measurements on almost every modern communication system, can be produced with the AWGN software options R&S AMU-K62.

Note:

If the noise generator is used, a frequency offset cannot be added to the wanted signal.
If two options R&S AMU-B13 are installed (paths A and B), AWGN can be generated either on path A or B with one R&S AMU-K62 option.
If AWGN is to be generated on paths A and B simultaneously, two options R&S AMU-K62 must be installed.

Differential output module (option R&S AMU-B16):
The differential output module (option R&S AMU-B16) provides symmetrical signals for differential inputs. The operating points of the inputs can be set and balanced by an offset between inverting and non-inverting output.
One option R&S AMU-B16 can be installed, the I/Q output signals are available for path A and B.

Digital output module (option R&S AMU-B18): The R&S AMU can be equipped with a standardized digital I/Q interface (LVDS) for online transfer of digital I/Q data. The digital output module (option R&S AMU-B18) enables the digital output of the I/Q baseband signal. This module can be installed twice (for path A and path B).

Applications of the R&S AMU

The modular design of the R&S AMU allows the instrument to be equipped with two paths. Up to four baseband sources, two internal generators and two external inputs can be installed. This allows a multitude of applications to be performed for which several baseband signal generators were previously required. A few examples are given below.

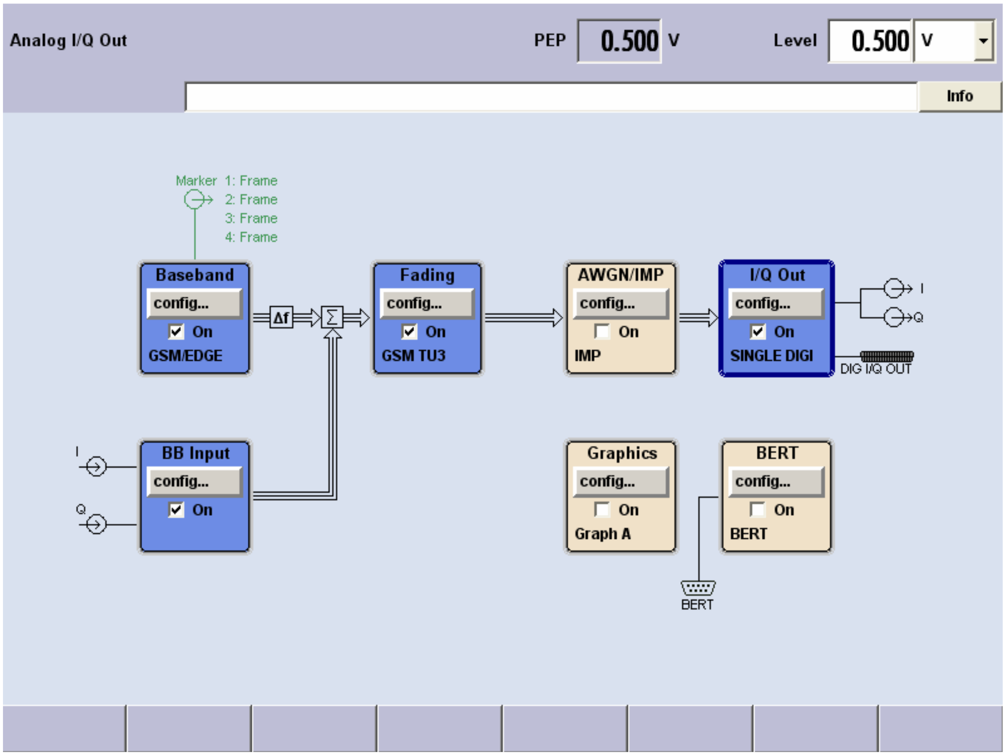
Possible applications:

- Generation of a baseband signal of different standards (realtime) or via arbitrary waveforms
- Addition of real time signals of different standards, e.g. GSM/EDGE and 3GPP FDD

- Baseband module tests with differential and digital signals
- BER Tests of baseband modules
- Design and tests of I/Q modulators
- Generation of a wanted signal and an interfering signal for tests on baseband sections of receivers
- Generation of multicarrier signals with real time components up to 80 MHz bandwidth
- Generation of fading and noise scenarios with external I/Q signals
- Signal Source for early development stage hardware simulators
- Development of new communication systems (e.g. LTE)
- Test of diversity techniques and real time baseband fading

One-path Instrument

A one-path R&S AMU requires at least one Baseband Main Module (option R&S AMU B-13) and a signal source. The signal source may be either the internal Baseband Generator (option R&S AMU-B9/B10/B11) or the external Baseband I/Q Input (option R&S AMU-B17).



Operation of R&S AMU with one baseband main module and two baseband sources

Additionally the following options can be part of a one-path configuration:

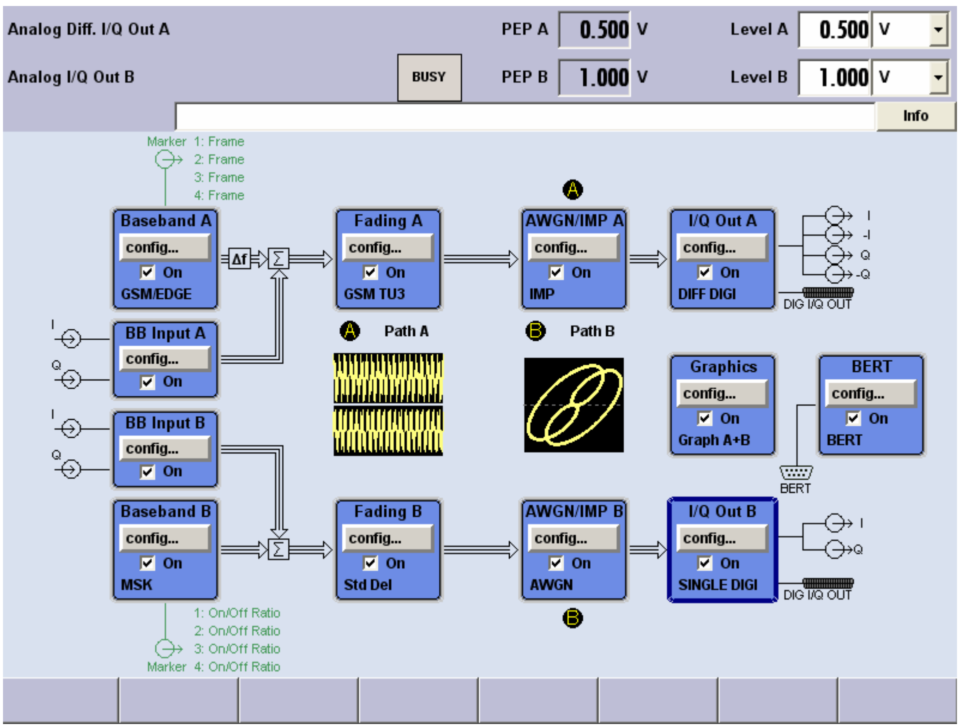
- Further baseband sources (up to a configuration with two internal Baseband Generators (option R&S AMU-B9/B10/B11) and one external Baseband I/Q Input (option R&S AMU-B17))
- The Fading Simulator (option R&S AMU-B14) and the Fading Simulator Extension (option R&S AMU-B15)
- Additive White Gaussian Noise AWGN (option R&S AMU-K62)

- Bit and Block Error Rate Measurement BERT (option R&S AMU-K80)
- One Differential I/Q Output (option R&S AMU-B16)
- One Digital I/Q Output (option R&S AMU-B18)

Note:
One-path instruments cannot use a second external Baseband I/Q Input option.

Two-path Instrument

A two-path R&S AMU requires at least two Baseband Main Modules (option R&S AMU-B13) and two signal sources. The signal sources may be the internal Baseband Generators (option R&S AMU-B9/B10/B11) or the external Baseband I/Q Inputs (option R&S AMU-B17).



Operation of R&S AMU as a fully equipped two-path instrument

Additionally the following devices can be part of a two-path configuration:

- Further baseband sources (up to a configuration with two internal Baseband Generators (option R&S AMU-B9/B10/B11) and one external Baseband I/Q Input (option R&S AMU-B17))
- The Fading Simulator (option R&S AMU-B14) and the Fading Simulator Extension (option R&S AMU-B15)
- Additive White Gaussian Noise AWGN (option R&S AMU-K62)
- Bit and Block Error Rate Measurement BERT (option R&S AMU-K80)
- The Differential I/Q Output (option R&S AMU-B16)
- The Digital I/Q Outputs (option R&S AMU-B18)

Description of Individual Diagram Blocks

Available Blocks

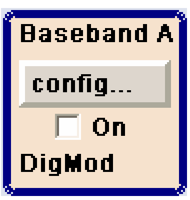
Block	**Function of block**	**Status display in the block**	**Effect of ON/OFF TOGGLE key**
Baseband A or B	Baseband source is configured and activated	Selected modulation	Switches the selected modulation (digital standard, dig modulation or ARB) on or off.
Baseband Input A or B	External baseband signal is activated	Activated input	Switches the input of external baseband signal on or off.
Fading A or B	Fading simulator is configured and activated	Selected test case or selected fading configuration	Switches the fading simulation on or off (Note: under certain signal routing conditions only one fader can be activated)
AWGN/IMP A or B	Additive white Gaussian noise production and digital impairments are activated	Active functions of block	Switches the active functions of the block on or off. The functions (AWGN, impairments or both) are activated in the respective menus.
Graphics	Graphical display is selected and activated	State of graphical display	Opens or closes the graphics window.
BERT	Bit and block error rate measurement are configured and activated	Selected measurement(s)	Switches the active function(s) of the block on or off. The functions (BERT and BLER) are activated in the respective menus.
I/Q Output A or B	I/Q basebandsignal output is activated and configured.	State of I/Q output analog (single ended or differential) and digital.	The ON/OFF TOGGLE key switches the I/Q output signals of the currently selected I/Q output block on and off, e.g. path A. A second stroke restores the status that was active before the last switch off. The BASEBD ON/OFF toggle key switches all baseband I/Q output signals of on and off (path A and path B, if two-path mode). A second stroke restores the status that was active before the last switch off. I/Q OUT OFF is displayed in the status bar.

Block Description

The block diagram shows the current configuration and the signal flow in the generator with the aid of function blocks containing an on/off switch. Clicking the function block opens a list of associated setting menus. Active menus, info windows and graphs are displayed on top of the block diagram. Input/Output symbols in the block diagram show the currently used inputs and outputs of the R&S AMU. Unused inputs and outputs are not shown. The lines indicate the signal flow.
The fully equipped R&S AMU comprises two signal paths (path A and path B). Up to two baseband signals can be added to each signal path. The two baseband signals paths can be processed independently of each other. Routing from path A to path B and vice versa is also possible, but not after the **IMP** or **AWGN/IMP** block.

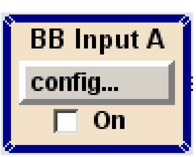
Note:
Each function block can be activated or deactivated with the ON check box (on/off toggling). The ON/OFF TOGGLE key at the front panel switches the currently selected block on or off.

Baseband A block



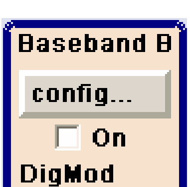
In this block, the (first) baseband source is configured and activated. The block is displayed only if one baseband generator (option R&S AMU-B9/B10/B11, Universal Coder and ARB) is available in the instrument. Depending on the installed software options, various digital standards, user-configured digital real time modulation or the built-in waveform generator (ARB) can be selected. The selected modulation is displayed in the block.

External Baseband In block A



This block controls the baseband input module for external I/Q signals. The block is displayed only if one baseband input module (option R&S AMU-B17) is installed. External I/Q signals can be applied either to the analog or the digital I/Q input. The output of the baseband input module can be connected to baseband path A or to path B (if available), provided at least one baseband main module is installed.

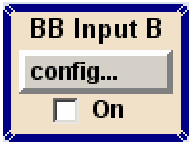
Baseband B block



Configures the second baseband source (if installed). The block is displayed only if the instrument contains two baseband generators (option R&S AMU-B9/B10/B11). Depending on the installed software option, various digital standards, user-configured digital real time modulation or the built-in waveform generator (ARB) can be selected.

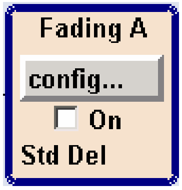
Note:
If two baseband generators are installed and two signals of the same standard (e.g. GSM/EDGE) should be output simultaneously, the two associated software options must also be installed (in this case option R&S AMU-K40). If only one option R&S AMU-K40 is installed and GSM/EDGE is selected in the first baseband generator, the second baseband generator is disabled for GSM/EDGE. However, a software option is not tied to a specific baseband generator. In our example, ***either*** *the first* ***or*** *the second baseband generator can output a GSM/EDGE signal.*

External Baseband In block B



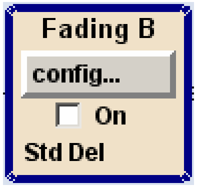
This block controls the second baseband input module for external I/Q signals. The block is displayed only if a second baseband input module (option R&S AMU-B17) is installed. External I/Q signals can be applied either to the analog or the digital I/Q input.
If one baseband path is configured (path A), the external baseband signal BB Input B is connected to this path. If two baseband paths are configured the external baseband signal BB Input B is permanently routed to path B.

Fading block A



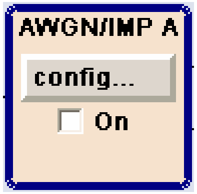
This block controls the fading module of path A. It is displayed only if a fading simulator (option R&S AMU-B14) is installed. Signal routing at the output of the fading module is configured also in this block. For instance, two-channel fading can be selected if the instrument contains two baseband paths and two faders (option R&S AMU-B15, Fading Simulator Extension).

Fading block B



This block controls the fading module of path B. It is displayed only if a fading simulator (option R&S AMU-B14) is installed. Signal routing at the output of the fading module is configured also in this block. For instance, two-channel fading can be selected if the instrument contains two baseband paths and two faders (option R&S AMU-B15, Fading Simulator Extension).

AWGN/IMP A block



This block is displayed only if a baseband main module is installed. In this block (digital) I/Q impairments for baseband path A can be set. With the aid of the software for AWGN generation (option R&S AMU-K62), an (additive) noise signal can be produced in path A.

AWGN and impairments can be activated independently of each other in the appropriate menus. The settings are displayed in the block.

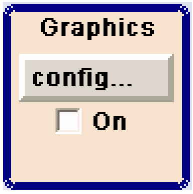
Note:
If the block is deactivated, the signal passes through the block unchanged.

AWGN/IMP B block

This block is displayed only if two baseband main modules (option R&S AMU-B13) are installed. In this block (digital) I/Q impairments for baseband path B can be set. With the aid of the software for AWGN generation (option R&S AMU-K62), an (additive) noise signal can be produced in path B.
AWGN and impairments can be activated independently of each other in the appropriate menus. The settings are displayed in the block.

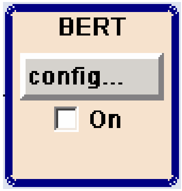
Note:
If the block is deactivated, the signal passes through the block unchanged.
If a noise signal should be applied to path A and B simultaneously, two software options R&S AMU-K62 are required.

Graphics block



With this block, the baseband signal (of path A or B) can be graphically displayed in real time. The block is displayed only if at least one baseband main module is installed.

BERT block

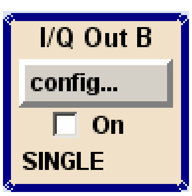


In this block an integrated bit and block error rate tester can be set. The bit error tester makes it possible to evaluate a signal demodulated and decoded by a DUT by measuring the bit error rate. The data used to drive the DUT can be generated by the R&S AMU or an user-defined external source. In addition, the block error rate measurement can be used to verify CRC checksums.

I/Q Out A block

This block is used to configure the digital and analog I/Q outputs of path A. Configurations like level display, output type, analog settings and digital settings can be performed in the corresponding menus.
I and Q components can also be swapped (I/Q Swap).
The status line in the block displays the currently active output types, e.g. **DIFF DIGI** denotes that the I/Q baseband signal is provided by the analog (in differential mode) and by the digital I/Q output .

I/Q Out B block



This block is used to configure the digital and analog I/Q outputs of path B. Configurations like level display, output type, analog settings and digital settings can be performed in the corresponding menus.
I and Q components can also be swapped (I/Q Swap).
The status line in the block displays the currently active output types, e.g. **SINGLE** denotes that the I/Q baseband signal is provided by the analog output (in single ended mode).

Example of Setup

A central element of the R&S AMU display is the block diagram that illustrates the signal flow. Each block represents an important section of signal generation. Thus the user always knows the position at which a parameter has an effect in the signal flow. The main settings of a block are indicated in the block. The interconnection of employed inputs and outputs is shown. Thus the user always is informed about the connection of inputs and outputs in the signal flow and where they can be configured.

A window is opened for each menu where parameters can be set. When the window is opened, an entry is made in the winbar below the display. All open menus have equal priority (not modal) and can be accessed any time.

The R&S AMU can be operated from the front panel entirely. Peripherals such as mouse or keyboard can be connected but are not essential.
Using the rotary knob, the user can navigate in the block diagram and the dialogs. The cursor is moved line by line through the block diagram or dialog. Turning the button clockwise advances the cursor.
The selected block can be activated or deactivated with the [ON/OFF TOGGLE] key. Active blocks are highlighted by a colored background.

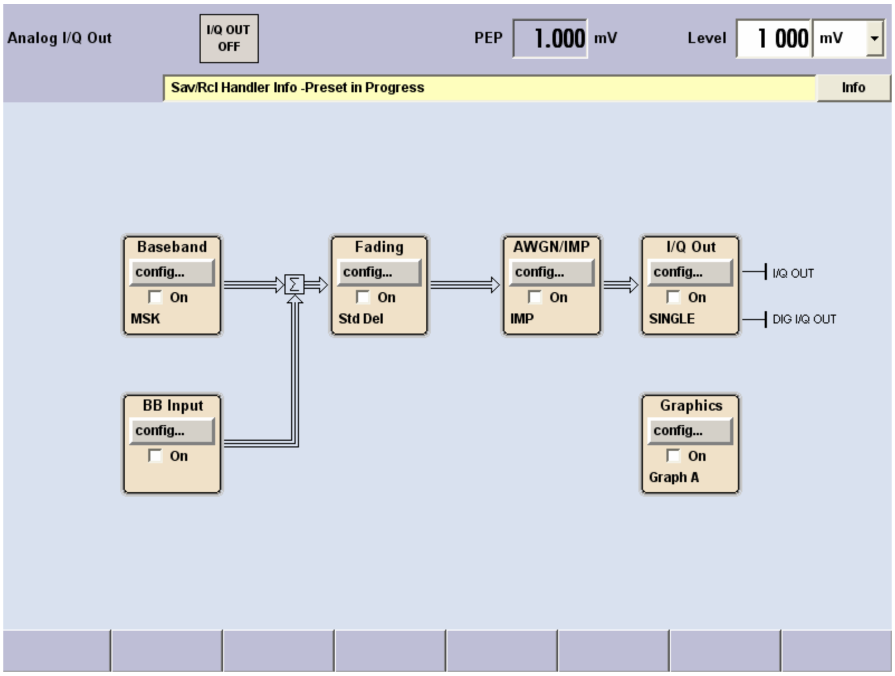
In the example, a fading signal in accordance with the standard GSM TU 3 (12Path) with a carrier frequency of 904,5 MHz (virtual RF) is configured.

Proceed as described below:

1. Activate default (preset) state.
2. Select and activate the GSM/EDGE signal generation.
3. Configure and activate the fading standard GSM TU 3 (12Path)
4. Select and activate the I/Q signal output
5. Select graphics display of I/Q signal.

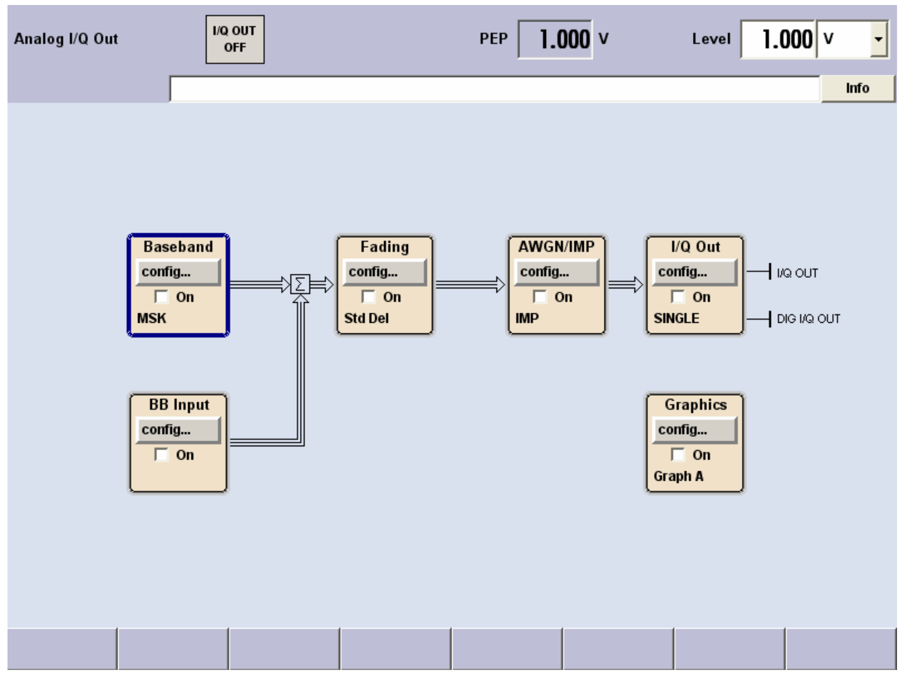
Step 1: Activate default (preset) state

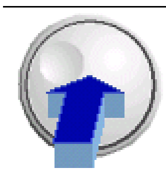
Set a defined instrument state by pressing the [PRESET] key.



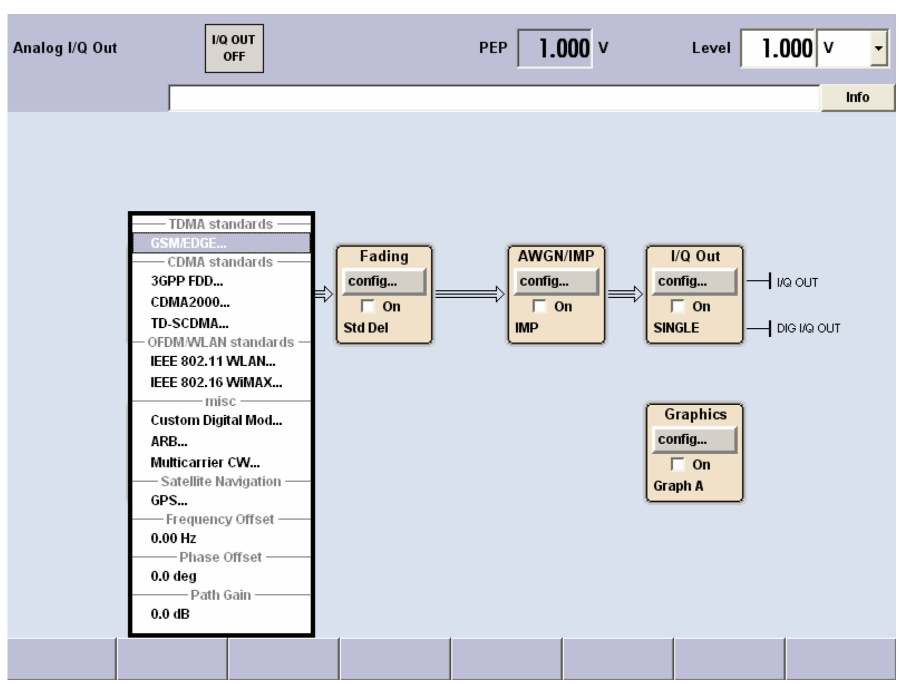
Step 2: Select and activate the GSM/EDGE signal generation

Select the **Baseband** block by turning the rotary knob.

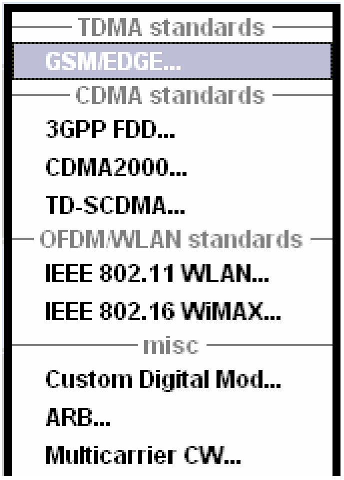




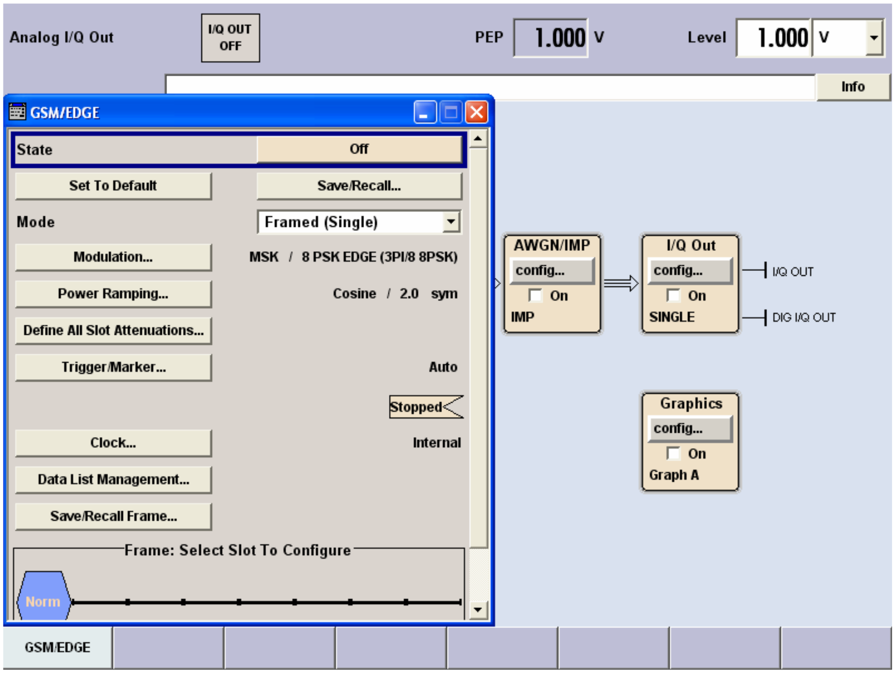
Press the rotary knob to open the menu where the GSM/EDGE modulation can be selected (different modulation modes are available depending on the options installed).

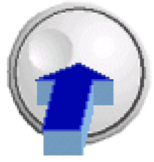


Highlight **GSM/EDGE..** by turning the rotary knob.

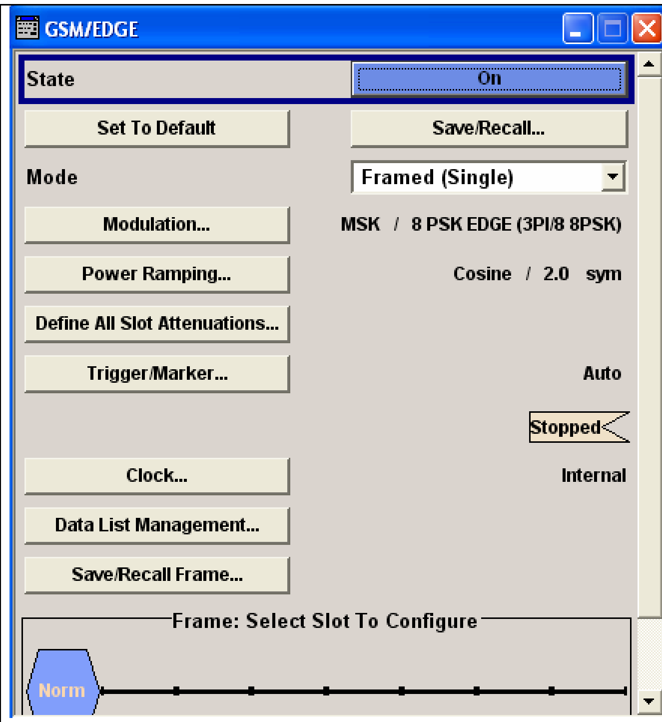


Press the rotary knob to open the **GSM/EDGE** menu.

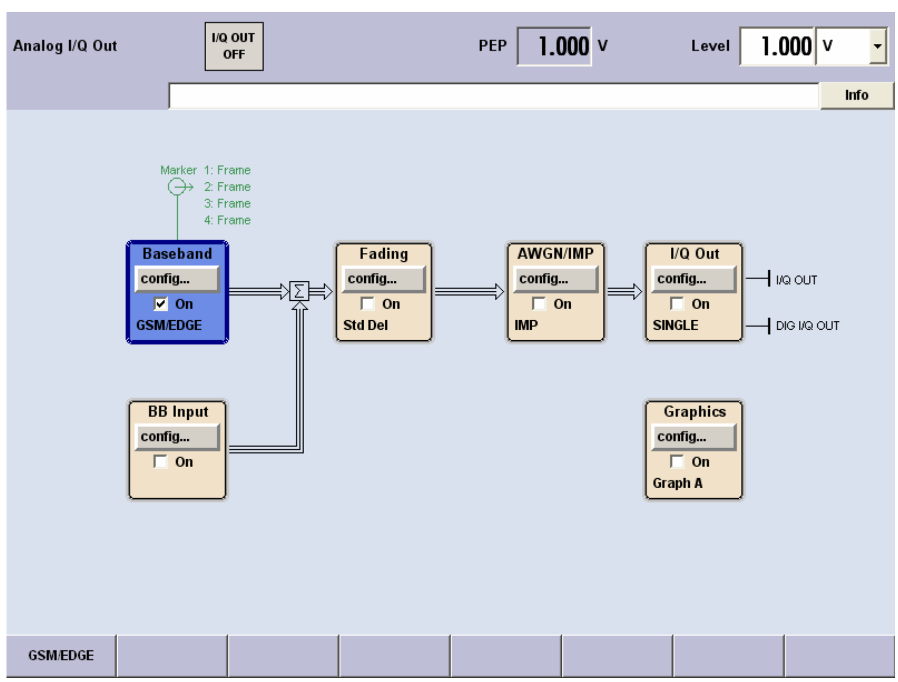




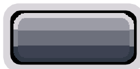
Switch on GSM modulation with default settings by selecting **State On**.



Press the DIAGRAM key to display the complete block diagram.

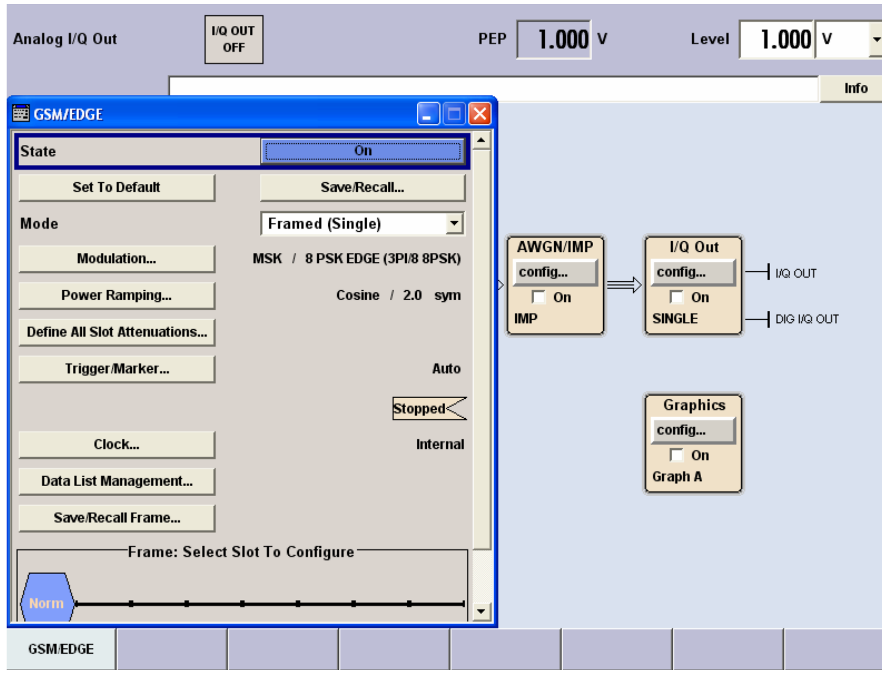


To indicate the active state, the **Baseband** block is displayed in blue and the check box **On** is ticked. The **Fading**, **AWGN/IMP** and **I/Q OUT** blocks are not yet active. The entry in the Winbar indicates that the GSM/EDGE menu is still open in the background.



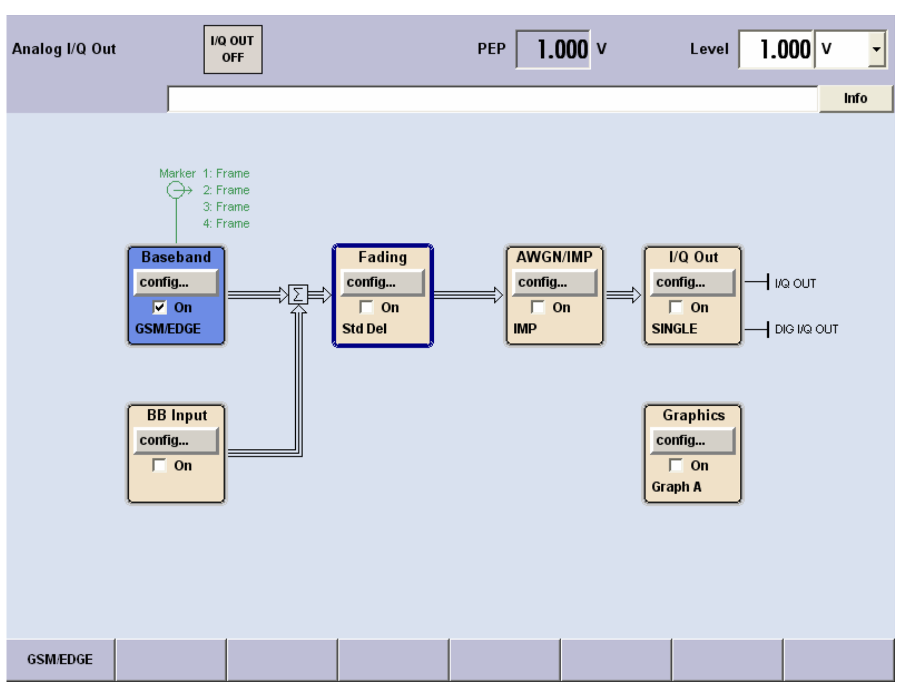
The menu can be displayed in the foreground by clicking the softkey in the Winbar or by pressing the key below the Winbar.

Press the HIDE key to minimize the menu again.

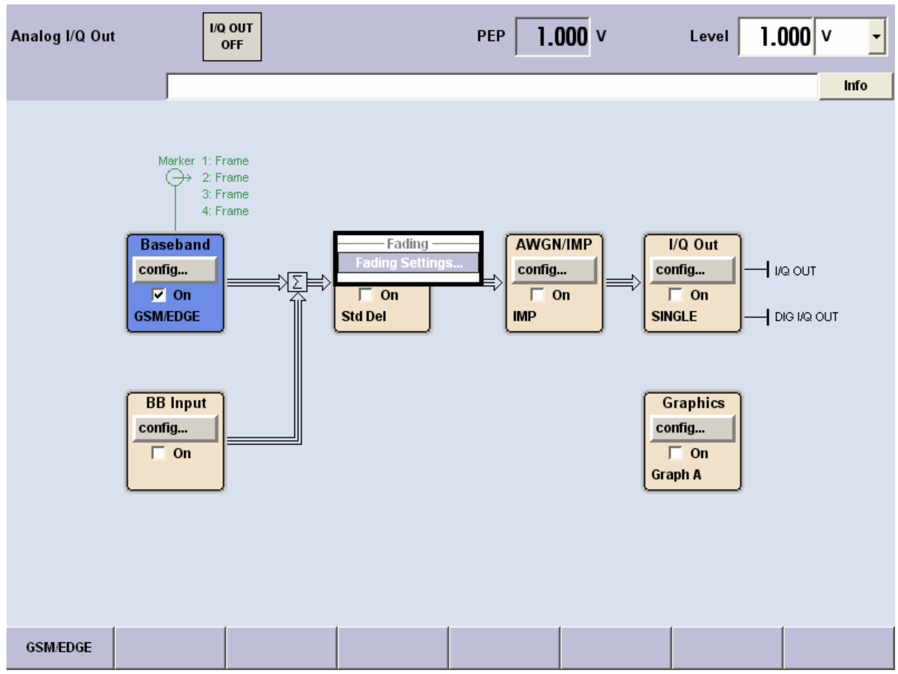


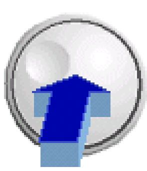
Step 3: Configure and activate the fading standard GSM TU 3 (12Path)

Select the **Fading** block by turning the rotary knob.

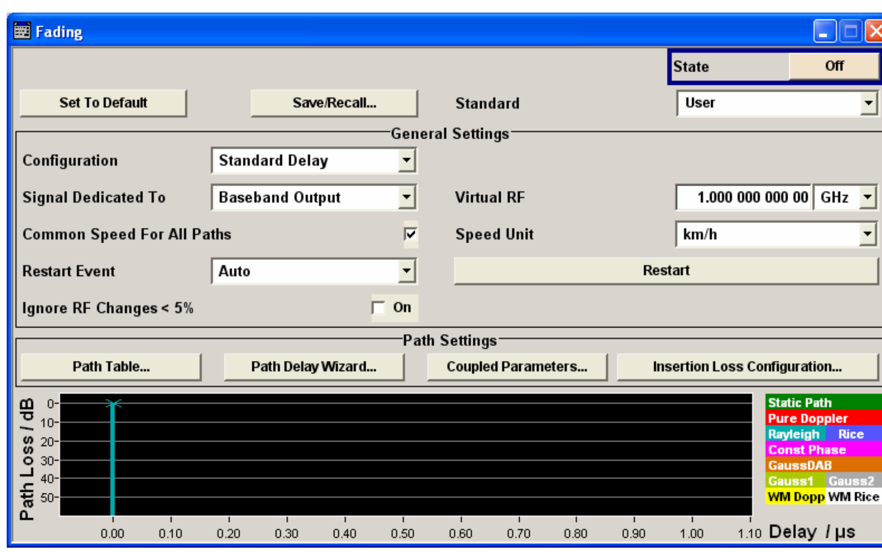


Press the rotary knob to open the menu where the fading settings can be configured.
Select **Fading Settings**.

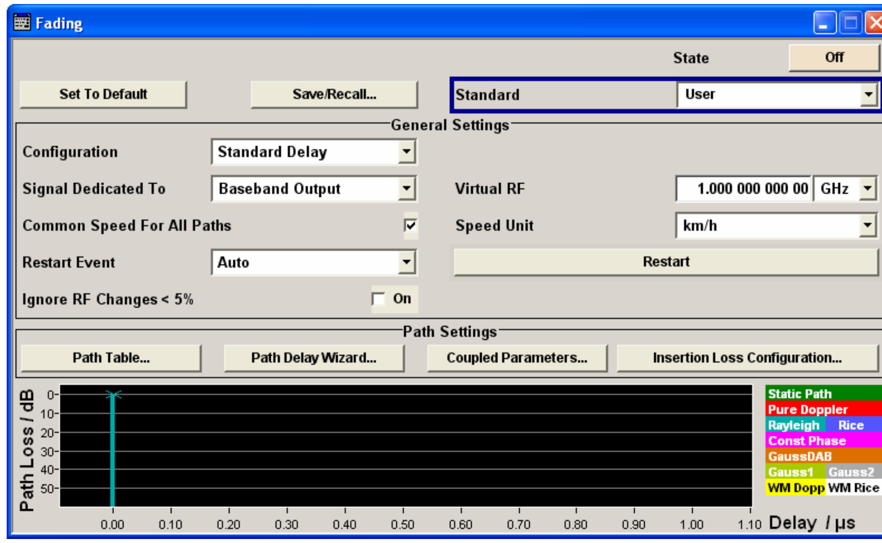




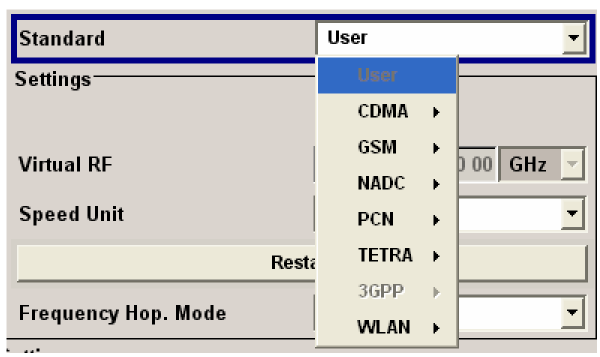
Press the rotary knob to open the **Fading** menu.



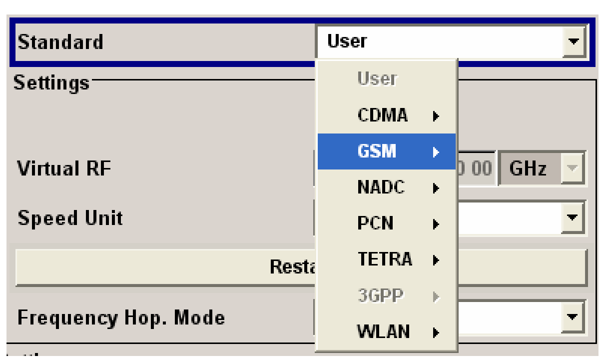
Select the **Standard** field by turning the rotary knob.



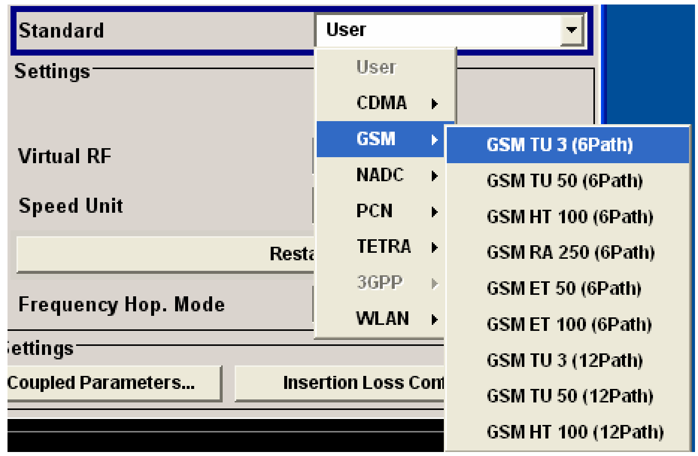
Press the rotary knob to open the **Standard** selection list.



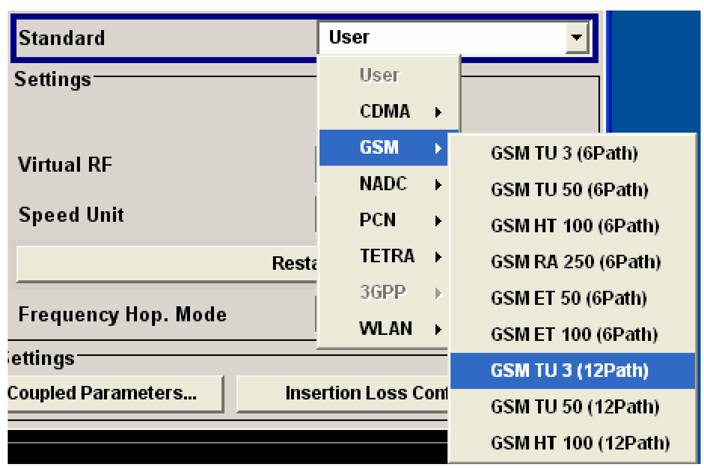
Select **GSM** by turning the rotary knob.



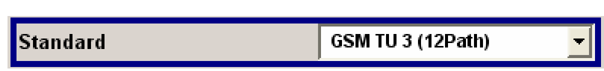
Press the rotary knob to open the **GSM** selection list.

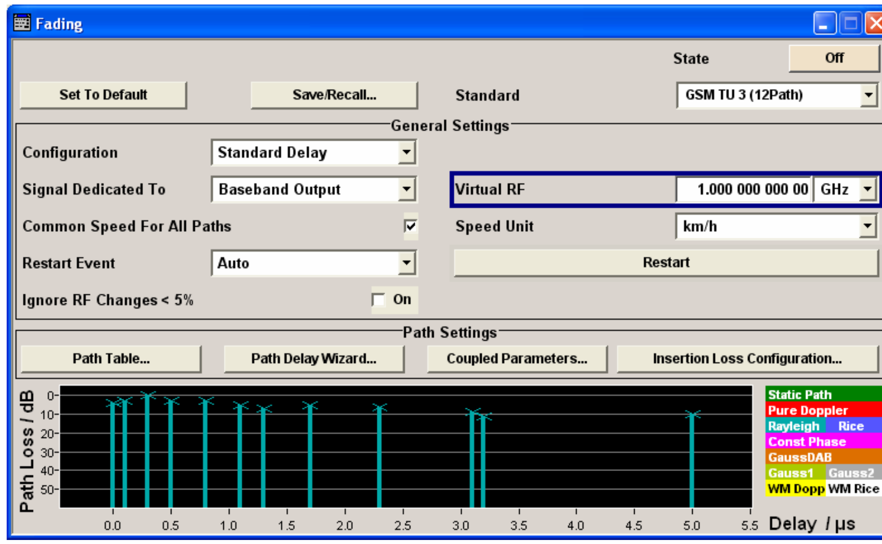
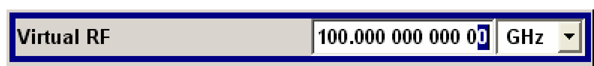
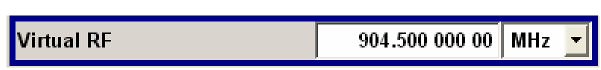
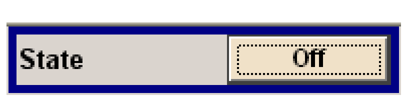


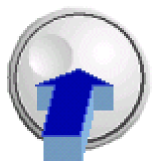
Select **GSM TU 3 (12Path)** by turning the rotary knob.



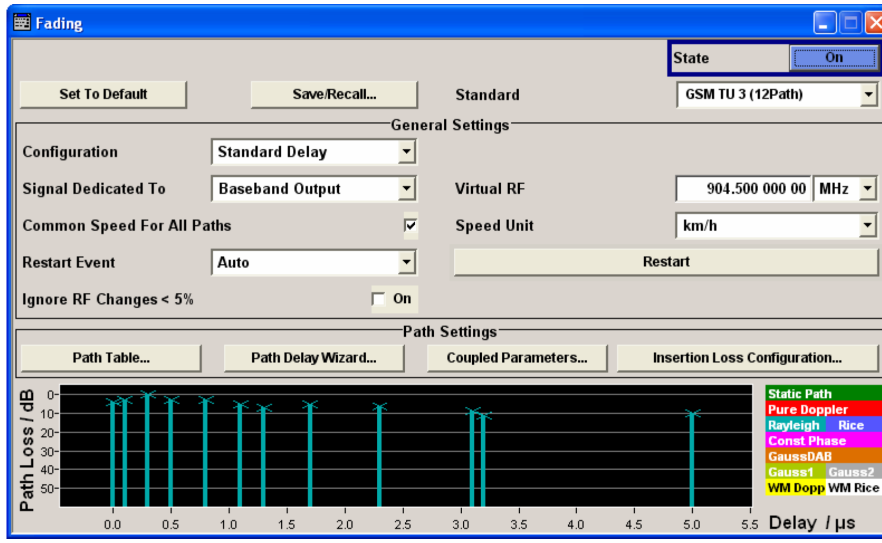
Confirm the selection by pressing the rotary knob.
The fading simulation of the standard "GSM TU 3 (12Path)" is preset.



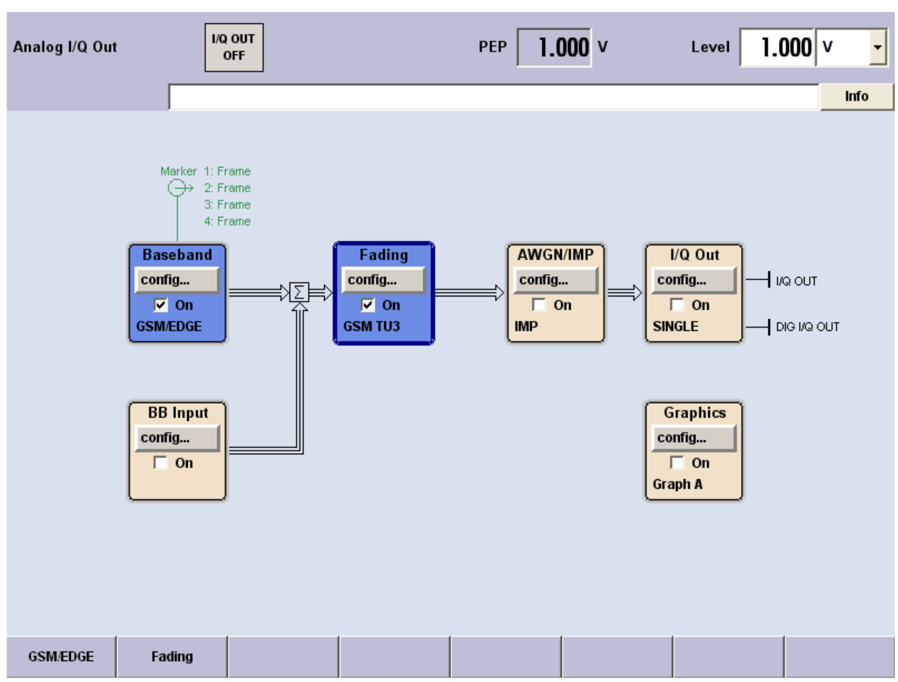
 Select the **Virtual RF** field by turning the rotary knob.	
 Press the rotary knob to activate the editing mode.	
 Enter the frequency value 904,5 MHz with the aid of the numeric keypad and the unit keys.	
 Select the **State** field by turning the rotary knob.	



Switch on the GSM fading simulation by selecting **State On**.



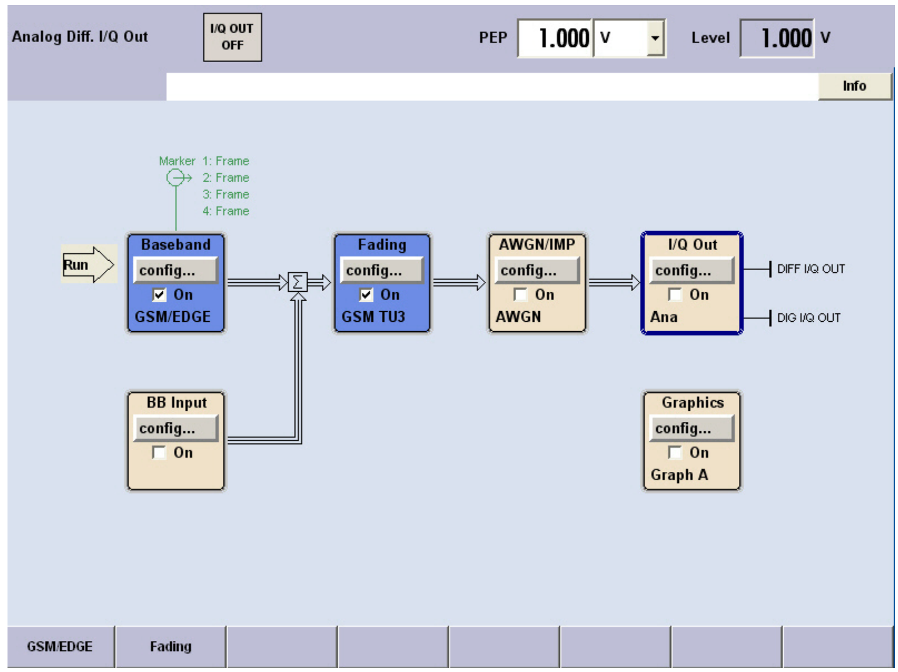
Press the DIAGRAM key to display the complete block diagram.

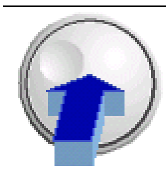


To indicate the active state, the **Fading** block is displayed in blue and the check box **On** is ticked. The **I/Q OUT** block is not yet active. The entry in the Winbar indicates that the Fading menu is still open in the background. The menu can be displayed in the foreground by clicking on the softkey (Fading) in the Winbar or by pressing the key below the Fading softkey. Press the HIDE key to minimize the menu again.

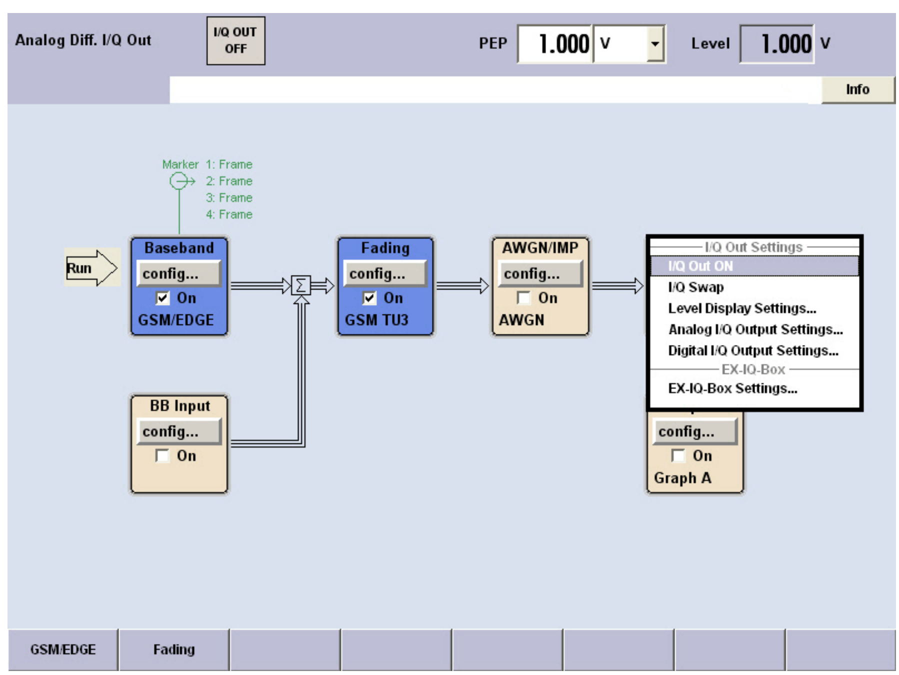
Step 4: Select and activate the I/Q signal output

Select the **I/Q Out** block by turning the rotary knob.

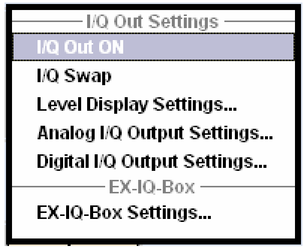




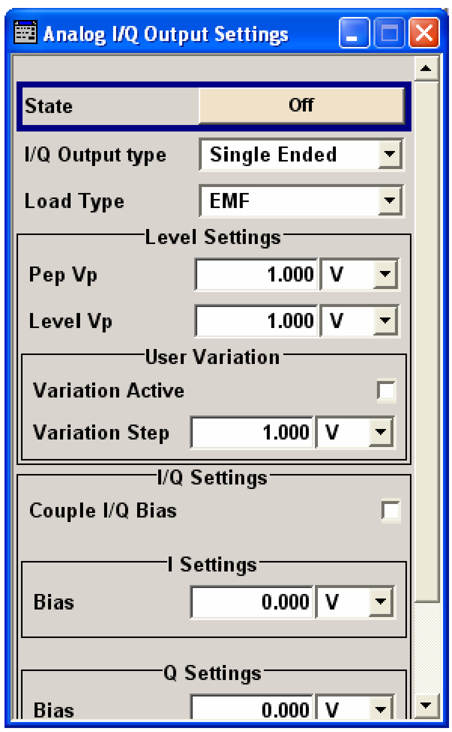
Press the rotary knob to open the menu where the output settings can be configured.



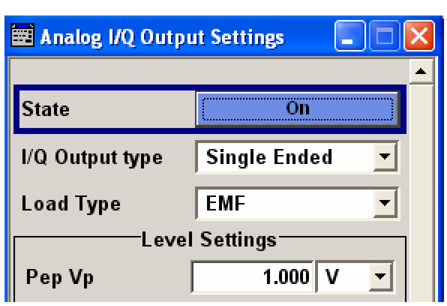
Highlight **Analog I/Q Output Settings…** by turning the rotary knob.



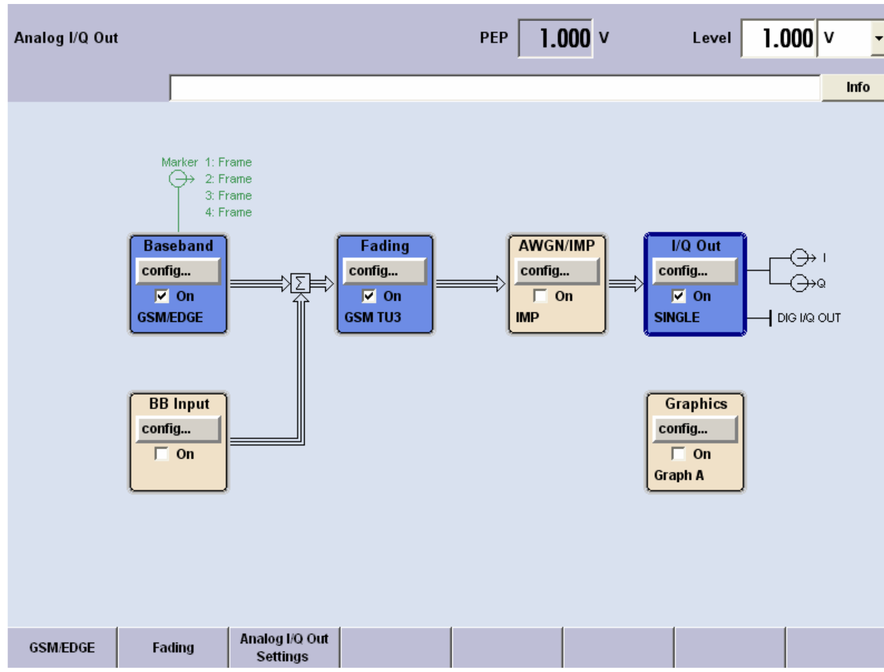
Press the rotary knob to open the **Analog I/Q Output Settings** menu.



Switch on the Analog I/Q Output signal by selecting **State On**.



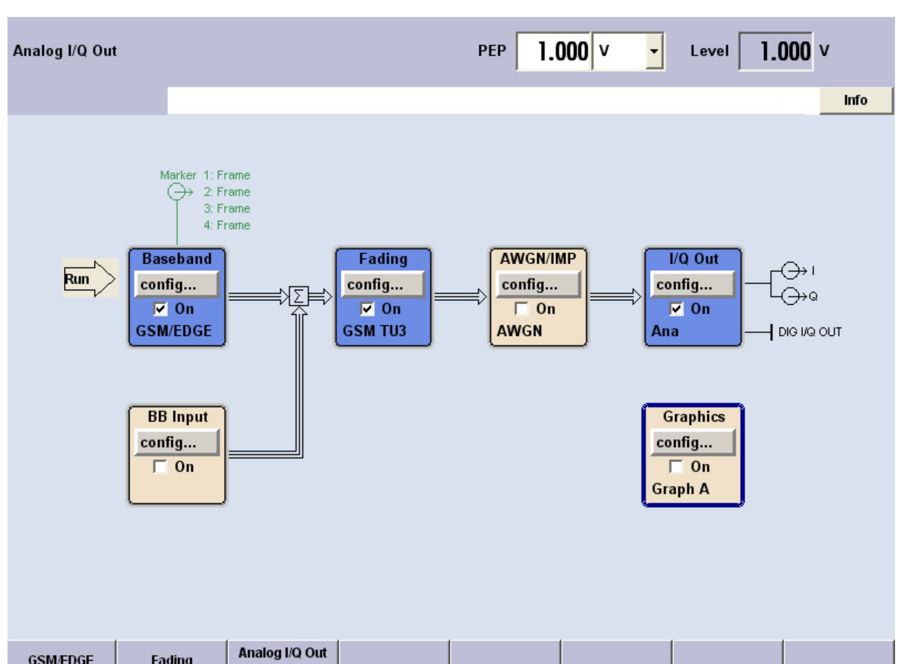
Press the DIAGRAM key to display the complete block diagram.

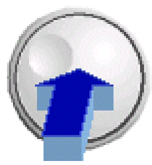
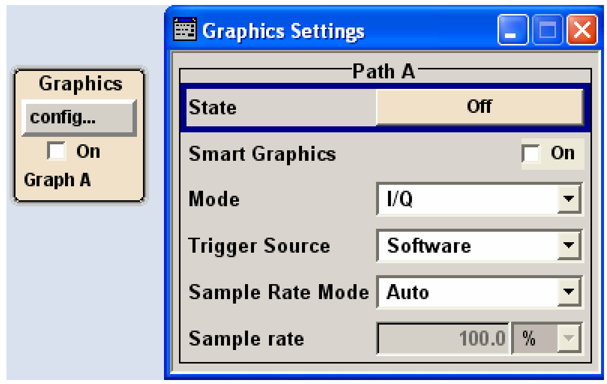
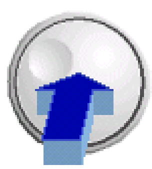
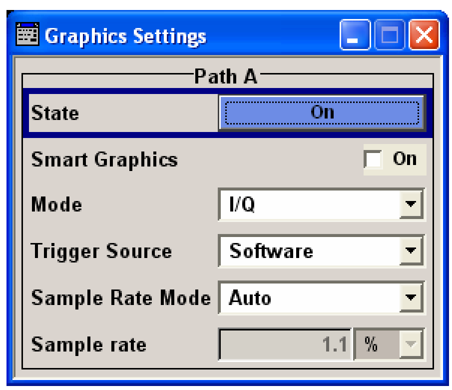
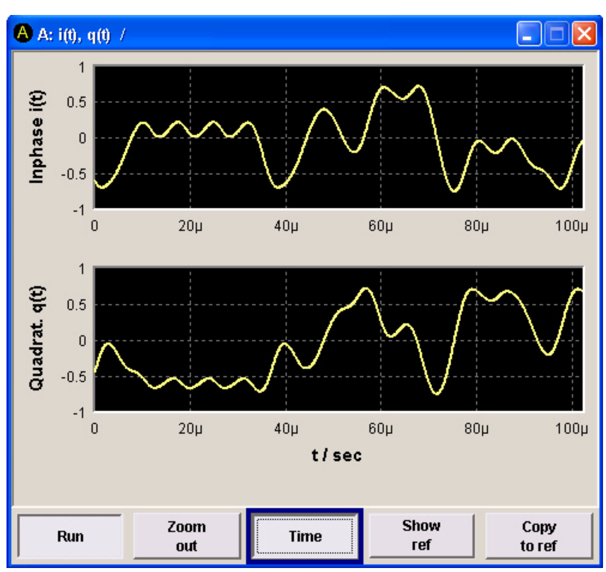


To indicate the active state, the **I/Q Out** block is displayed in blue and the check box **On** is ticked. The currently used outputs of the signal are indicated by the output symbols of the **I** and Q components. The entry in the Winbar indicates that the **Analog I/Q Out Settings** menu is still open in the background. The menu can be displayed in the foreground by clicking on the softkey (Analog I/Q Out Settings) in the Winbar or by pressing the key below the Analog I/Q Out Settings softkey.
Press the HIDE key to minimize the menu again.

Step 5: Select the graphics display of the I/Q signal

Select the Graphics block by turning the rotary knob.



 Press the rotary knob to open the **Graphic Settings** menu.	
 Switch on the Graphic display by selecting **State On**.	
The graphical display of the output signal is displayed. It can be minimized and called the same way as a menu.	

Info and Help System

The R&S AMU comprises a comprehensive **info** and **help system**. Context-sensitive help can be called any time with the HELP key. The help system indicates the currently selected parameter and offers additional services such as cross references, index, and contents. The content of the help system corresponds to the operating manual of the R&S AMU.

Warning and conflict messages caused by incorrect operation as well as further information are displayed in the **Info line**. A complete list of existing conflicts is displayed when the INFO key is pressed. Additional information on entries can be requested from the help system. The history function permits display of all messages.

Assistants simplify the completion of tables. After data entry in the assistant, the table is modified only after the **Accept** button has been pressed**.** Pressing the **Accept** button also stores the assistant data.

Detailed operating instructions and an overview of menus follow in "*Manual Operation*".
Menus and instrument functions are described in detail in chapter 4, "*Instrument Functions*".

Contents - Chapter 3 "Manual Operation"

3 Manual Operation

Introduction - Manual Operation

The R&S AMU 200A Baseband Signal Generator and Fading Simulator can be operated either via the interactive block diagram or via a menu tree. All menus are in the form of windows that can be operated in the same way. Rotary knob, keys and softkeys, or alternatively a mouse, allow direct and therefore convenient access to entries and settings. The clear-cut display shows the current state of the instrument. Numerous help functions support the user in signal configuration.

The following section describes manual operation of the R&S AMU. This includes a description of screenshots, operation of menus and the block diagram and the setting of parameters.

Chapter 4 includes a detailed description of R&S AMU functions. Chapter 2 explains the operating concept in general and includes a brief introduction to operation by a step-by-step description of the configuration. Remote control of the instrument is described in chapters 5 and 6.

Operating Concept

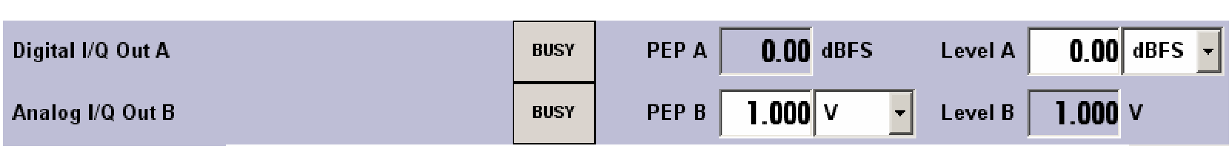
The operating concept of the R&S AMU enables the user to make settings as intuitively as possible and at the same time gives a permanent overview of characteristics of the generated signal and of the current instrument state. Numerous on-line help functions support user settings.

The block diagram is the core of the operating concept

A large graphics display showing the current configuration and the signal flow in the form of a block diagram is the core of the operating concept of the R&S AMU. The block diagram gives an overview of signal configuration, and the graphical elements can be accessed for operation. The desired element is selected by means of the rotary knob and the associated setting function is called by clicking on this button. Required menus are displayed on the block diagram which is displayed again in the foreground whenever the DIAGRAM key is pressed.

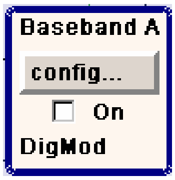
Display of level settings of the baseband output signal

The level values of the baseband signal are displayed in the header section of the screen. Depending on the instrument´s operating mode different information is displayed. Either of the values (PEP or Level) can be set directly in the field. Changing one of the values effects that the according value will be adjusted proportionally. The editable fields of path A and path B can be selected by multiple pressing the BASEBD LEVEL key.

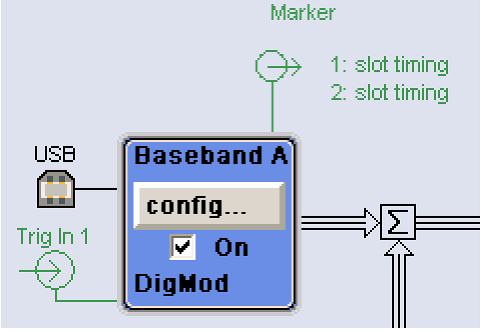


Operation via the graphics interface

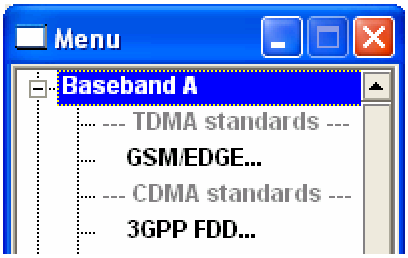
Menus are assigned to the specific function blocks in the block diagram. The function blocks represent elements of signal generation, e.g. the baseband block which contains all menus required for baseband signal configuration. In this block all digital standards and the digital modulation can be selected. Function blocks displayed with a blue frame can be directly switched on and off by means of the TOGGLE ON/OFF key. In the example, digital modulation can be activated in this way. The menus of the highlighted function blocks can be called by clicking on the rotary knob or by pressing the ENTER key.



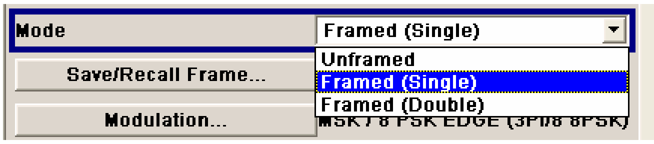
The signal flow between the function blocks and the employed inputs and outputs are also shown.



The menu tree can be opened and closed with the MENU key. The menu tree is organized in the same way as the directories under Windows. The function blocks correspond to the first directory level, the menus to subdirectories.

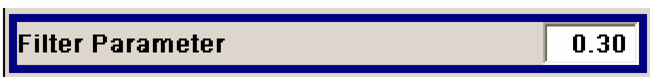


Operation corresponds to the Windows concept
To offer the user a familiar environment, operation is very similar to operation of Windows user interfaces. All menus and tables are made up of known elements, e.g. selection lists,



check boxes,

or entry fields.

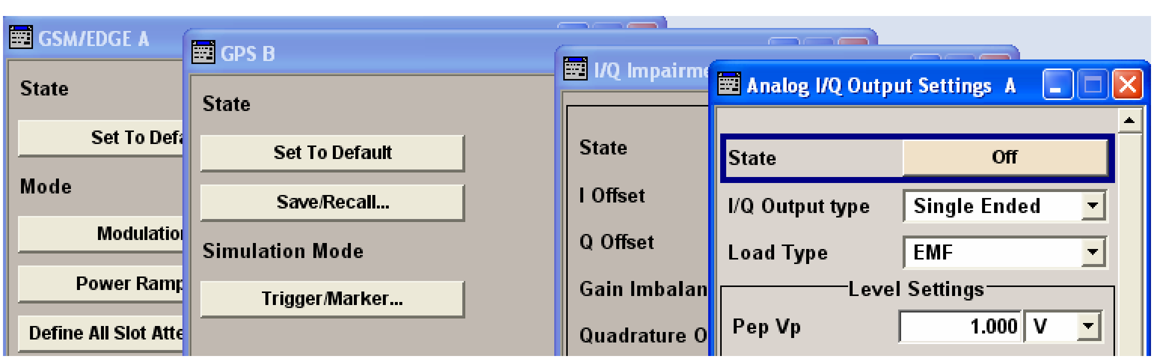


A blue frame indicates that the selected item is active. In the highlighted element, entries can be made.

Most of the settings can be easily made with the rotary knob
Operation is possible via front-panel keys, an external keyboard and the mouse. Most of the settings can be made with the rotary knob:

- Turning the rotary knob shifts the entry focus to the desired element.
- Clicking on the rotary knob activates the selected entry field.
  Depending on the parameter, the submenu is now called, the numeric value varied, the list entry selected or the check box activated or deactivated.
- If a value is entered, the entry is stored by another click on the rotary knob and the editing mode is exited.

Clear settings with the aid of independent submenus
A separate menu is opened for each menu and submenu. The menus can be operated independently of each other, i.e. none of the menus requires that settings are completed in other menus before it can be closed. This ensures flexible operation at all times.

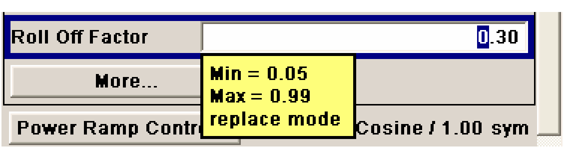


The winbar gives an overview of menus and simplifies their access.
The menus are displayed on top of the block diagram but they can be "hidden", i.e. they can be displayed in the form of a button in the winbar at the lower end of the screen (by pressing the HIDE key). They can be displayed again in full size by pressing the REARR key. This function is used to clear space on the screen for other displays that may be required but the setting menus can thus be accessed any time.

The keys are assigned simple functions
Most keys on the front panel of the R&S AMU directly perform a simple function. Since a great number of settings can thus be made by a keystroke, the operation is easy. For instance, the CLOSE key closes the active menu; with the BASEBD ON/OFF key the baseband output signal can be switched on or off.
An exception are keys that call a menu such as the MENU key which opens the complete menu tree of the R&S AMU, the SETUP key which opens the menus for general instrument settings or the FILE key which opens the menu for file management.

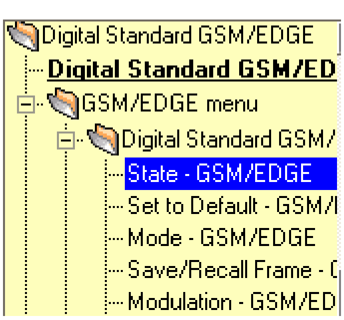
Help functions support the user

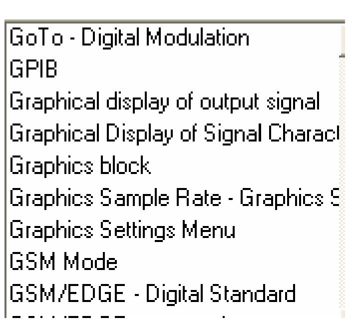
Numerous help functions support the user in signal configuration.
The valid setting range can be displayed for each numeric parameter. This requires a short wait after activation of the entry field. The range then is displayed automatically after a few seconds. If the entered value is outside the permissible range, the next permissible value is automatically set and a message is output (see below).



Context-sensitive help for each parameter can be called by pressing either the HELP or the F1 key:

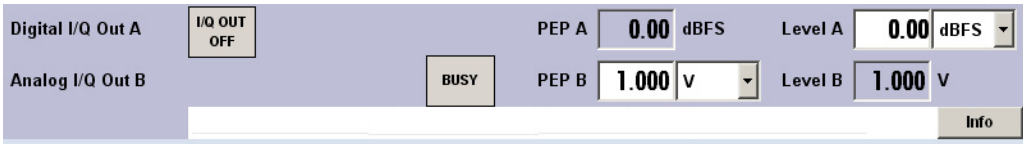
Each help page is part of a comprehensive online help function which can be called by means of the **Content**, **Index**, **Back**, **Previous** and **Next** links.



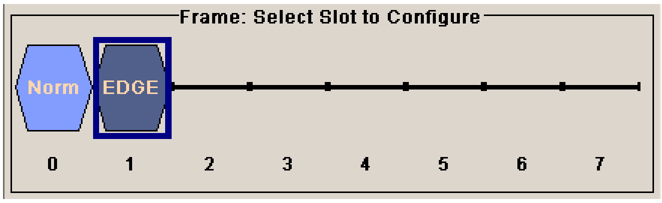


Messages indicate the current instrument state

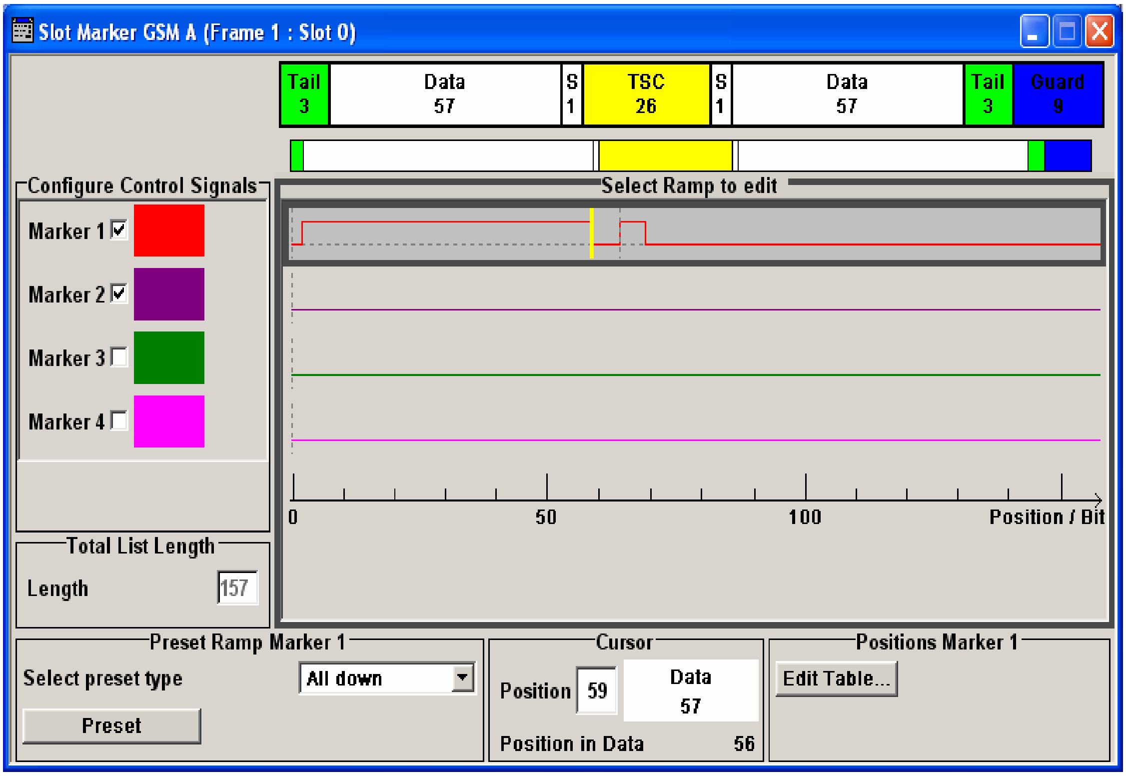
A great variety of different messages such as status messages, error messages, warnings, or information are displayed in the info field of the screen. With the aid of the [INFO] key, help pages can be called for most of the messages. They provide background information on the message and indicate operating steps that may be required. All messages are explained in the online help which can be called with the [HELP] key.



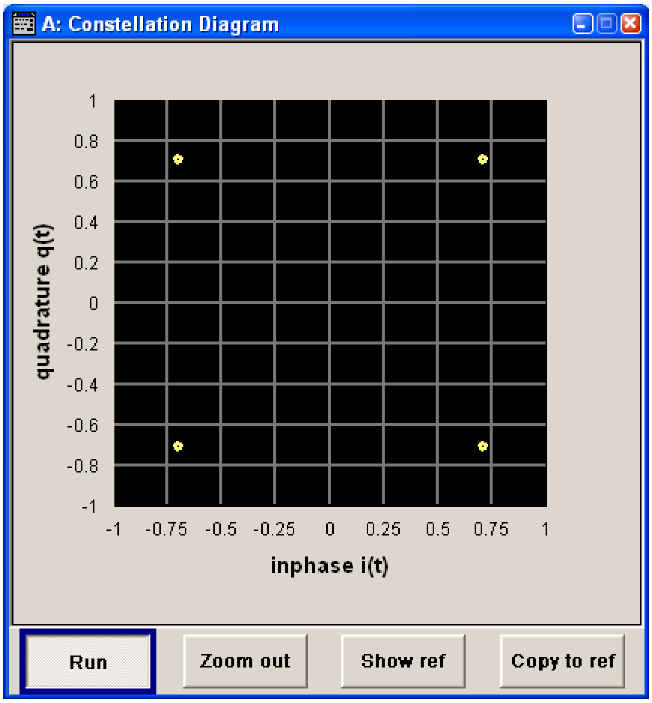
Graphical display of data structure
The structure of the baseband signal is displayed graphically in the respective menus; the individual signal elements can be graphically selected for processing.



Definition of control signals with the aid of a graphics editor
Control signals are also configured graphically.



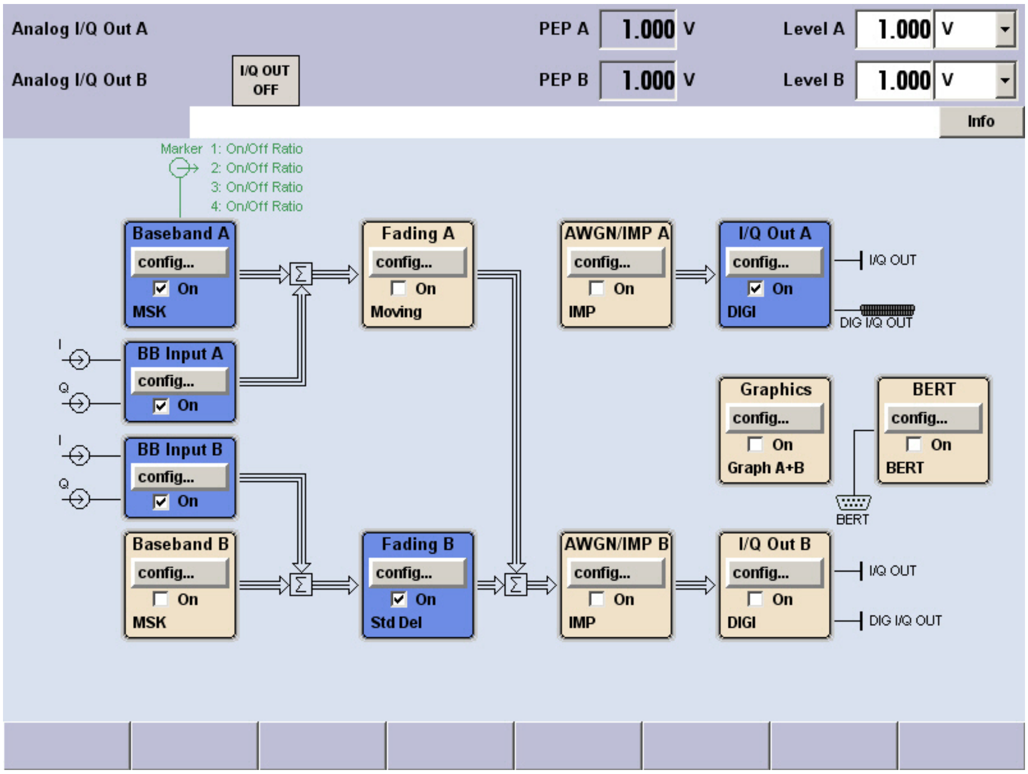
Graphical display of the output signal in a diagram
The output signal can be graphically displayed in a number of diagrams. This allows a fast check of signal characteristics. Zoom functions and the insertion of a reference trace permit in-depth evaluation without an external analyzer being required.



Display

The display shows the current state of the R&S AMU and offers graphical elements for direct operation. It is divided into three sections:

- The frequency and level display with the info line indicates the main output signal parameters and reports the current state with status, error and warning messages.
- The block diagram shows the instrument configuration, the signal characteristic as well as the inputs and outputs used and permits interactive operation via graphics elements. Active menus and graphs are displayed on top of the block diagram.
- The winbar with labelled softkeys for menu display.



Level Setting - Display

Level settings and a few status messages (see below) are displayed in the header field of the screen. The display may vary depending on the instrument's operating mode:

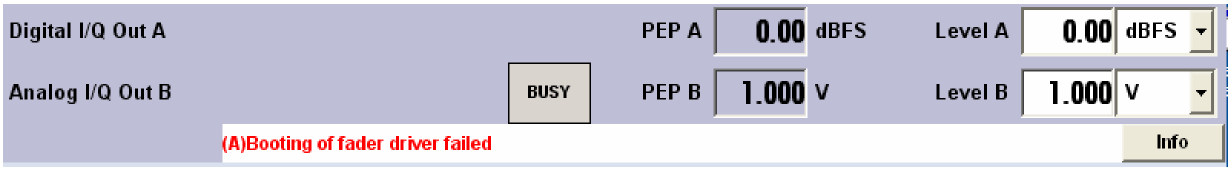
- In case of two-path instruments, the baseband signal information of the two paths is displayed in two lines.
- **PEP** indicates the peak envelope power and **Level** indicates the output voltage at the I/Q output.

Status Information and Messages - Display

The status information and messages are displayed in the header section of the screen. The messages differ with respect to their importance (errors, warnings, info) and the time of their appearance (brief and permanent messages). They require different treatment by the user. Further information on all messages can be called in the info window (see section "*Info Window - Display*").
Chapter 9, "*Error Messages*" includes an overview of all status information and messages as well as instructions for error elimination.

Status Information

The status information gives the user an overview of the main operating states and settings of the R&S AMU. The states are indicated for information only and do not necessitate any action by the user. Status information is displayed between the information on the current mode of the baseband output signal and the level fields, at the left of the info line or in the info line itself. On two-path instruments, all states that can occur independently in the two paths are displayed separately for each path. The associated path is indicated in the info line.



Messages

Messages indicate errors in the instrument. They are displayed in the info line in different colors depending on their importance and display duration. Errors (e.g. (A) Booting of fader driver failed) are displayed in red, information (e.g. file not found) and warnings in black. Warnings indicate less significant errors (e.g. the instrument operates outside specified data).

Brief messages

Brief messages report automatic settings in the instrument (e.g. switching off of incompatible types of modulation) or on illegal entries that are not accepted by the instrument (e.g. range violations). They are displayed in the info line on a yellow background. They are displayed on top of status information or permanent messages.
Brief messages do not normally demand user actions and disappear automatically after a brief period of time. They are stored in the history, however.

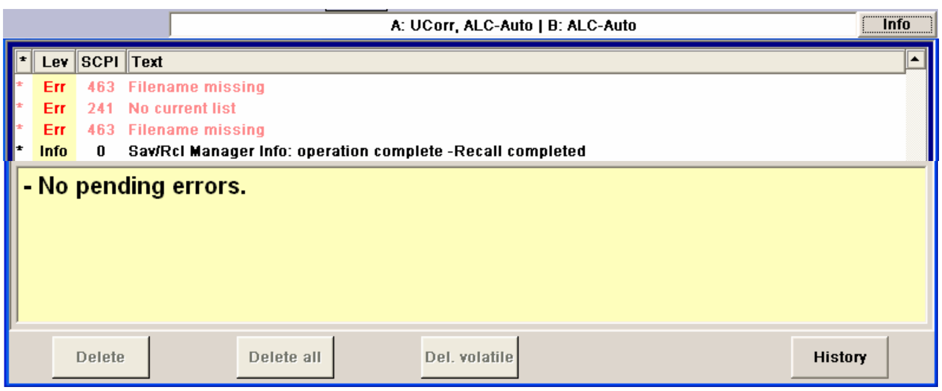
Permanent messages

Permanent messages are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signalled by a permanent message must be eliminated before correct instrument operation can be ensured.
The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

Info Window - Display

A few operating states and the current message are displayed in the info line (see also "*Error Messages*").

The info window with a list of current permanent messages and a detailed description of each message can be opened with the INFO key.
The upper section of the info window contains a list of all current permanent messages in the order of their occurrence, i.e. the most recent message is displayed first. In the lower section of the window, additional information on the highlighted message is displayed.
A history of all messages that have occurred since instrument switch-on can be called with the **History** button. The most recent message is displayed first.



Info line
List of current messages with short message text.

Detailed description for highlighted message

Softkeys

The messages are color-coded according to their level. Device-specific messages are red, info and remote control errors are black. The level is also indicated in the **Lev** column (Err, Sys or Info). Column **SCPI** indicates the SCPI error code.

With the aid of the softkey buttons, error messages can be cleared and a history of all messages called.

Delete

Clears the highlighted message. This button is available only if the history of the messages is displayed.

Remote-control command:
(see below)

Delete All

Clears all messages.
This button is available only if the history of the messages is displayed.

Remote-control command:
`SYST:ERR:ALL`

Delete Vol.

Clears all brief messages. This button is available only if the history of the messages is displayed.

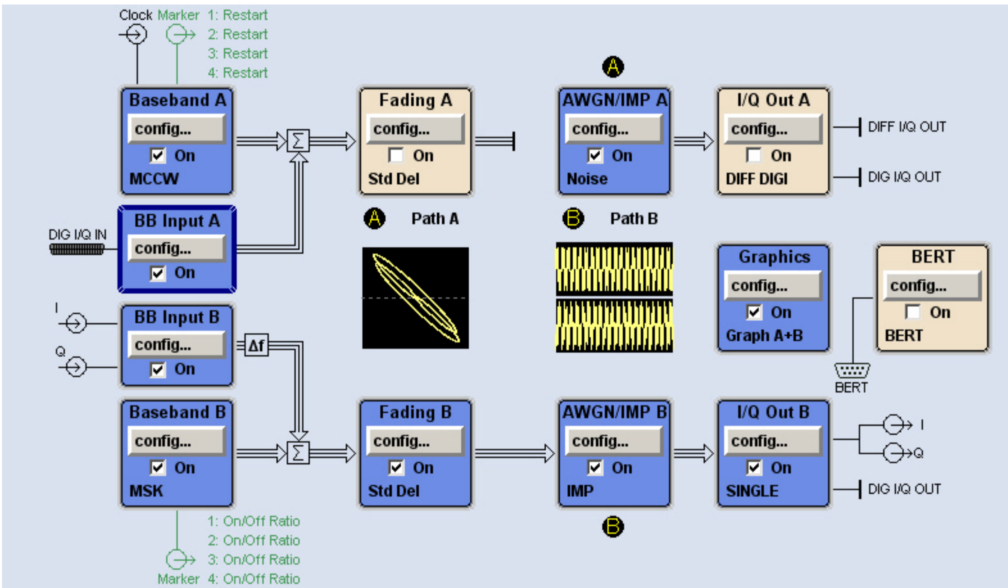
Remote-control command:
(see below)

History

Calls the list of all messages that have occurred since instrument switch-on. The most recent messages are displayed at the top of the list. When the button is pressed again, the list of current messages is displayed.
Remote-control command:
`:SYST:ERR?` or `:STAT:QUE?`
(Each time a `SYSTem:ERRor?` or `:STATus:QUEue?` query is sent, the oldest entry in the error queue is returned and at the same time cleared in the list).

Block Diagram - Display

The block diagram shows provided options, signal configuration and the currently selected signal flow of the generator with inputs and outputs used. Signal generation can be completely operated from the block diagram. The highlighted function block can be directly switched on and off with the [TOGGLE ON/OFF] key. Clicking on the rotary knob (= Enter) opens the associated setting menu.

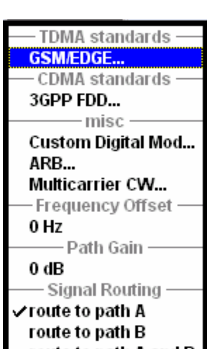


Function Blocks in the Block Diagram

Each block represents a function of signal generation. The function is indicated in the headline of the block, e.g. **Baseband A.** In this block, the digital modulation signal, the digital standards, arbitrary waveform generation and multicarrier CW are set, for instance.

In the check box ☑ On, the respective function can be quickly activated/ deactivated with the [TOGGLE ON/OFF] key. After activation, the block is displayed in blue.
A status information is displayed below the check box. It is different for the different blocks. In the baseband block, for instance, the selected modulation and associated additional information, e.g. the number of channels, are indicated.

Clicking on the rotary knob (front panel) or the **config...** button (mouse) opens the associated setting menu. In all function blocks where the signal flow can be influenced, the top menu level for setting **signal routing** parameters is offered.

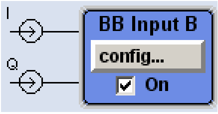


Signal Flow and Input/Output Symbols in the Block Diagram

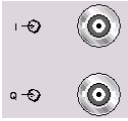
The input/output symbols in the block diagram show the currently used inputs and outputs of the R&S AMU. Unused inputs and outputs are not shown. The lines indicate the signal flow.

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

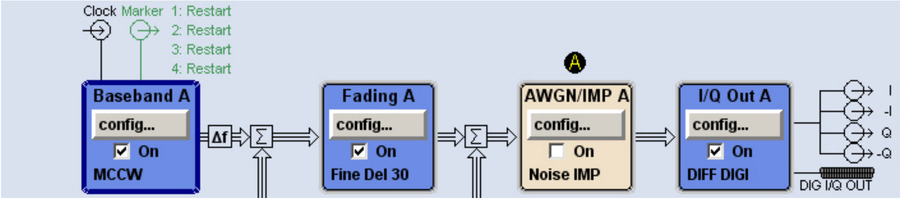
Example:



The symbols indicate the inputs for the analog I and Q signal on the instrument front panel.



The marker characteristics are listed next to the marker symbol of the active markers.



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

The signal flow is configured in the individual menus. User interfaces are configured in the Setup – **Environment – USER Marker /AUX I/O Settings** menu.

Winbar and Softkeys - Display

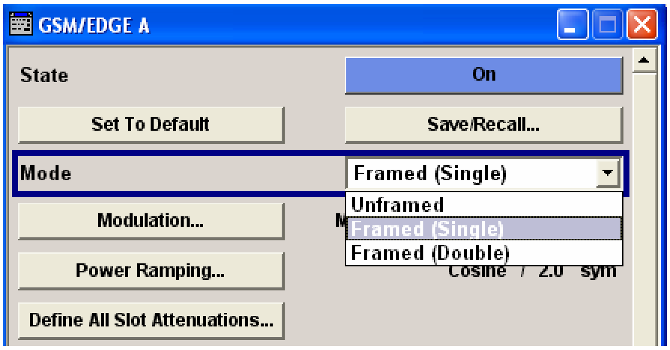
The Winbar with eight buttons is displayed below the block diagram. Labelled buttons represent open menus, the label indicates the menu. If several menus are open, the button of the currently active menu is displayed in a lighter colour. The buttons also assign functions to the softkeys of the next lower level for front-panel operation. Up to eight menus may be open simultaneously. When the ninth menu is opened, the menu that was opened first is automatically closed.

Some menus, e.g. data and list editor menus, cover the Winbar and assign menu-specific functions to the front-panel softkeys by way of the menu buttons.

Any of the open menus can be activated either with the respective button in the Winbar or the front-panel softkey. In combination with the keys for menu operation (CLOSE, HIDE and REARR), convenient menu operation can be ensured. Menu operation is described in section "*Menu Operation*", page *3.26*.

Menu Structure - Display

The parameters are set in the menus. Menus are called either via the function blocks in the diagram or by means of the MENU key. The menus are displayed on top of the block diagram. If the menu buttons assign menu-specific functions to the softkeys, the winbar is hidden.



This section describes the menu structure. Menu operation is described in section "*Menu Operation*", page *3.26*, the setting of parameters in section "*Setting Parameters*", page *3.15*.

The menus are in Windows format. They differ in details depending on their function but they consist of the same main elements.

Menu header

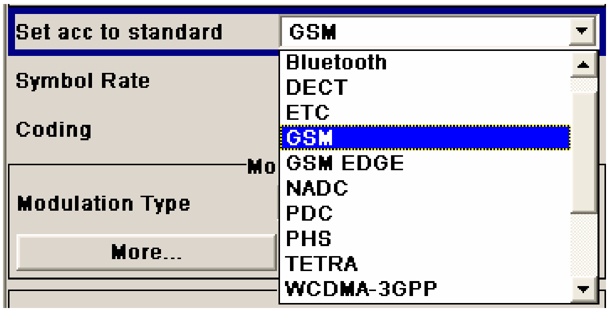
The header line contains the name of the menu (e.g. GSM/EDGE A) and the buttons for minimizing and closing the menu. The buttons can be operated with the mouse. For operation from the front panel, the HIDE and CLOSE keys can be used.

The remaining menu area is variable and comprises various fields for setting parameters.
Each of the setting fields is assigned a parameter name. The kind of setting varies depending on the parameter to be set.

Each of the setting fields is assigned a parameter name. The kind of setting varies depending on the parameter to be set.

Entry field

A numeric value (e.g. Filter Parameter) or an alpha-numeric value (e.g. file name) can be entered in those fields.

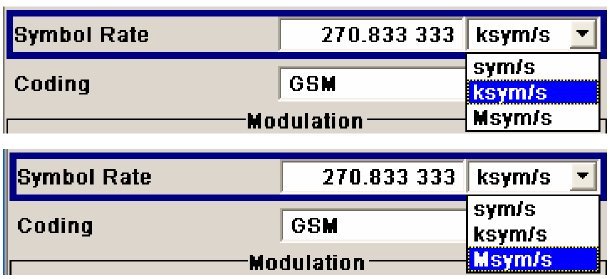


Selection field

The button indicates that a selection can be made from a list. The fold-down selection list is displayed below the selection field. Depending on the number of entries, the full list or only part of it is shown.

One entry at a time can be selected from the list.

If an item is not available for selection, it is printed in grey and cannot be accessed.

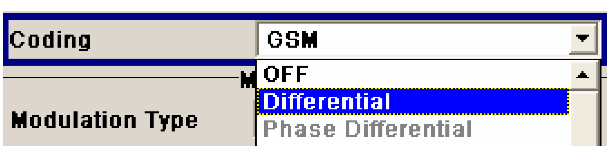


Units

The unit of a parameter is displayed next to the value. When the parameter is edited, the unit is selected either from the list or by means of the front-panel keys. When the entry is completed, the unit can be changed. In this case the value remains unchanged but is automatically adapted to the new unit.

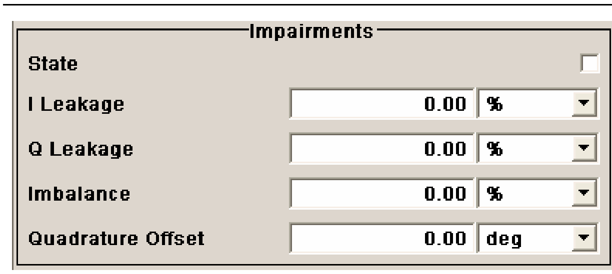
Check-box field

If the check box is ticked, the associated parameter setting is active (e.g. switched on).



Access denied

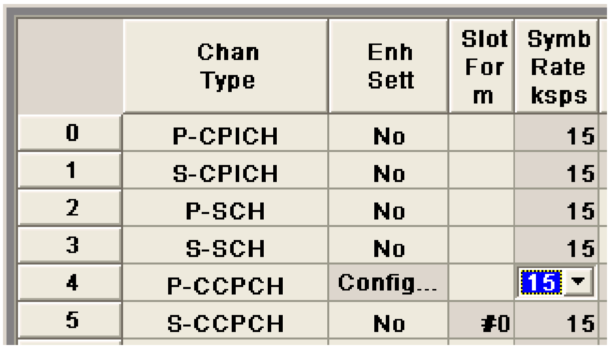
Some settings can only be made in a specific configuration. If setting is not permitted with the selected specific configuration, the respective item is disabled and displayed in grey and the entry or selection field cannot be accessed.



Menu area

Several fields of associated but separately set parameters can be organized in a menu area.

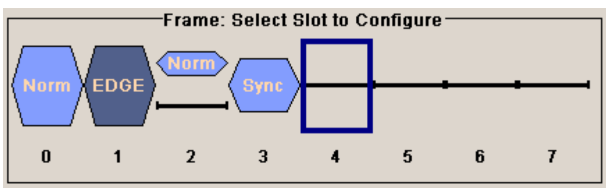
The menu area is framed and labelled with the function common to all parameters (e.g. Impairments).



	Chan Type	Enh Sett	Slot Form	Symb Rate ksps
0	P-CPICH	No		15
1	S-CPICH	No		15
2	P-SCH	No		15
3	S-SCH	No		15
4	P-CCPCH	Config...		15
5	S-CCPCH	No	#0	15

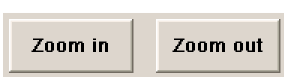
Tables

Tables are made up of a header, which normally contains the column labels, and lines containing the text.



Graphical display

Graphical displays show signal characteristics and in some of them the element to be set can be selected.



Buttons

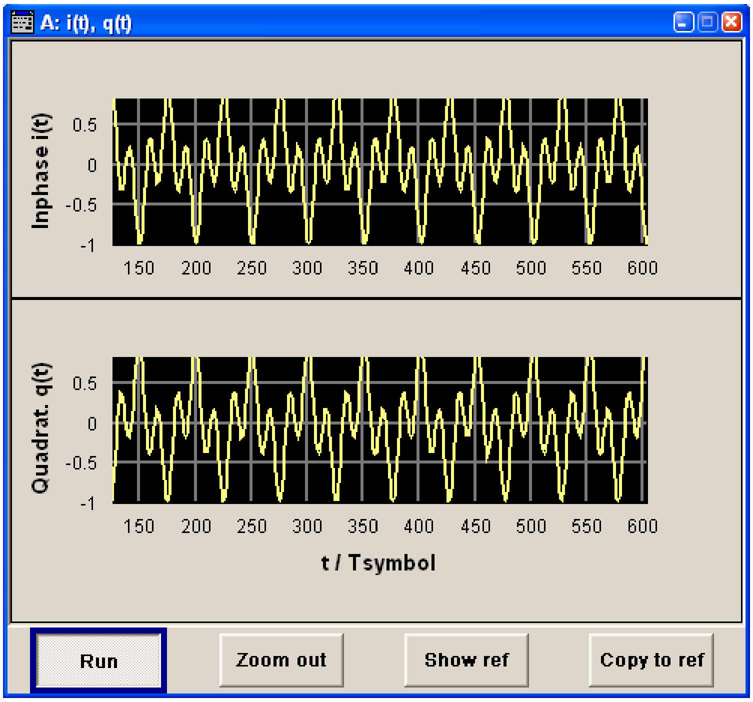
The buttons either trigger a single action (e.g. **Execute Single Sweep**), or call the next menu level (to be identified by 3 dots, e.g. **Trigger/Marker...**).

Some menus contain buttons that assign a function to the front-panel softkey below (e.g. **Zoom in** **Zoom out**). These menus cover the winbar .

Graphical Display of Output Signal Characteristics

The graphical display of the output signal enables the user to rapidly check signal characteristics without connecting an analyzer. Zoom functions and the display of a reference trace allow in-depth evaluation. The diagram is displayed on top of the block diagram. It can be minimized and called in the same way as a menu.

Example: I/Q diagram



The **Graphics Settings** menu for selecting the graphics display of the output signal can be called either via the **Graphics** function block in the diagram or with the aid of the MENU key. The operation of the graphics windows is analogous to menu operation.

The menu and the individual graphical displays are described in chapter 4, section "*Graphics Display - Graphics*".

Setting Parameters

The R&S AMU offers several and sometimes alternative possibilities for setting parameters. Operation is possible from the front panel, with the aid of a mouse and/or from a PC keyboard. Operation of the R&S AMU with the aid of these control media is shown in the tables below.

Level parameters are directly set in the header area of the display using the BASEBD LEVEL key. Some of the keys trigger a direct action, e.g. the BASEBD ON/OFF key switches the baseband output on and off. An overview of key functions can be found at the end of this chapter (see section "*Legend of Front-Panel Controls*"), a detailed description of key functions is given in "*Instrument Functions*"..

Most of the parameters are set in the menus. Menus can be opened from the function blocks of the diagram either with the aid of the rotary knob (= Enter) on the front-panel or by a mouse click on the **Config...** button.

An exception are the **Setup**, **File** and **Hardcopy** menus. In the **Setup** menu, general settings are made which are not directly concerned with signal generation, e.g. setting of the IEC/IEEE bus address. In the **File** menu, files and lists are managed; in the **Hardcopy** menu, printout is configured and hardcopies can be made. These menus can only be called with the SETUP, FILE and HCOPY keys.

Specific settings can also be made directly in the block diagram, e.g. activating a function block by means of the TOGGLE ON/OFF key. Changes affecting the signal flow are immediately visible in the graphics display.

The R&S AMU uses the Windows XP® operating system. Settings at system level are only rarely required, e.g. installation of a new printer driver. For convenient operation of Windows XP®, a keyboard and a mouse are required.

Calling a Menu - Setting Parameters

After the instrument switch-on, the cursor is always on the first function block of the diagram (default setting). It can be moved by means of the rotary knob or the arrow keys. Clicking on the rotary knob opens the menu associated with the function block. The MENU key opens the complete menu tree.
With the aid of the appropriate keys and softkeys, the cursor can also be moved to the header area or the winbar.

- The BASEBD LEVEL key activates the level entry fields in the header area.
- The DIAGRAM key moves the cursor to the block diagram.
- The WINBAR key moves the winbar to the foreground. The button that was active last in the winbar is highlighted. The associated menu is activated by clicking on the rotary knob (= Enter).
- A front-panel **softkey** immediately activates the associated menu and the cursor is on a parameter in this menu.
- The MENU key opens the complete menu tree, the FILE and SETUP keys the respective menus. Menus can be closed with the CLOSE key.
- The cursor can also be moved with the ESC key. However, the function of this key depends on the current cursor position:

  Parameter field (editing mode)**:**
  The editing mode is terminated and the previous value is restored (exception: value variations with the rotary knob cannot be cancelled).

  Menu area:
  The cursor is set to another menu area.

  Menu:
  The menu is closed and the cursor changes to the next higher control level.

  Frequency/level field:
  The cursor is set on the previously active menu or, if no menu was active, on the first function block in the diagram.

  Function block in the diagram:
  The cursor is set on the first menu in the winbar. If no menus are open, the current cursor position remains unchanged.

Function	Front panel	PC keyboard	Mouse
Activates the level entry fields in the header area.	Press BASEBD LEVEL key. Enter a value.	Press CTRL + R. Enter value.	Click on the entry field and enter value.
Activates the block diagram	Press DIAGRAM key.	Press CTRL + D.	Click on the function block.
Activates the winbar	Press softkey. Press WINBAR key .	Press CTRL + F1... F8 Press CTRL + W.	Click on a button in the winbar.
Calls the Setup or File menu or the menu tree	Press SETUP, FILE or MENU key.	Press CTRL + E (Setup), CTRL + S (File) or CTRL + M (menu tree).	Move the cursor in the function block area. Click on the right mouse button. The key emulation window is displayed. Click on the Setup, File or Menu button in the key emulation window.

Selecting a Control Element - Setting Parameters

Control elements are always selected in the same way no matter whether a function block in the diagram, a menu in the menu tree, a parameter in the menu, or an entry in a list or table is concerned.

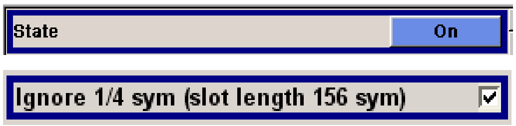
- An element is activated by means of the cursor. An active element is highlighted by a blue frame.

Function	Front panel	PC keyboard	Mouse
Selects an element	Select element by means of the rotary knob or the arrow keys.	Select element by means of the arrow keys.	Click element.

Switching Parameters On/Off - Setting Parameters

A parameter can be activated and deactivated using a button or a check box.

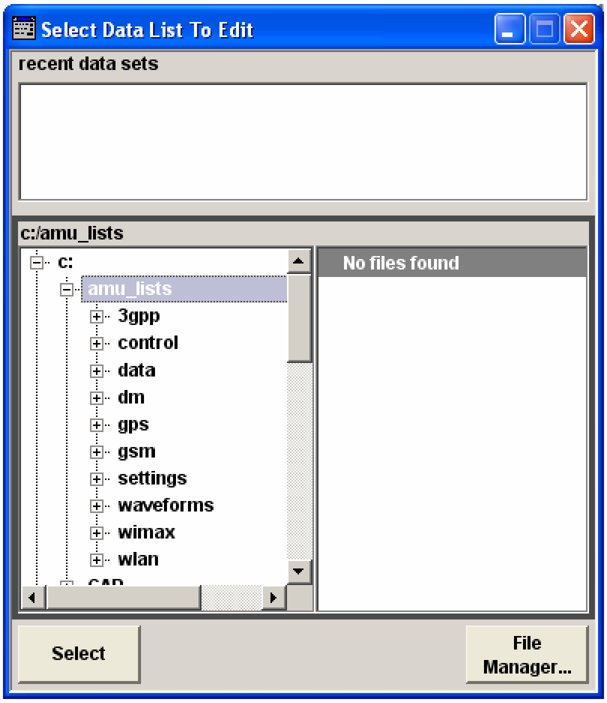
- The ENTER function of the different control media switches the highlighted element on or off (toggle function). Colour and label of a button change, the check box is ticked or the tick is removed.



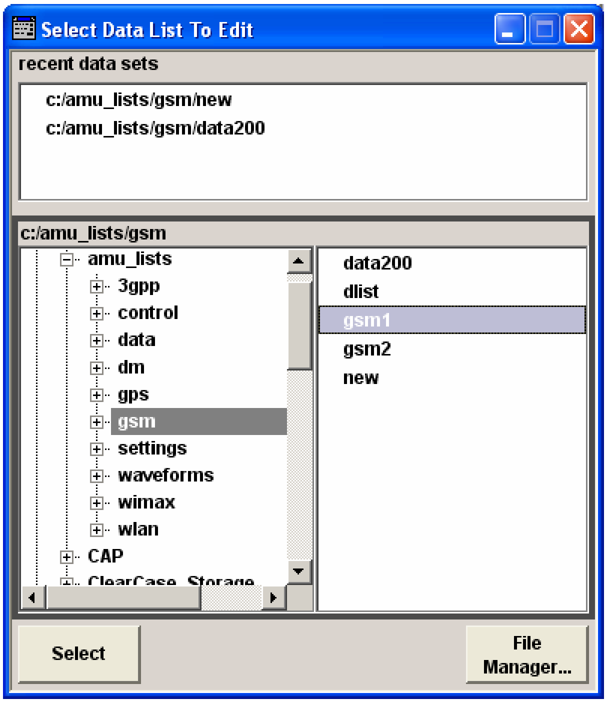
Function	Front panel	PC keyboard	Mouse
Switches on/off	Press rotary knob, ENTER or TOGGLE ON OFF key.	Press Enter key.	Click check box or button.

Selecting and Exiting a Menu Area - Setting Parameters

Some menus are organized in areas. The cursor can be moved either only within an area or between the higher-level menu areas. This applies to the **File Select** menus when files are saved or loaded. When the menu is called, one of the menu areas is highlighted by a blue frame.



- Another menu area can be selected (highlighted) by means of the rotary knob or the arrow keys.
- Clicking the rotary knob (= Enter) moves the cursor to the highlighted menu area. When the cursor is placed on a lower-level area in the menu, the area is highlighted by a grey frame. The currently selected item is printed on a blue background (in the example the selected directory). The rotary knob and the arrow keys up/down move the cursor only within the grey-framed area.



- Clicking the rotary knob (= Enter) terminates the setting, i.e. selection of a file. The cursor is either set on the next higher menu level or the menu is closed as in our example.
- The left/right cursor keys first shift the entry focus within the menu range form left to right (or vice versa); in the example, from the directory tree to the file list. Press again and the entry focus is shifted up one menu level.
- Clicking the rotary knob (= Enter) performs a setting.
  In the example of the **File Select** menu, this is the display of the subdirectories if a directory is marked and, if a file is marked, the selection of this file. After a file has been selected, the menu closes automatically.
- The ESC key moves the cursor to the next higher menu level.

Function	Front panel	PC keyboard	Mouse
Selects a menu area	Select menu area using the rotary knob or the arrow keys. Press the rotary knob or the ENTER key. Rotary knob and arrow keys up/down move the cursor only within the selected menu area.	Select menu area using the arrow keys. Press the Enter key. The arrow keys up/down move the cursor only within the selected menu area.	- (The menu area is selected by selecting an entry.)
Exits a menu area	Press the ESC key. Rotary knob or arrow keys move the cursor between different menu areas.	Press the Enter key. The arrow keys move the cursor between different menu areas.	- (The menu area is exited by setting the cursor on an item outside the area).

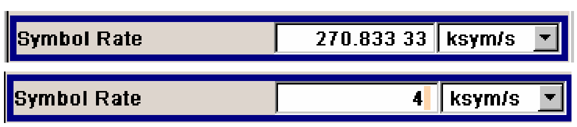
Entering a Value - Setting Parameters

Numeric and alphanumeric values can be edited in the entry fields. In the editing mode, cursors of different colour are used. A blue cursor indicates the overwrite mode, a green cursor the insert mode. The INSERT key toggles between the two modes. The insert mode is the default setting.

Numeric values can either be newly entered or the existing value can be varied. Incorrect entries are cleared with the BACK SPACE key.

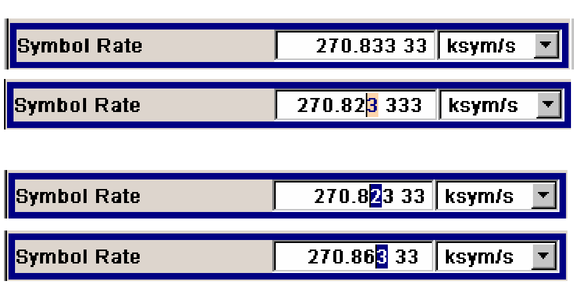
- **New entry:**
  The entry is started by clicking on an alphanumeric key.

- **Entering a new value:**
  A click on a numeric key activates the editing mode. The previous value is cleared and the new value can be entered.

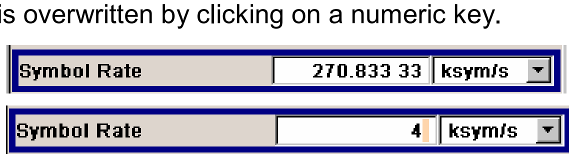


- **Editing:**
  An existing value, e.g. a file name, can be changed in the insert mode (see example) or in the overwrite mode.

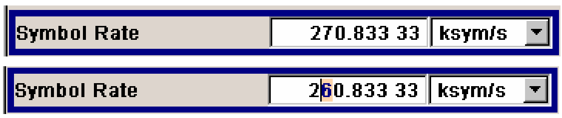
- **Editing a value in the insert mode (default setting):**
  Clicking the rotary knob (= Enter) activates the editing mode. Set the cursor to the left of the number to be changed using the left/right arrow keys. The cursor is displayed in green. A change to the overwrite mode is possible any time. In this case the cursor changes its colour and the number to be replaced is highlighted. If the cursor is placed at the right of the total value, the insert mode is always active.



- **Editing a value in the overwrite mode:**
  Clicking the rotary knob (= Enter) activates the editing mode. Set the cursor on the number to be varied using the left/right arrow keys. In the overwrite mode, the cursor is blue. The highlighted value is overwritten by clicking on a numeric key.



- **Variation:**
  Clicking the rotary knob (= Enter) activates the editing mode. Set the cursor to the left of the number to be changed using the left/right arrow keys. The value at the cursor position is varied. An increase or decrease of the value depends on the cursor used (up/down) or on the direction of rotation of the rotary knob.



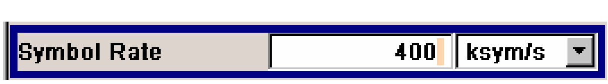
Alphanumeric values can either be newly entered or existing values can be edited (e.g. file name).

Function	Front panel	PC keyboard	Mouse
Enters a new value	Press an alphanumeric key. If **hexadecimal values** are to be entered, the numeric front-panel keys are changed to hexadecimal values automatically.	Press a letter key or a numeric key.	-
Edits a value	Click the rotary knob. Select the desired numeric digit with the rotary knob and mark it by clicking on the button. Change the number using the keypad. Use the INSERT key to toggle between the insert mode and the overwrite mode.	Press the Enter key. Select the desired numeric digit using the left/right arrow keys. Enter new value using the keyboard. Use the Insert key to toggle between the insert and the overwrite mode.	Click the desired position to set the cursor. Change the value using the keyboard.
Varies a value	Click the rotary knob. Select the desired numeric digit with the rotary knob and mark it by clicking on the button. Vary the number using the rotary knob.	Press the Enter key. Select the desired numeric digit using the left/right arrow keys. Vary the number using the up/down arrow keys.	-

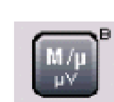
Selecting a Unit - Setting Parameters

The entry of a numeric value can be terminated by pressing a unit key on the front panel, selecting a unit in the selection field next to the value or by clicking on the rotary knob (= Enter). The unit is assigned in different ways:

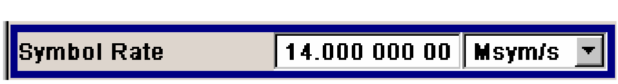
Terminating the value entry by selecting a unit in the units field
When the entry is terminated with a unit key on the front panel, the key assigns the unit to the value. In the example, the M/μ key assigns Msym/s to the entered value 14.



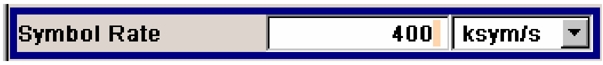
+



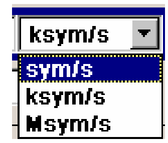
yields



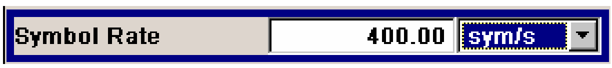
Terminating the value entry by selecting a unit in the units field
When the entry is terminated by selecting a unit in the units field next to the value, the selected unit is assigned, e.g. sym/s (for list selection see next section).



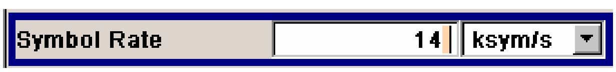
+



yields

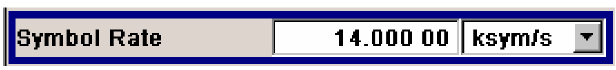


Terminating the value entry with Enter
If an entry is terminated by clicking on the rotary knob (= Enter) or with the ENTER key, the unit displayed in the entry field next to the value is assigned (in the example ksym/s).



+

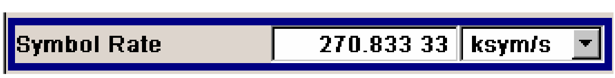
yields



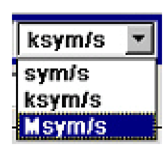
If a unit is subsequently changed, i.e. after the entry has been terminated and when the editing mode is not active, the value remains unchanged but the display is automatically adapted to the new unit. This applies if the unit is changed by means of the unit keys on the front panel or via the unit field next to the value.

+

or



+



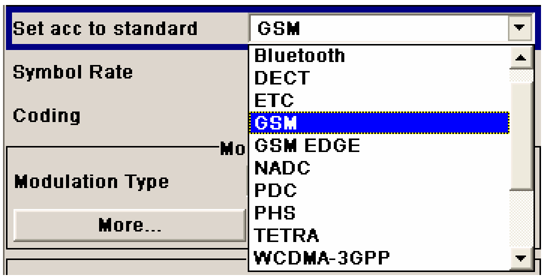
yields

Function	**Front panel**	**PC keyboard**	**Mouse**
Assigns a unit	To terminate the entry, press one of the unit keys or select unit in the field at the right of the value (for list selection see next section).	To terminate the entry press one of the key combinations ALT + F9/ + F10/+ F11/+ F12 or select the unit in the field at the right of the value (for list selection see next section).	Select unit in the field at the right of the value **before** entering the value (for list selection see next section).
Changes a unit	After the value entry has been terminated press a unit key or select unit in the field at the right of the value (for list selection see next section).	After the value entry has been terminated press one of the key combinations ALT + F9/+ F10/+ F11/+ F12 or select unit in the field at the right of the value (for list selection see next section).	Select unit in the field at the right of the value **after** the value entry (for list selection see next section).

Selecting a Value from a List - Setting Parameters

The button next to the value field indicates that a selection list is available.

- Clicking the rotary knob (= Enter) opens the list. Selection is made by choosing an entry (item is highlighted) and confirmation with ENTER. If the list is longer than the displayed window, a scroll bar is available



Function	Front panel	PC keyboard	Mouse
Opens the selection list	Press rotary knob or ENTER key.	Press Enter key.	Click button.
Selects an entry	Select entry using the rotary knob or the up/down arrow keys and confirm with the rotary knob or the ENTER key or press ON/OFF TOGGLE key several times until the desired entry is displayed in the selection field.	Select entry using the up/down arrow keys and confirm with the Enter key.	Double-click the desired entry.
Scrolls	Shift the displayed list section using the rotary knob or the up/down arrow keys.	Shift the displayed list section using the up/down arrow keys.	Press or button in the scroll bar until the desired entry is displayed.

Terminating Entries - Setting Parameters

Variations by means of the rotary knob are immediately set, e.g. baseband level variation.
All other parameter settings have to be confirmed by pressing the rotary knob or one of the unit keys (see also section "*Selecting a Unit*").

Some settings require additional confirmation with the **Accept** button. This is the case when it is useful to first enter a few values and to confirm them together, e.g. when carriers for a multicarrier CW signal are defined in the carrier table. Settings not yet confirmed by **Accept** are displayed on a yellow background in the menu. This indicates that the currently displayed values do not represent the desired signal.

All settings of instrument functions that can be switched on and off are calculated and effective only after this function has been switched on.

Calculation and setting may take up different periods of time. Many settings are made without noticeable calculation times. If a short period is required, **BUSY** is displayed during this time in the status field of the header section. If more time is required for calculation, a window with a progress bar is displayed. Calculation can be aborted with the **Abort** button in this window.

If time-consuming calculations are required, signal generation is automatically switched off and calculation is interrupted to allow the user to make further settings. Calculation is restarted with the RECALCULATE key and the modulation is switched on again when the calculation is completed.

Hint:
If several settings are to be made for an instrument function, recalculation of the signal can be prevented by switching off the function. When the function is switched on again after all parameter have been changed, the signal is recalculated only once.

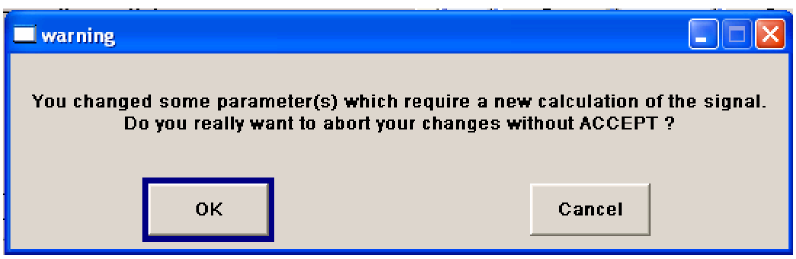
Function	Front panel	PC keyboard	Mouse
Accepts value immediately	Vary the value using the rotary knob or the up/down arrow keys.	Vary the value with the up/down arrow keys.	-
Confirms entries	Press rotary knob or ENTER key or press unit key.	Press Enter key or one of the key combinations ALT + F9/+ F10/+ F11/+ F12.	Exit entry field.
Confirms entries in the menus with the Accept button.	Press **Accept** button.	Select **Accept** button with the arrow keys and press Enter.	Click **Accept** button.
Sets the entries in the instrument	If the instrument function is active, the new value is immediately calculated and set. If the instrument function is not active, the new confirmed value is calculated and set only when the function is switched on.	(see front panel)	(see front panel)

Restoring the Previous Value - Setting Parameters

Parameter variations with the rotary knob are immediately set and therefore not reversible.
Normally, values cannot be restored also in the case of mouse control because no explicit confirmation is required in this case and entries are automatically confirmed when the entry or selection field is exited.

In the case of front-panel control or operation from the keyboard, previous values can be restored as long as the new value is not confirmed, i.e. the entry is not completed. This can be done with the [ESC] key.

With settings requiring an additional confirmation with the **Accept** button, all settings are aborted when the [ESC] key is pressed. Before the changes are aborted, a confirmation query is displayed. If **OK** is clicked on, the changes are aborted; if **Cancel** is clicked on, the menu with the previous settings is displayed again.



Function	Front panel	PC keyboard	Mouse
Restores previous values	Press the [ESC] key before the entries are confirmed.	Press the Esc key before the entries are confirmed.	-
Restores all previous values in menus with Accept button	Press the [ESC] key. Answer the confirmation query with [OK] (see above).	Press the Esc key. Answer the confirmation query with OK (see above).	Click the [X] button. Answer the confirmation query with OK (see above).
Restores all previous values after an extended calculation has been started	Press the **Abort** button in the progress bar.	Select the **Abort** button in the progress bar using the arrow keys and press the Enter key.	Click the **Abort** button.

Menu Operation

Menus are operated with the aid of the winbar buttons and with the HIDE, CLOSE, DIAGRAM and REARR keys on the front panel.
If the winbar is covered by a menu, it can be called to the front with the WINBAR key.

- The DIAGRAM key moves the cursor to the block diagram. All active menus are minimized and displayed as winbar buttons. They are still open and can be displayed again with the WINBAR key.
- The CLOSE key closes an active menu.
- The HIDE key minimizes an active menu. It is displayed as a Winbar button.
- The REARR key rearranges all open menus that where shifted outside the display range with the mouse. Then they overlap as little as possible.
- The WINBAR key toggles the cursor between a winbar button and the block diagram.

Note:
The ESC key also closes the active menu if the cursor is at the highest menu level.

Function	Front panel	PC keyboard	Mouse
Displays the block diagram in the foreground	Press the DIAGRAM key.	Press CTRL + D.	Click function block.
Displays a menu in the foreground	Press the associated button.	Press CTRL + F1 to F8.	Click the respective button in the winbar.
Minimizes an active menu	Press the HIDE key.	Press CTRL + H.	Click the ☒ button in the menu bar.
Closes an active menu	Press the CLOSE key.	Press CTRL + G.	Click the ☒ button in the menu bar.
Hides all menus	Click the DIAGRAM key.	Press CTRL + D.	-
Automatically arranges displayed menus	Click the REARR key.	Press CTRL + A.	The menus can be shifted with the mouse as required. The frequency and level fields and the info line cannot be covered, however.

Editors

The R&S AMU provides user-friendly editors for defining data lists as well as control and marker signals. Internally generated data lists can be used for digital modulation and digital standards; the same applies to internally defined control and marker signals.
The lists are saved to files and may thus have any length. The file name of the lists and the directory to which the files are saved are user-selectable. The file prefix is different for each list type and is permanently assigned by the system (see section "*File Management*").

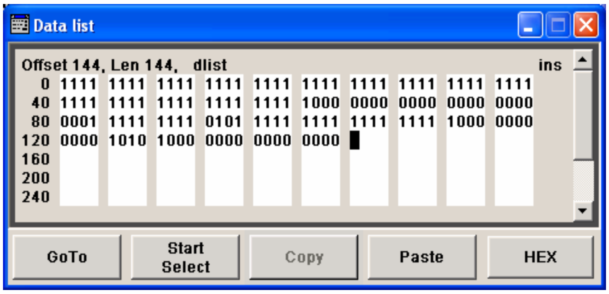
Data Editor

The **Data Editor** can be used to internally generate binary data lists for digital modulation and digital standards.

A list of binary values with a maximum length of 2^31 bits can be entered in the **Data Editor**. This value corresponds to a file size of approx. 268 Mbyte. While it is being processed, the file is continuously automatically buffered. When the menu is exited, the file is automatically saved with the new values, i.e. there is no extra **Save** button. Depending on the size of the file, saving may take some time.

It is called up in the individual menus by means of the **Edit Data List...** button.

- The selected data list is displayed.



- To increase readability, the bits are displayed in groups of four. The current cursor position, the length of the list and the list file name are displayed above the list. The offset starts with the value 0 which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.
- An existing list can be edited in the insert or overwrite mode.
- By means of the **GoTo** button, any bit position can be accessed.
- By means of the **Start Select** , **Copy** and **Paste** buttons, any range of bits can be marked, copied and subsequently pasted at any position in the list.
- By means of the **HEX** button, switchover to hexadecimal display is possible.
- For a new list to be edited, it must first be created in the **File Select** menu (see section "*File Management*", page 3.36) and then selected.

Function	Front panel	PC keyboard	Mouse
Call up editor. The cursor marks the start value of the list.	Use the rotary knob or the cursor keys to mark the **Edit Data List...** button in the list management submenu of the individual menu, click on the rotary knob or press the ENTER key.	Mark the **Edit Data List...** button in the list management submenu of the individual menu and press the Enter key	Click the **Edit Data List...** button in the list management submenu of the individual menu.
Enter value. Depending on selected mode, either insertion or overwrite, the value is either inserted or it replaces an existing value.	Use the numeric keys to enter the values 0 or 1.	Use the numeric keys to enter the values 0 or 1.	-

Function	Front panel	PC keyboard	Mouse
Delete value. The value before the marked bit is deleted.	Use the rotary knob or the cursor keys to mark the bit that follows the value to be deleted. Press the [INSERT] key to activate the insertion mode. Values cannot be deleted in the overwrite mode. Press the [BACKSPACE] key.	Use the cursor keys to mark the bit that follows the value to be deleted. Press the Insert key to activate the insertion mode. Values cannot be deleted in the overwrite mode. Press the Backspace key.	-
Select bit position. The cursor marks the bit at the selected position.	Use the rotary knob or the cursor keys to mark the **GoTo** button, click on the rotary knob or press the [ENTER] key. Enter the bit position in the **GoTo Offset** entry field by means of the numeric keys, click on the rotary knob or press the [ENTER] key.	Mark the **GoTo** button and press the Enter key. Use the numeric keys to enter the bit position in the **Offset** entry field and terminate the entry by pressing the Enter key.	Click bit.
Copy and paste bits. The selected and copied bits are pasted after the selected position.	Use the rotary knob or the cursor keys to mark the start bit of the selection. Press the [ESC] key. Use the rotary knob or the cursor keys to mark the **Start Select** button, click on the rotary knob or press the [ENTER] key. Use the rotary knob or the cursor keys to mark the selection. Press the [ESC] key. Use the rotary knob or the cursor keys to mark the **Copy** button, click on the rotary knob or press the [ENTER] key. Use the rotary knob or the cursor keys to mark the insert position. Press the [ESC] key. Use the rotary knob or the cursor keys to mark the **Paste** button, click on the rotary knob or press the [ENTER] key.	Move the cursor to the start of the selection. Press the ESC key. Mark the **Start Select** button and press the Enter key. Move the cursor to the end of the selection. Press the ESC key. Mark the **Copy** button and press the Enter key. Move the cursor to the insert position. Press the ESC key. Mark the **Paste** button and press the Enter key.	Click the bit at the start of the selection. Click the **Start Select** button. Click the bit at the end of the selection. Click the **Copy** button. Click the bit position after which the copied bits should be pasted. Click the **Paste** button.

Function	Front panel	PC keyboard	Mouse
Display and edit the values in hexadecimal form. Each four bits are displayed as a hexadecimal value: To increase readability, the hexadecimal values in turn are displayed in pairs of two. The hex functions are automatically assigned to the numeric keys at the front panel.	Use the rotary knob or the cursor keys to mark the **Hex** button, click on the rotary knob or press the ENTER key.	Mark the **Hex** button and press the Enter key.	Click the **Hex** button.
Save list. The list is saved automatically when the menu is closed.	Press the ESC key.	Press the ESC key.	Click the ☒ button in the menu bar.
Create new list.	Mark the **Data List...** button in the list management submenu of the individual menu, click on the rotary knob or press the ENTER key. Mark **Create New List,** click on the rotary knob or press the ENTER key. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37).	Mark the **Data List...** button in the list management submenu of the individual menu and press the Enter key. Mark **Create New List** and press the Enter key. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37)	Double-click on the **Data List...** button in the list management submenu of the individual menu. Double-click on **Create New List**. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37)

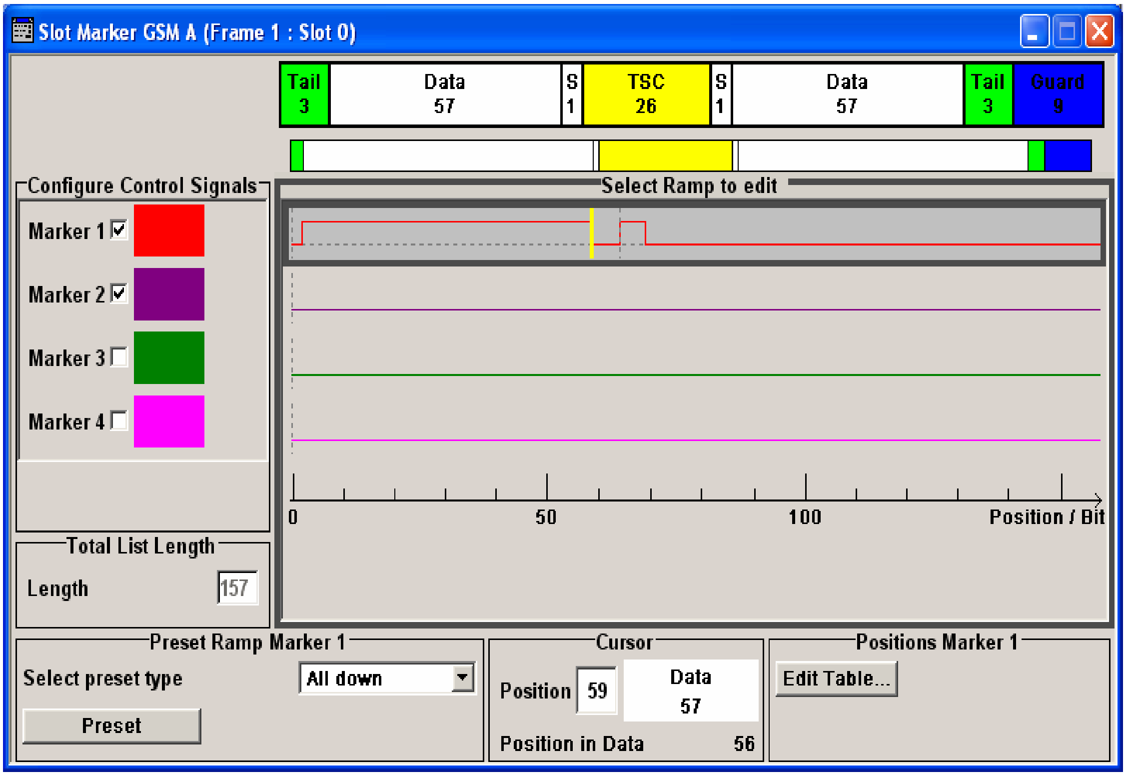
Control and Marker List Editor

The control and marker signals for digital modulation and digital standards can be very conveniently graphically defined in a **Control and Marker List Editor**.

The four available marker signals – and, with custom digital modulation, the CW, Hop, Burst Gate and Lev Att control signals – can be defined in the **Control and Marker List Editor**. While it is being processed, the file is continuously automatically buffered. When the menu is exited, the file is automatically saved with the new values, i.e. there is no extra **Save** button. Depending on the size of the file, saving may take some time.

The **Control List Editor** is called up in the Custom Digital Mod menus by means of the **Edit Control List...** button.
The **Slot Marker Definition** Editor is called up in the Burst submenu of the GSM/EDGE menus by means of the **Slot Marker Definition...** button.

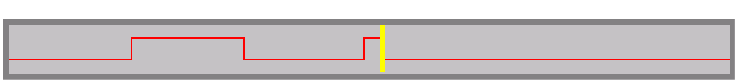
The following figure shows the **Slot Marker Definition** Editor of the GSM/EDGE menu as an example.



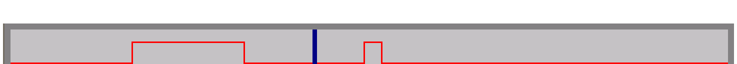
- The upper area displays the signal (in the example, the GSM slot) for which the marker signals are to be defined. On the left side, the available signals (marker and control signals) are listed and colour-coded.
- Auxiliary functions are offered in the lower editor area, e.g. presetting for the ramps in the marker signal, cursor positioning by entering the bit position and possible editing by means of value entries in a table.
- The actual graphic definition of the control signals occurs in the center area of the editor. Each control signal is represented by means of a colored line along the bit axis. A cursor can be shifted alongside this line and marks the position where a ramp is to be set.

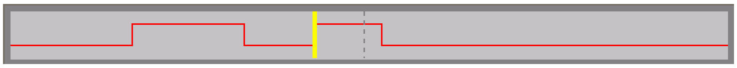
  The color of the cursor changes depending on the current function. The switch over between the colors (and therefore functions) is by means of the Enter key:
  black: marks the bit position on the marker line
  yellow: sets a ramp
  green: activates the marked ramp for shifting

  The ramp transition of the newly set ramp depends on the current status (high/low) of the control signal. If the signal is low, a ramp with low/high transition is generated; if the signal is high, a ramp with high/low transition is generated.

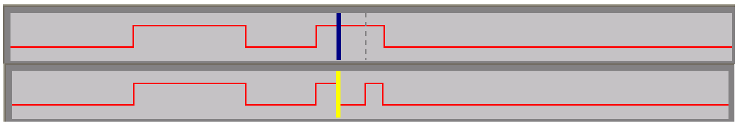


When ramps are set between existing ramps, the transition of the new ramp is also defined by the status of the signal before the new ramp. For this reason, a ramp that has already been set can be assigned low/low or high/high transition (as in the example), i.e. it will have no effect on the control signal in this configuration. However, the ramp remains saved, and its position is indicated by a dashed line.

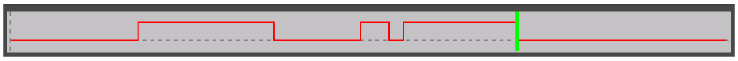




If another change produces effective transition, this ramp will be regenerated.



- An existing ramp can be shifted to any positions. The transitions are adjusted accordingly.



- To make the setting easy, a selection of preset ramp characteristics is offered in the **Preset Signal** area.
- In the **Cursor** area, the cursor can be specifically set to a defined bit position in the data signal.
- The ramps can also be set in the table in the **Marker Positions** area.

The various functions of the editor are explained in the individual menus. The following table explains only the general use of the graphic editor.

Function	**Front panel**	**PC keyboard**	**Mouse**
Call up editor. The cursor marks the first control signal in the list on the left side of the menu.	Use the rotary knob or the cursor keys to mark the button in the individual menu, click on the rotary knob or press the [ENTER] key.	Mark the button in the individual menu and press the Enter key.	Click the button in the individual menu.
Activate control/marker signal line for editing The cursor is active for the selected line.	Use the rotary knob or the cursor keys to mark the editable graphic area, click on the rotary knob or press the [ENTER] key. Use the rotary knob or the cursor keys to mark the control/marker signal line, click on the rotary knob or press the [ENTER] key.	Use the cursor keys to mark the editable graphic area and press the Enter key. Use the cursor keys to mark the control/marker signal line and press the Enter key.	Click row.
Set ramp. The ramp transition depends on the status (high/low) of the control/marker signal before the ramp.	Use the rotary knob or the cursor keys to move the cursor to the position where the ramp is to be inserted. Click the rotary knob or press the [ENTER] key.	Use the cursor keys to move the cursor to the position where the ramp is to be inserted. Press the Enter key.	Double click on the cursor; the cursor changes colour and the ramp is inserted.

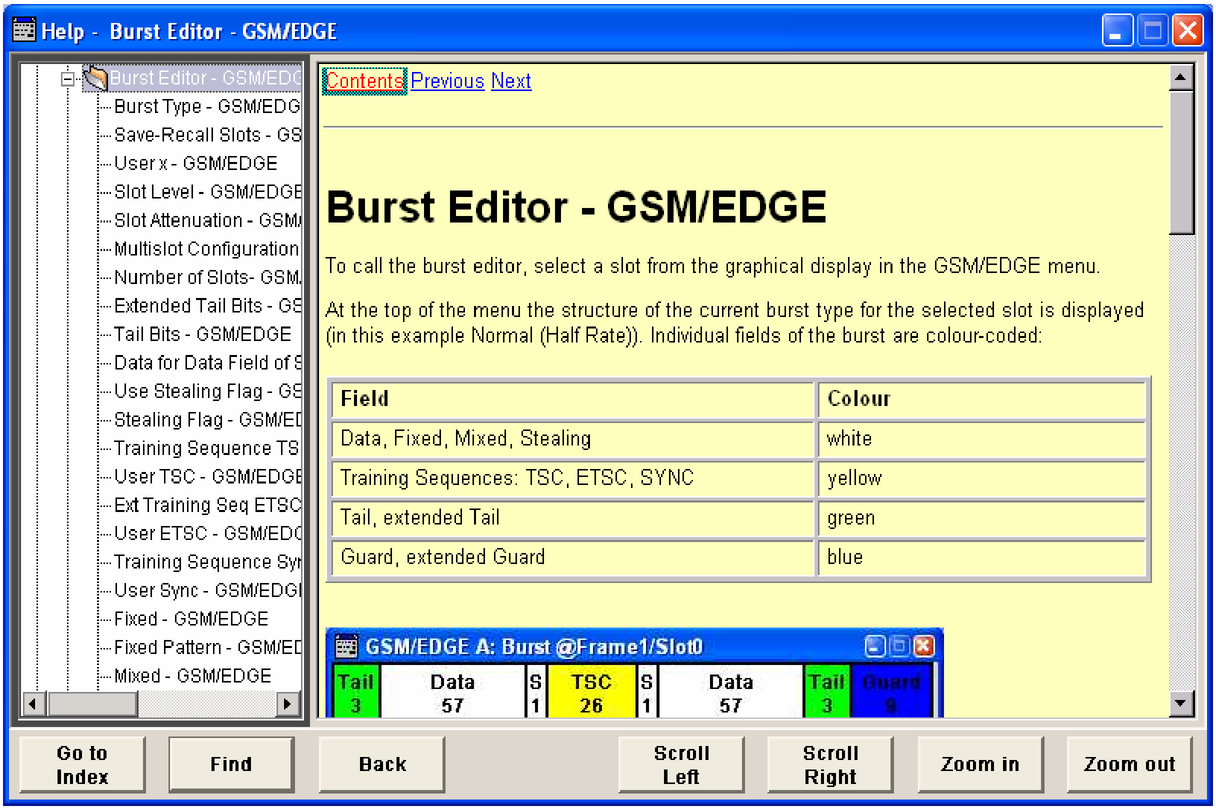
Function	Front panel	PC keyboard	Mouse
Shift ramp. The ramp transition depends on the status (high/low) of the control/marker signal before the ramp.	Use the rotary knob or the cursor keys to move the cursor to the ramp position; the cursor changes colour. Click the rotary knob or press the ENTER key. The cursor again changes colour. The ramp will now be shifted by means of the cursor. Click the rotary knob or press the ENTER key. The ramp will be set at the current position.	Use the cursor keys to move the cursor to the ramp position; the cursor changes colour. Press the Enter key. The cursor again changes colour. The ramp will now be shifted by means of the cursor. Press the Enter key. The ramp will be set at the current position.	After double-clicking on the cursor, click on it once again and, while holding down the left-hand mouse button, drag it. The cursor changes colour. The ramp is set as soon as the left-hand mouse button is released.
Delete ramp. The ramp transitions of the other ramps are adapted to the changed signal status (high/low).	Use the rotary knob or the cursor keys to move the cursor to the ramp position; the cursor changes colour. Press the BACKSPACE key. The ramp will be deleted.	Use the cursor keys to move the cursor to the ramp position; the cursor changes colour. Press the Delete key. The ramp will be deleted.	-
Define length of control list (Custom Dig Mod only).	Use the rotary knob or the cursor keys to mark the **Total List Length** entry field, click on the rotary knob or press the ENTER key. Enter the length by means of the numeric keys. Click the rotary knob or press the ENTER key. The control list length is defined.	Use the cursor keys to mark the **Total List Length** entry field and press the Enter key. Enter the length by means of the numeric keys. Press the Enter key. The control list length is defined.	-
Zoom displayed range (Custom Dig Mod only). Approx. 300 bits around the current cursor position are displayed.	Use the rotary knob or the cursor keys to mark the **Zoom in** button, click on the rotary knob or press the ENTER key.	Use the cursor keys to mark the **Zoom in** button and press the Enter key. Enter the length by means of the numeric keys. Press the Enter key. The control list length is defined.	Click the **Zoom in** button.
Save list. The list is saved automatically when the menu is closed.	Press the ESC key.	Press the ESC key.	Click the X button in the menu bar.

Function	Front panel	PC keyboard	Mouse
Create new list (Custom Dig Mod only).	Mark the **Control List...** button in the list management submenu of the individual menu, click on the rotary knob or press the ENTER key Mark **Create New List,** click on the rotary knob or press the ENTER key. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37).	Mark the **Control List...** button in the list management submenu of the individual menu and press the ENTER key Mark **Create New List** and press the Enter key. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37)	Double-click on the **Control List...** button in the list management submenu of the individual menu. Double-click on **Create New List**. Enter the file name in the **File Select** menu and select the directory (see section "*File Select Menu*", page 3.37)

Help system

The R&S AMU is equipped with a context-sensitive help function. A help page is available for each parameter and can be called any time during instrument operation. The context-sensitive page which is opened with the [HELP] key is part of a comprehensive help system. It is possible to move from this context-sensitive page to any page of the help system.

Note:
Compiled online help systems are also available for all functions of the R&S AMU on the CD-ROM supplied with the instrument. This help program can be called on any controller with Internet Explorer version V 4.0 and higher.



The help function is provided with a navigation bar, i.e. other help pages can be called from the context-sensitive page via the table of contents, the index, arrows for scrolling, and page-internal links.

Operation of context-sensitive help

Function	Front panel	PC keyboard	Mouse
Open the help system The help page for the respective parameter is displayed.	Press HELP key.	Press F1 key.	-
Close the help system	Press HELP key again.	Press F1 key again.	-
Activate the link The help system branches to the linked page.	Select link with rotary knob or arrow keys and activate by clicking on the rotary knob or ENTER key.	Select link using the arrow keys and activate with the ENTER key.	Click link.
Page Up/down	Select **Previous**, **Next** or **Back** in the help window using the arrow keys and activate by clicking on the rotary knob or the ENTER key.	Select **Previous**, **Next** or **Back** in the help window using the arrow keys and activate with the ENTER key.	Click **Previous**, **Next** or **Back.**
Scroll	Move indicated help window area using the rotary knob and the arrow keys	Move indicated help window area using the arrow keys	Click the scroll bar and move to the desired position.
Select an item in the table of contents The help page of the item is displayed.	Activate Content window using the arrow keys left/right. Select the desired item using the rotary knob or the arrow keys up/down and activate by clicking on the rotary knob or the ENTER key.	Select **Content** in the help window using the arrow keys left/right and activate with the ENTER key. Select the desired item using the arrow keys and activate with ENTER.	Set indicated area by moving the vertical scroll bar. Click item.
Select an index term The help page of the term is displayed.	Select **Go-to-Index** button using the arrow keys and activate by clicking on the rotary knob or the ENTER key. Enter the first letter of the term in the entry field. Select the term using the rotary knob or the arrow keys and press the rotary knob or the ENTER key.	Select the **Go-to-Index** button using the arrow keys and activate with the ENTER key. Enter the first letter of the term and press the ENTER key. Select the term with the arrow keys and press the ENTER key.	Click the **Go-to-Index** button. Set indicated area by moving the vertical scroll bar. Click term.
Shift the indicated area of the navigation window to the left or right	Shift the entry focus up one level using the ESC key. Select **Scroll Right** or **Scroll Left** -button using the arrow keys and activate by clicking on the rotary knob or the ENTER key.	Shift the entry focus up one level using the ESC key. Select **Scroll Right** or **Scroll Left** -button using the arrow keys and activate with the ENTER key.	Set indicated area by moving the horizontal scroll bar.

File Management

The R&S AMU uses files to save all instrument data, i.e. system and user data. The user data includes saved instrument settings, data for the different digital standards as well as the waveforms for the arbitrary waveform generator.

The files are stored on the hard disk of the instrument. Drive D:\ can be used to save user-defined data; any directory structure can be created on D:\. Some default directories are predefined, but can be changed at any time.
The C:\ drive is a protected system drive. The files on this drive contain data that must not be changed. Therefore, this drive should not be accessed, since reconstruction of the system partition will lead to data loss. To prevent inadvertent deletion or overwriting of system files, this drive is not specified in the file menus. It can be accessed if a protection level (see protection level, Setup menu) is revoked.

Files can be exchanged either via a memory stick or a connected network.
A memory stick is connected to the USB interface and is assigned the E:\ drive.
In the case of a connected network, all network drives that can be accessed are available (see "*Connecting the R&S AMU to a Network (LAN)*").

The user data can be roughly divided into four data types:

- Settings
- Complex modulation and control data
- Waveforms

The files are accessed in a **File Select** window in the individual menus. Depending on the data type, a file can either be selected or it can be selected and saved:

- Settings, e.g. the frame setting of the GSM/EDGE standard, can be loaded and saved. In this case, the current setting is saved to the specified file.

- Complex modulation and control data can be loaded. It can be generated either externally or internally. For internal generation, a new list must be created which will then be edited in the data and control list editor. These functions are offered in the **Data List Management** window of the individual modulation menu.

- Waveforms are generated externally (e.g. by means of the R&S WinIQSIM program that is supplied together with the optional Baseband Generator R&S AMU-B9/B10/B11) and can be loaded in the **Arbitrary Waveform Generation** menu.

The files are differentiated according to their extensions; each type of file is assigned a specific file content. The extension is usually of no consequence to the user since access to the files occurs in the individual menus 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** menu.

A button in the individual menu calls up the selection of the **Save**, **Recall** and **File Manager** functions. If the file can only be loaded, the **Select** or **Load** and **File Manager** selection is available.

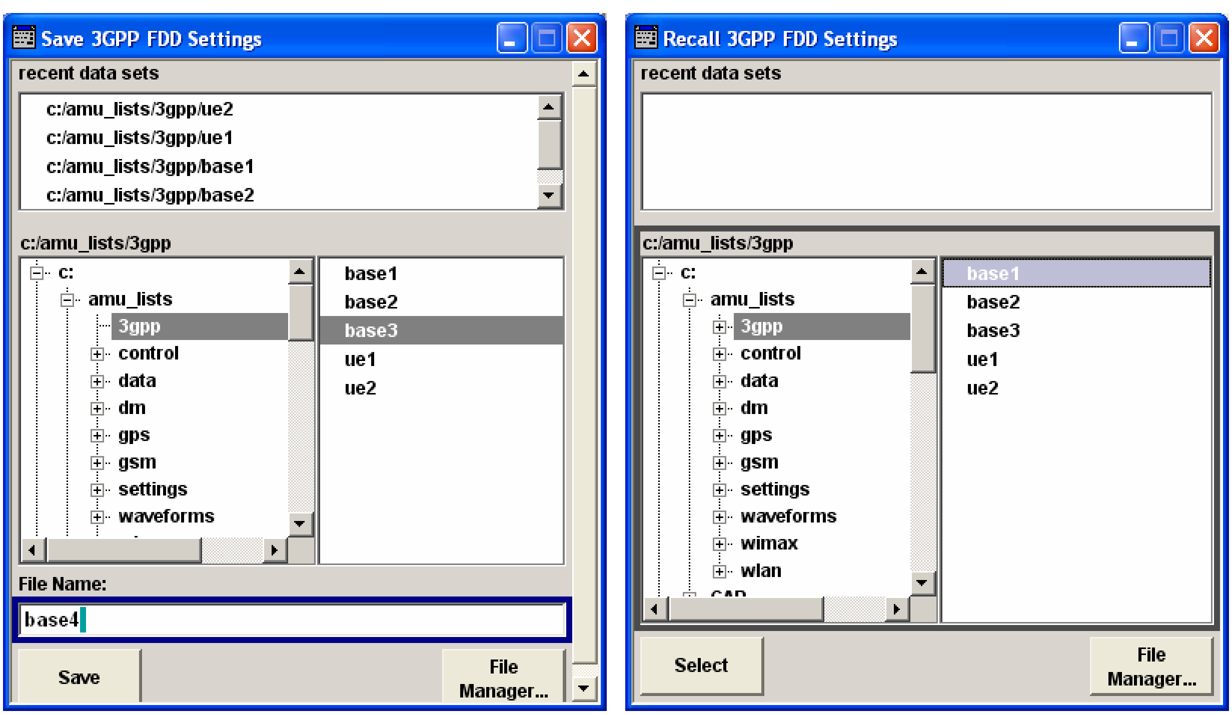
After the **Save/Recall** or **Select/New** selection, a **File Select** window for loading, saving or creating a file is displayed (see the following section "*File Select Menu*", page 3.37).

After the **File Manager** selection, a menu for managing all files is displayed (see section *File Manager*, page 3.39).

The complete instrument settings are saved and loaded in the **File** menu which is called up by means of the [File] key (see chapter 4, section "*Storing and Loading Instrument Data – File Key*").

File Select Menu

The **File Select** menu consists of several areas.



In the upper area, **Recent Data Sets**, the files last used are listed; a maximum of ten files is displayed.

The available drives and directories are displayed on the left side, the files of the selected directory on the right side. The currently selected path is displayed above the windows. Only the relevant files without file extensions are displayed. If the area is opened several times, the path last selected is displayed.

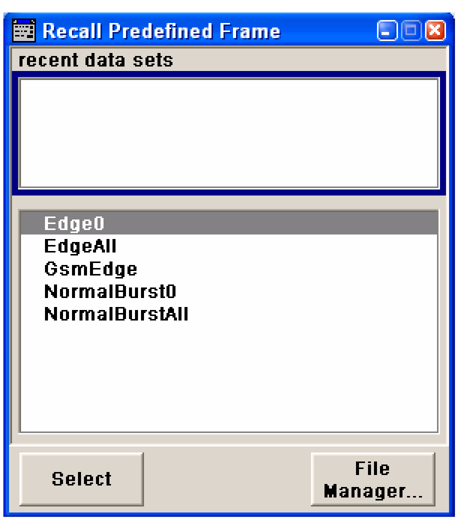
When a file is saved or created, its name is user-selectable; the extension is assigned automatically and cannot be entered.

The file is saved to the selected path.

Operation is similar to the operation of menus with several areas (see section "*Selecting and Exiting a Menu Area - Setting Parameters*"): By using the rotary knob or cursor keys, the area is marked; the entry focus is shifted to this area by clicking on the rotary knob or using the Enter key. The rotary knob and the up/down cursor keys will then navigate only within this area. By using the left/right cursor keys, it is possible to switch between the directory tree and the file list. The subdirectories of the selected directory will only be displayed after a short delay to allow quick navigation in the directory tree. Pressing the ESC key again shifts the entry focus up one level. The button for saving or loading the file can be selected and pressed. After the setting, e.g. after selecting the file, the menu will be closed automatically.

- **Load file:**
  Mark file and load it by clicking on the rotary knob or by pressing the **Select** button/softkey.
- **Save file:**
  Enter file name in the **File Name:** field. Mark the directory to which the file is to be saved and then click on the **Save** button/softkey.
- **Create file:**
  Enter the file name in the **File Name:** field. Mark the directory to which the file is to be saved and then click on the **Create** button/softkey. The created file is empty; it must be filled with the necessary values in the individual editor.

In addition to the files saved by the user, some menus also offer files containing predefined contents. These files are saved to a specific directory on system drive C.\; for this reason, this directory cannot be chosen from the **File Select** menu. The following example shows the **File Select** menu of the GSM/EDGE digital standard when **Recall Predefined Frames** is selected.



File Manager

The **File Manager** allows general file management such as copying, shifting, renaming and deleting files as well as generating new directories. Thus, also externally created files, for example waveforms created by using the **R&S WinIQSIM** program, can be saved to the R&S AMU by copying them from a memory stick or a network to the internal hard disk.

The **File Manager** can be called up in any menu to which files can be saved. Call-up is either at the level of the small selection menu

or via the **File Manager** button in the **File Select** window.

The File Manager can also be called up in the **Save/Recall - Setup-Settings** menu.

In the upper area, **File Type**, the **File Manager** allows the type file selection to be displayed. This can be used to process either all files (all files (*:*) selection) or a specific selection of files (e.g. waveforms (*.wv) selection). The table at the end of this section contains a list of the file types.

The available drives and directories are displayed on the left side, the files of the selected directory on the right side. The currently selected path is displayed above the windows. If the area is opened several times, the path last selected is displayed. Unlike the **File Select** window, the **File Manager** displays the full file names including extensions.

The buttons/softkeys trigger the associated actions such as copying, shifting or deleting the marked files. Plus, a new directory can be created in the level below the marked directory.

Operation is similar to the operation of menus with several areas (see section "*Selecting and Exiting a Menu Area - Setting Parameters*"): By using the rotary knob or cursor keys, the area is marked; the entry focus is shifted to this area by clicking on the rotary knob or using the Enter key. The rotary knob and up/down cursor keys will then navigate only within this area. By using the left/right cursor keys, it is possible to switch between the directory tree and the file list. The subdirectories of the selected directory will only be displayed after a short delay to allow quick navigation in the directory tree. Pressing the ESC key again shifts the entry focus up one level. The buttons/softkeys can be selected and activated.

- **Shift file:**
  Mark file and then press the **Cut** button/softkey. Mark the directory to which the file is to be shifted and then click on the **Paste** button/softkey. If the target directory already contains a file with the same name, a confirmation query is displayed to confirm overwriting of this file.
- **Copy file:**
  Mark file and then press the **Copy** button/softkey. Mark the directory to which the file is to be copied and then click on the **Paste** button/softkey. If the target directory already contains a file with the same name, a confirmation query is displayed to confirm overwriting of this file.
- **Rename file:**
  Mark file and then press the **Rename** button/softkey. An entry window for entering the new file name opens. Enter the name and press the Enter key. If a file with the same name already exists, a confirmation query is displayed to confirm overwriting of this file.

- **Delete file:**
  Mark file and then press the **Delete** button/softkey. Prior to deletion, a confirmation query is displayed which the user must confirm for this file to be deleted.
- **Create new directory:**
  Mark drive or directory level where the new directory is to be created and then press the **Create New Directory** button/softkey. An entry window for entering the directory name opens. Enter the name and press the Enter key.

List of file extensions for user files the R&S AMU assigns automatically

List type	Contents	File suffix
Instrument State		
Instrument State	Instrument settings	*.savrcl
Arbitrary Waveform Generator		
Waveform, Multisegment Waveform	ARB waveforms	*.wv
Multisegment Configuration	Configuration info for multisegment waveforms	*.inf_mswv
DM		
Data List	Digital modulation data	*.dm_iqd
Control List	Data to control digital modulation	*.dm_iqc
GSM/EDGE		
Slot	User-defined slot data	*.gsm_slu
Frame	User-defined frame data	*.gsm_fu
3GPP FDD		
3GPP Settings	Complete setting of the 2GPP (FDD) menu	*.3g
Channel Coding DPCH	Channel coding enhanced DPCH channels (uplink)	*.3g_ccod_ul
Channel Coding DPDCH	Channel coding enhanced DPDCH channels (downlink)	*.3g_ccod_dl
CDMA2000		
CDMA2000 Settings	Complete setting of the CDMA2000 menu	*.cdma2k
WLAN		
WLAN Settings	Complete setting of the IEEE 802.11 WLAN menu	*.wlan
WiMAX		
WiMAX Settings	Complete setting of the IEEE 802.16 WiMAX menu	*.wimax
GPS		
GPS Settings	Complete setting of the GPS menu	*.gps
TD-SCDMA		
TD-SCDMA Settings	Complete setting of the TD-SCDMA menu	*.tdscdma

Manual Remote Control

The R&S AMU can be remote-controlled from an external PC. This allows convenient operation of the R&S AMU from the desktop although the instrument is integrated in a rack somewhere else.

Manual remote control (remote access) in contrast to **remote control** does not use remote-control commands but separate Windows software which is installed on the external PC. After its start, the remote control software simulates the user interface of the R&S AMU. The instrument can thus be manually operated from the PC as on the unit itself.

A precondition for manual remote control is a connection between the RS AMU and the PC via a LAN network and the installation of the software on the R&S AMU and on the PC.
Establishing the connection and installation of the remote-control software on the external PC is described in section "*Connecting the R&S AMU to a Network (LAN)*".

After the connection is established, the current screen with the block diagram is displayed and the R&S AMU can be manually remote-controlled from the external PC. The individual functions are operated using the mouse and keyboard. Specific instrument functions can be executed using specific key combinations on the keyboard. Front-panel keys which are not directly available on the keyboard can be substituted by key combinations or by the front panel key emulation panel (see next section).

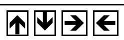
When the connection is set up with **Remote Control Desktop**, the device firmware of the R&S AMU is disabled. Direct control on the R&S AMU is not possible while manual remote control is active. The access of an external PC is indicated by the logon screen of Windows XP which identifies the accessing user.

When the connection is set up with **Ultr@VNC**, direct control on the R&S AMU is possible while manual remote control is established, it can be performed alternately with the manual remote control.

For return to direct operation on the R&S AMU, the connection must be cut. After cutting the connection, it is still enabled and can be established again any time. The connection is disabled only after deactivation of the program (see section *Manual Remote Control via an External Controller*).

Legend of Front-Panel Controls

The following table lists all key functions available on the front panel. Key combinations used on the PC keyboard to trigger key functions on the instrument front panel are also described. Keyboard labels are described in alphabetical order.
In addition, a front panel key emulation and an on-screen keyboard can be used for manual operation by mouse only (see below).

Front-panel key	Key of PC keyboard	Function
	Tab key (towards the right) Shift + Tab (towards the left)	Sets the cursor with the rotary knob.
	Enter	Pressing the rotary knob confirms an entry; it has the same function as the ENTER key.
	Arrow keys	Moves the cursor.
*1 / dB(m)	ALT + F12	Confirms entries in the base unit and values without a unit. The unit dBm is inactive.
. / *...#	. / *...#	Enters a period/decimal point. Enters a special character.
+/- / A↔a	- / (shift+) a—z	Enters the sign. Switches between upper-case and lower-case letters.
0-9 / a...z	CTRL + 0-9 / a...z CTRL	Enters the number/letter.
BACKSPACE	Backspace	Clears the last entry (number, sign or decimal point)
BASEBD LEVEL	CTRL + L	Activats the level entry. In the two-path mode, the baseband level entry field that was active last is activated. Pressing the key again activates the baseband level entry for the second path.
BASEBD ON/OFF	CTRL + R	Switches the baseband output signal on and off. In the two-path mode the baseband ON/OFF key switches all signals off. A second stroke restores the status that was active before the last switch off. I/Q OUT OFF is displayed in the status bar.
CLOSE	CTRL + G	Closes an active menu.
DIAGRAM	CTRL + D	Sets the cursor on the block diagram and hides all menus.
ENTER	Enter	Terminates an entry.
ESC	ESC	Selects the next higher menu/selection level. When the editing mode is exited with ESC, the previous value is restored.
FILE	CTRL + S (storage under Windows)	Activates a menu for storing or loading the settings of the instrument. Pressing the key again closes the dialog.
G/n / dBμV	ALT + F9	Selects the unit Giga/Nano. The unit dbμV is inactive.
HCOPY	CTRL + Y	Opens the menu for configuring and starting a hardcopy.
HELP	F1	Opens/closes context-sensitive help.

Front-panel key	Key of PC keyboard	Function
HIDE	CTRL + H	Minimizes the active menu. Pressing the respective button in the winbar opens the menu again.
INFO	CTRL + I	Opens/closes the info window.
INSERT	Ins	Activates the insert mode.
k/m / µV	ALT + F11	Selects the units Kilo/Milli and µV for levels.
LOCAL	CTRL + Q	Switches the instrument from remote control to manual operation.
M/µ / µV	ALT + F10	Selects the units Mega/Micro and µV for levels.
MENU	CTRL + M	Calls the menu selection list.
ON/OFF TOGGLE	CTRL + T	Switches a block or parameter on/off. Toggles between the different possibilities of setting a selection parameter.
PRESET	CTRL + P	Restores a defined basic instrument setup.
REARR	CTRL + A	Arranges open menus automatically.
RECALCULATE	CTRL + C	Starts recalculation of the signal.
SETUP	CTRL + E	Opens the setup menu for general instrument settings.
Softkey 1 – 8	CTRL + F1 – F8	Triggers the function assigned to the softkey.
WINBAR	CTRL + W	Displays the winbar in the foreground/background.

Front Panel Key Emulation

The R&S AMU provides a front panel key emulation to enable the execution of the front panel key functions by mouse e.g. for manual remote control (remote access). The emulation is called by a right mouse click. The front panel key functions are executed by a mouse click on the associated button.

On-screen Keyboard

In addition, the Windows XP operating system provides a keyboard emulation that can be used for system settings if no external keyboard but a mouse is available. It is called in the **START - Programs - Accessories - Accessibility** menu, selection **On-Screen Keyboard**.

Contents - Chapter 4 "Instrument Functions"

4 Instrument Functions

Overview of Instrument Functions

This chapter explains the functions of the R&S AMU and the options available in the setting menus. The associated GPIB command is specified for each parameter (where applicable).

The description begins with the general instrument settings which do not directly affect signal generation. The majority of these settings can be accessed by means of front-panel softkey menus and not by means of function block menus. One exception is, for example, the signal graphics which are called up in the **Graphics** block.

All functions for the generation of the baseband signals are described, following the order of the signal process - generation of internal baseband signals, input of external baseband signals, fading, noise generation and impairment and the analog and digital signal outputs. These functions are accessed by the means of the function blocks **Baseband A/B**, **Baseband Input A/B**, **Fading A/B**, **AWGN/IMP A/B** and **I/Q Out A/B**.

The general instrument settings include various functions, such as:

- Setting a defined basic setup using the PRESET key
  (section "*Default Instrument Settings - Preset Key*" on page 4.3")
- Switching from remote control to manual operation using the LOCAL key
  (section "*Switching to Manual Operation - Local Key*" on page 4.20")
- Configuring the generator and its interfaces in the **Setup** menu - e.g. setting the IEC/IEEE bus address, starting an adjustment, querying instrument data
  (section "*General Configuration of Instrument - Setup Key*", page 4.4)
- Generating a hardcopy of the display using the HCOPY key
  (section "*Generating a Hardcopy of Display - Hcopy Key*", page *4.21*)
- Calling up the online help using the HELP key
  (section "*Help System - Help Key*", page *4.22*)
- Querying messages using the INFO key
  (section "*Messages - Info Key*", *page 4.21*)
- Loading and storing complete instrument settings in the **File** menu
  (section "*Storing and Loading Instrument Data - File Key*", *page 4.24*)
- Calling up the baseband signal graphics in the **Graphics** function block
  (section "*Graphical Display - Graphics*", page *4.30*)

The integrated bit error rate and block error tester is configured and activated in the **BERT** function block:

- Bit error rate and block error measurement
  (section "*Bit and Block Error Rate Measurements - BERT Block*", page 4.42)

Noise can be added to the baseband signal and the baseband signal can be impaired or faded. It is possible to output the baseband signal with impairments analog (single ended and differential) and digital via the **I/Q Out** function block.

- Impairing the signal
  (section "*Introduction - Impairments and AWGN*", page *4.65*)

- Adding noise
  (section "*Introduction - Impairments and AWGN*", page *4.65*)
- Fading the signal
  (supplement "*Fading Simulation")*

The baseband signal is available at the I/O outputs.

- Single Ended I/Q Output
  (section "*Analog I/Q Output*", page *4.68*)
- Differential I/Q Output
  (section "*Analog I/Q Output*", page *4.68*)
- Digital I/Q Output
  (section "*Digital Output*", page *4.76*)

The R&S AMU offers various possibilities for generating digital modulation signals in compliance with the definitions of digital standards or with characteristics which can to a large extent be freely defined. The range of software options for this is being extended continuously.
In addition, external baseband signals can be fed into the baseband path.

- Baseband signals - Introduction
  (section "*Baseband Signal - Baseband*, page 4.95)
- External Baseband signals
  (section "*External Baseband Signals - Baseband Input*", page 4.113)
- Digital modulation
  (section "*Digital Modulation - Custom Digital Modulation*", page 4.123)
- Arbitrary waveform generator ARB
  (section "*Arbitrary Waveform Generator ARB*", page 4.161)
- Multicarrier CW signals
  (section "*Multicarrier Continuous Wave*", page 4.198)

The following digital standards are described in separate supplements:

- Digital standard GSM/EDGE
- Digital standard 3GPP FDD (WCDMA)
- Digital standard CDMA2000
- Digital standard TD-SCDMA
- Digital standard WLAN
- Digital standard WiMAX
- Digital standard DVB-H
- Digital standard EUTRA/LTE
- Digital standard GPS

General Instrument Settings

Overview of General Instrument Settings

The section "General Instrument Settings" describes the settings which do not directly affect signal generation.

Most of these settings can only be accessed by means of menus which are opened using keys. This does not apply to the graphical representation of output signals which is activated in the **Graphics** function block, or settings which can additionally be called up in the menus of the function blocks, e.g. input configuration which is possible in the **Setup** menu and in almost every menu of the **Baseband** function block.

The general instrument settings therefore affect various functions, such as storing instrument settings using the FILE key or setting the IEC/IEEE bus address in the menu of the SETUP key. The order in which the descriptions are given corresponds to the layout of the keys on the front panel of the R&S AMU (from top left to bottom right).

Default Instrument Settings - Preset Key

The PRESET key calls up a defined instrument setup. All parameters and switching states are preset (also those of inactive operating modes). The default instrument settings provide a reproducible initial basis for all other settings.

Remote-control command:
`*RST`

Note:
In remote control it is possible to preset the settings of the two instrument paths separately (see chapter 6, section "Preset Commands").

In addition, only those settings associated with the menu can be reset directly in the individual menus, e.g. all fading settings in the **Fading settings** menu. These settings are identical to those which are called up using the PRESET key.

When the instrument is switched on, it is not the preset state that is active, but rather the instrument state that was set before the instrument was switched off.

User-defined instrument states can be stored and called up in the **File** menu.

The following table gives an overview of the presets for the most important generator settings. The other presets can be found in the preset tables of the individual menus and the information accompanying the GPIB commands.

Table 4-1 Preset state - important generator settings

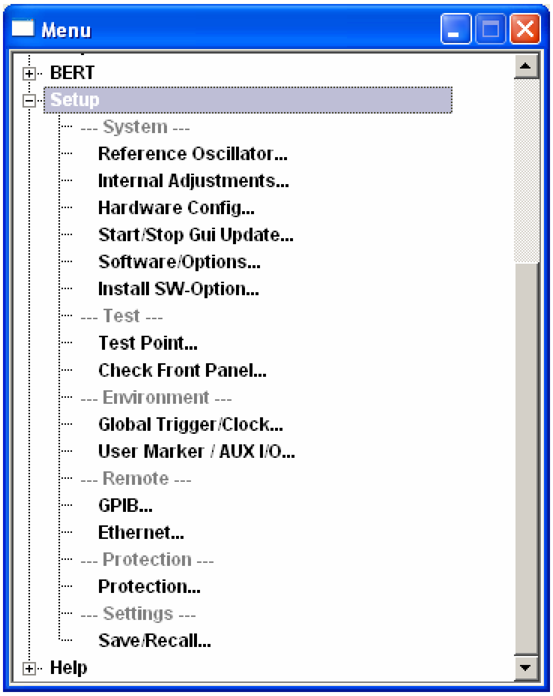
Reference frequency	Internal, adjustment off
Offsets	0
Digital modulations	Switched off
IEC/IEEE bus address	Not changed

General Configuration of Instrument - Setup Key

The SETUP key opens the **System** menu used to set general instrument parameters and the **Environment** menu used to configure the instrument interfaces.

Most submenus of this key can be accessed only via the SETUP key or the menu tree (MENU key, with the following exceptions:

- The **Global Trigger/Clock/ External Inputs** submenu (see section "*Global Trigger/Clock/External Inputs* - Setup-Environment", page *4.14*) is also available in all modulation menus of the **Baseband** function block where it can be called up with the **Global Trigger/Clock Settings** button in the trigger/marker and clock submenus.
- The **Save/Recall** submenu can also be called up with the FILE key and is therefore described in the section on this key (see section "*Storing and Loading Instrument Data - File Key*", page 4.24).



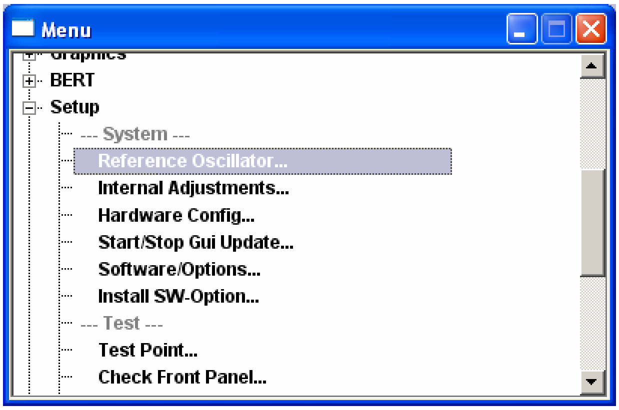
Reference Oscillator - Setup-System

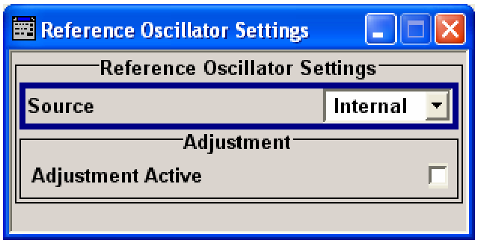
In the internal reference mode the internal reference signal is available at the REF OUT connector (rear of instrument). The frequency of the internal reference signal is permanently set to 10 MHz.

In the external reference mode an external signal with selectable frequency and defined level must be input at the REF IN connector. This signal is output at the REF OUT connector. The **EXT REF** status message appears in the display header.

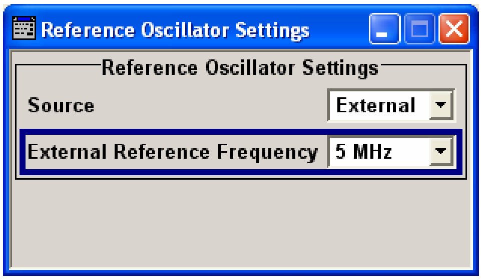
The reference frequency setting is effective for both paths.

The **Reference Oscillator** menu is opened up using the [SETUP] or [MENU] key under **System**.





Selecting the **internal** reference signal source, 10 MHz are used, comprising either the calibrated or a user-defined adjustment value.



Using the **external** reference signal source, 5 MHz, 10 MHz or 13 MHz can be selected.

Source - Setup System Reference Oscillator

Selects the source of the reference frequency.

Internal

The internal reference signal of 10 MHz is used.

Remote-control command:
`SOUR:ROSC:SOUR INT`

External

An external reference signal is used.

The frequency of the external signal, either 5 MHz, 10 MHz or 13 MHz must be selected under **External Frequency**.

Remote-control command:
`SOUR:ROSC:SOUR EXT`

Adjustment Active - Setup System Reference Oscillator
(Source Internal only)

Activates the adjustment mode.

On

A user-defined adjustment value is used. The value is entered under **Adjustment DAC value**. This allows the frequency to be impaired freely, for example to simulate a frequency error.
The instrument is no longer in the calibrated state. However, the calibration value is not changed and the instrument resumes the calibrated state after switching the Adjustment State to Off.

Remote-control command:
`SOUR:ROSC:INT:ADJ:STAT ON`

Off

The calibrated adjustment value of the internal reference frequency is used. This value is determined at one of the R&S service shops during calibration.

Remote-control command:
`SOUR:ROSC:INT:ADJ:STAT OFF`

Adjustment DAC value - Setup System Reference Oscillator

Enters a user-defined adjustment value for the internal reference frequency. This value is not used unless **Adjustment Active On** is ticked.

Remote-control command:
`SOUR:ROSC:INT:ADJ:VAL 500`

External Reference - Setup System Reference Oscillator

Selects the frequency of the external reference signal. An external reference signal with a frequency of 5 MHz, 10 MHz or 13 MHz can be used.

Remote-control command:
`SOUR:ROSC:EXT:FREQ 13E6`

Internal Adjustments - Setup-System

The R&S AMU is extremely accurate thanks to the integrated procedures for adjustments.

All internal adjustments for which no external measuring equipment is needed can be started in the **Internal Adjustments...** menu. The adjustments with external measuring equipment are described in the Service Manual (on CD ROM, supplied with the instrument).

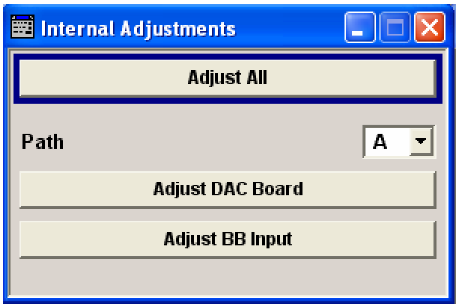
Adjustment is recommended if the temperature range in which the instrument is operated changes, or prior to all applications which require maximum level and frequency accuracy.

During adjustment a bar indicates the status of progress. If an error occurs, adjustment is terminated and an error message is output in the info line.

Note:
Make sure that the instrument is warm before performing adjustments. The warm-up time is 30 minutes.

In the case of two-path instruments, adjustment can be performed separately for the two paths.

The **Internal Adjustments** menu is opened up using the SETUP or MENU key under **System**. The adjustments offered also depend on the installed options, e.g. BB Input.



Adjust All - Setup System Internal Adjustments

Starts all internal adjustments for which no external measuring equipment is needed. The adjustments with external measuring equipment are described in the Service Manual (supplied).

With two-path instruments, adjustment is performed for both paths.

Remote-control command:
`CAL:ALL:MEAS?`

Path A/B - Setup System Internal Adjustments

Selects the path for which the following adjustments are to be performed.

Remote-control command: n.a.
With remote control, the path is selected by using the numerical suffix under CALibrate.

Adjust DAC Board - Setup System Internal Adjustments

Performs all adjustments which affect the DAC board of the selected path.

Remote-control command:
`CAL1:DAC:MEAS?`

Adjust Baseband Input-Setup System Internal Adjustments

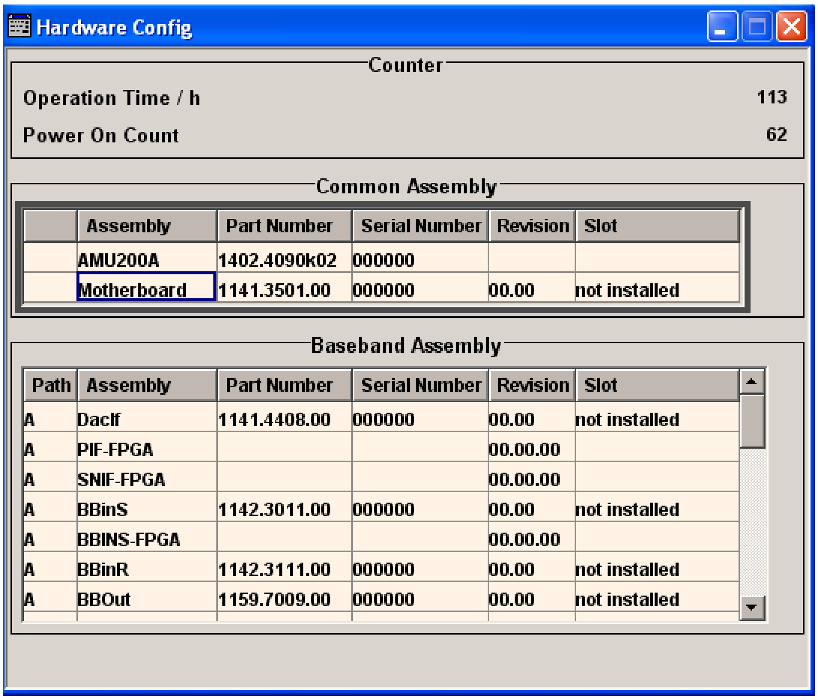
Starts the adjustment for the baseband input. The I/Q input is adjusted with respect to DC offset and gain.

Remote-control command:
`CAL:BBIN:MEAS?`

Hardware Config... - Setup-System

In the **Hardware Config** menu, the installed assemblies together with their variants and revision states can be displayed for servicing purposes.

The **Hardware Config** menu is opened using the SETUP or MENU key under **System**.



	Assembly	Part Number	Serial Number	Revision	Slot
	AMU200A	1402.4090k02	000000		
	Motherboard	1141.3501.00	000000	00.00	not installed

Path	Assembly	Part Number	Serial Number	Revision	Slot
A	Dacif	1141.4408.00	000000	00.00	not installed
A	PIF-FPGA			00.00.00	
A	SNIF-FPGA			00.00.00	
A	BBinS	1142.3011.00	000000	00.00	not installed
A	BBINS-FPGA			00.00.00	
A	BBinR	1142.3111.00	000000	00.00	not installed
A	BBOut	1159.7009.00	000000	00.00	not installed

The section **Counter** in the upper part of the menu shows the operation hours (**Operation Time / h)** and the number of power on (**Power On Count**).

Remote-control commands::
`DIAG:INFO:OTIM?`
Response: `"100023"`

`DIAG:INFO:POC?`
Response: `"123"`

The table below lists the installed assemblies. It is divided into the sections **Common Assembly** and **Baseband Assembly**.

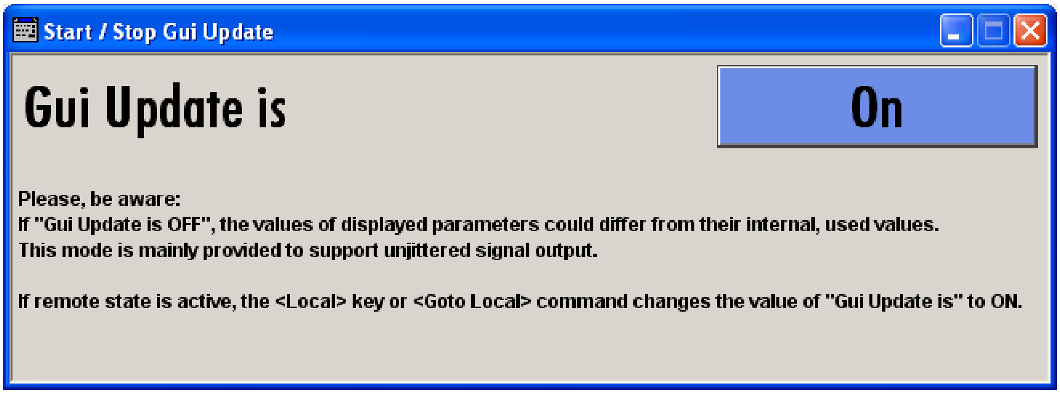
Path	Indicates the path the assembly belongs to
Assembly	Assembly name
Part Number	Part Number of the assembly
Serial Number	Serial Number of the assembly
Revision	Revision state of the assembly
At slot	Indicates whether the assembly is connected to the serial bus or PCI bus

Remote-control command:
`DIAG:BGIN? "MBRD"`
Response: `"MBRD 1141.3501.02 1.5.3 100023"`

Start/Stop Gui Update... - Setup-System

The **Start/Stop Gui Update** menu**...** provides the possibility to switch off update of the displayed parameters in order to increase speed for certain settings.

The indicated values are not updated and may therefore differ from the intern, used values.



Remote-control command:
`SYST:DISP:UPD OFF`

Software / Options... - Setup-System

The **Software / Options...** shows the firmware version of the instrument software as well as all installed hardware and software options.

Note:

Software options purchased at a later stage can be activated with a keycode. The activation code is supplied with the software option. How to install options is described in chapter 4 of the Service Manual (supplied with the instrument).

The installation of hardware options purchased at a later stage is also described in chapter 4 of the Service Manual (supplied with the instrument). Most hardware options need to be installed at an authorized Rohde&Schwarz service shop.

The **Software / Options** menu is opened using the SETUP or MENU key under **System**.

Remote-control commands:
`*OPT?`
Response: `"AMU-B10, AMU-B10, AMU-B13, AMU-B13, ...."`

`*IDN?`
Response: `"Rohde&Schwarz,AMU200A,1402.4090k02/123456,1.00.0.0 (Release)"`

The **Firmware** section of the menu shows the firmware version and the version of the software platform.

The tables in the sections **Hardware, Software** and **WinIQSIM** list the installed hardware and software options.

Option	Short name of option
Designation	Name of Option
Licenses	Number of licenses The license for the software options are "floating licenses". This means that in the case of two-path instruments just one license is required to use the option for either of the two paths. However, two licenses must be purchased to use an option on both paths simultaneously.
Expiration Date	Expiration date of option For regular options, Permanent is indicated in this column. Some options are available as trial versions. This column shows their expiration date. After this date, the option is no longer available on the instrument.

Hardware Options

Option	Designation		
AMU-B10	Baseband A with ARB(64MS) and Dig. Mod.		
AMU-B10	Baseband B with ARB(64MS) and Dig. Mod.		
AMU-B13	Baseband Main Module		
AMU-B13	Baseband Main Module		
AMU-B14	Fading Simulator		
AMU-B16	Differential I/Q out		

Software Options (Internal)

Option	Designation	Licenses	Expiration Date
AMU-K40	Dig. Std. GSM/EDGE	2	
AMU-K42	Dig. Std. 3GPP FDD	2	
AMU-K43	Dig. Std. 3GPP Enh. BS/MS Test incl. HSDPA	2	
AMU-K44	Dig. Std. GPS	2	
AMU-K45	Dig. Std. 3GPP FDD HSUPA	2	
AMU-K46	Dig. Std. cdma2000	2	

WinIQSIM (External Software Options)

Option	Designation	Licenses	Expiration Date
AMU-K5	Dig. Std. Bluetooth (ext. Software)	2	
AMU-K8	Dig. Std. Tetra (ext. Software)	2	
AMU-K351	T-DMB/DAB Waveforms	2	
AMU-K240	Dig. Std. GSM/EDGE	2	
AMU-K242	Dig. Std. 3GPP FDD	2	
AMU-K243	Dig. Std. 3GPP Enh. BS/MS Test incl. HSDPA	2	

The section **Loaded Modules** is provided for service purposes. It lists all loaded software modules with their versions and offers a short description of each module.

Loaded Modules

Path

Path	Module	Version	Description
C:\Prog..	hardcopy.dll		
C:\Prog..	ComponentEnvironmentServer.exe	2.1.8.0	Componen..
C:\Prog..	RsComponentShell.dll	2.1.8.0	Componen..
C:\Prog..	RsParameter.dll	2.1.8.0	Componen..
C:\Prog..	RsPrint.dll	2.1.8.0	Componen..

Install SW-Option... - Setup-System

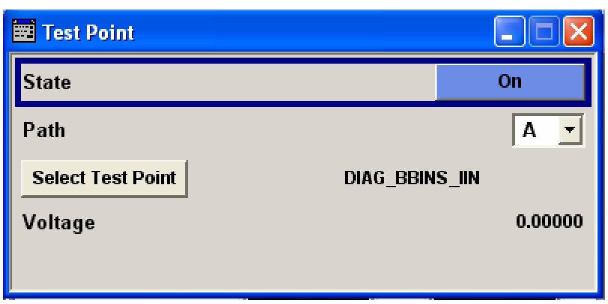
Newly purchased software options are enabled in the **Install SW-Options** menu**...**. They are ready to operate after they are enabled by means of a key code supplied with the option.

Only if the R&S AMU is equipped with an older firmware version, a firmware update prior to enabling the software option may be required. The information on the valid firmware versions for the purchased software option is provided together with the option. The firmware update is described in the service manual, chapter 4 (on CD ROM, supplied with the instrument).

Test Point... - Setup-Test

The **Test Point...** menu provides access to the test points available in the instrument. When activated, the voltage of the selected test point is measured and displayed. A detailed description of the test points can be found in chapter 3 of the Service Manual (supplied with the instrument).

The **Test Point...** menu is opened using the SETUP or MENU key under **System**.



State - Setup System Test Point

Activates the measurement of the voltage at the selected test point.

Remote-control command:
`DIAG1:MEAS:POIN? 'DIAG_BBINS_IIN'`
`Response: 0.5` (the voltage at the test point is 0.5 volt)

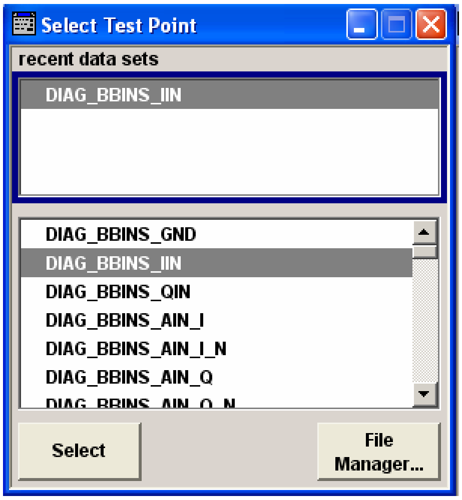
Path - Setup System Test Point

Selects the path along which the test point is measured. Selection is only possible with two-path instruments.

Remote-control command: -
The path is selected using the suffix under DIAGnostic.

Select Test Point - Setup System Test Point

Calls the submenu for selecting the test point. The currently selected Testpoint is shown next to the button.



Remote-control commands:
`DIAG1:POIN:CAT?` (Command lists all test points)
`DIAG1:MEAS:POIN? 'DIAG_BBINS_IIN'`
With remote control, voltage measurement starts as soon as the test point is selected.

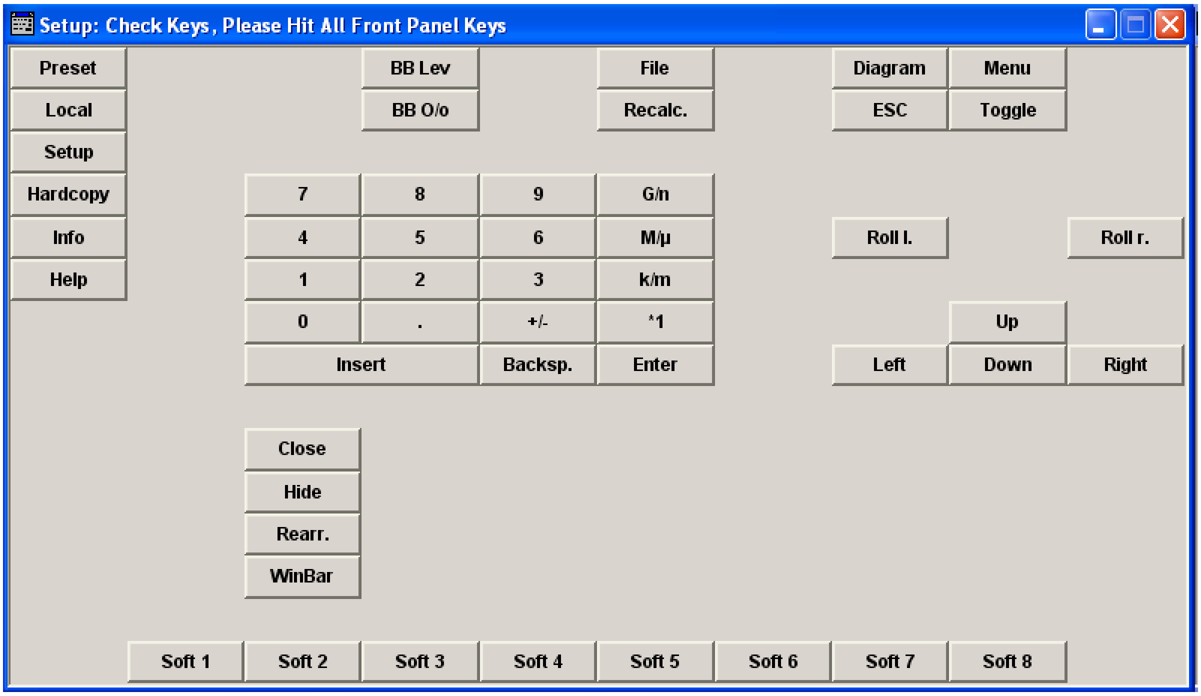
Voltage - Setup System Test Point

Displays the measured voltage measurement at the selected test point.

Remote-control command:
`DIAG1:MEAS:POIN? 'DIAG_BBINS_IIN'`
Response: `0.5`
The voltage at the test point is 0.5 volt.

Check Front Panel - Setup-Test

The **Check Front Panel** menu is used to check whether the front panel keys are functioning correctly. The menu displays all the front panel keys arranged in the same way as on the front panel. The respective function is executed by pressing the associated key.

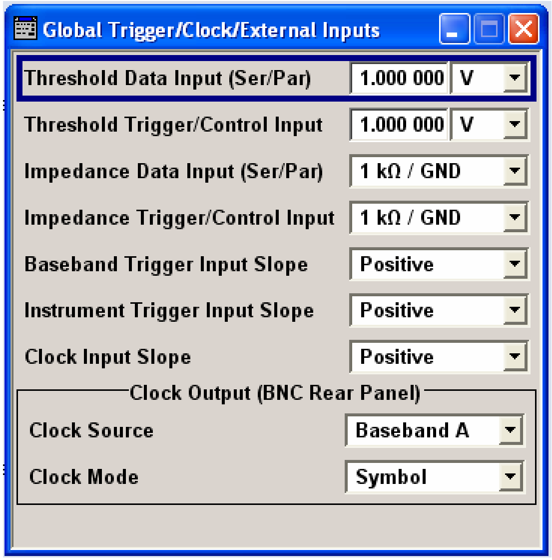


Global Trigger/Clock/External Inputs - Setup-Environment

The **Global Trigger/Clock/External Inputs** menu can be opened using the SETUP or MENU key under the **Environment** menu as well as in all clock and trigger menus of the **Baseband** function block.

This menu is used to determine the physical characteristics of the input connectors for trigger, clock and control signals.

A common trigger threshold and input impedance is effective for all trigger and control signal inputs (path A and path B). The settings influence the digital modulations, the generation of waveforms or multicarrier signals, and all digital standards. Irrespective of this, a common threshold and input impedance is effective for the serial and parallel data input (path A only). These data sources are available for digital modulation (**Custom Digital Modulation**).



Threshold Data Input - Setup Environment Global Trigger/Clock/External Inputs

Sets the high/low threshold in volts for the serial and parallel data input.

The serial data is input at the DATA connector on the front of the instrument. The parallel data is input via the AUX I/O interface at the rear of the instrument (DATA pins).

Remote-control command:
`SOUR:INP:DATA:THR 1.0`

Threshold Trigger/Control Input - Setup Environment Global Trigger/Clock/External Inputs

Sets the high/low threshold in volts for the trigger and control signal inputs of the baseband section.

The setting affects the TRIGGER 1 and 2 inputs (BNC connectors at the front and rear of the instrument) and the BURST and LEV_ATT inputs (AUX I/O interface at the rear of the instrument).

Remote-control command:
`SOUR:INP:TRIG:LEV 1.0`

Impedance Data Input (Ser/Par)- Setup Environment Global Trigger/Clock/External Inputs

Selects the input impedance for the serial and parallel data inputs.

50 Ohm/GND should be selected for high clock rates.

The serial data is input at the DATA connector on the front of the instrument. The parallel data is input via the AUX I/O interface at the rear of the instrument (DATA pins).

Remote-control command:
`SOUR:INP:DATA:IMP G50`

Impedance Trigger/Control Input - Setup Environment Global Trigger/Clock/External Inputs

Selects the input impedance for the external trigger and control signal inputs. 50 Ohm/GND should be selected for high clock rates.

The setting affects the TRIGGER 1 and 2 inputs (BNC connectors at the front and rear of the instrument) and the BURST and LEV_ATT inputs (AUX I/O interface at the rear of the instrument).

Remote-control command:
`SOUR:INP:TRIG:IMP G1K`

Baseband Trigger Input Slope - Setup Environment Global Trigger/Clock/External Inputs

Selects the polarity of the active slope of an externally applied trigger signal at the BNC connector TRIGGER 1/2.

Remote-control command:
`SOUR:INP:TRIG:BBAN:SLOP POS`

Instrument Trigger Input Slope - Setup Environment Global Trigger/Clock/External Inputs

Sets the polarity of the active slope of an applied instrument trigger.

This setting affects the INST TRIG input (BNC connector at the rear of the instrument, instrument trigger for path A) and the INST TRIG B input of the AUX I/O interface at the rear of the instrument, instrument trigger for path B).

Remote-control command:
`SOUR:INP:TRIG:SLOP POS`

Clock Input Slope - Setup Environment Global Trigger/Clock/External Inputs

Sets the polarity of the active slope of an externally applied bit clock pulse or symbol clock pulse.

This setting affects the CLOCK input (BNC connector at the front of the instrument). An external clock signal can only be supplied for path A.

Remote-control command:
`CLOC:INP:SLOP POS`

The polarity of the clock output at the rear panel is set and the path selected in the **Clock Output (BNC Rear Panel)** section.

Clock Output Source - Setup Environment Global Trigger/Clock/External Inputs

Indicates the path for which the clock signal at the CLOCK OUT connector is to be output (always path A).

This setting is only possible for two-path instruments.

Remote-control command:
`CLOC:OUTP:SOUR?`
Response: `A`

Clock Output Mode - Global Settings

Sets the output of bit or symbol clock pulses at the CLOCK OUT connector at the rear panel.

Remote-control command:
`CLOC:OUTP:MODE SYMB`

User Marker / AUX I/O - Setup-Environment

The R&S AMU provides four USER interfaces which can be freely assigned a selection of signals and which can be configured as both inputs and outputs.

The following signals can be applied at the connector:

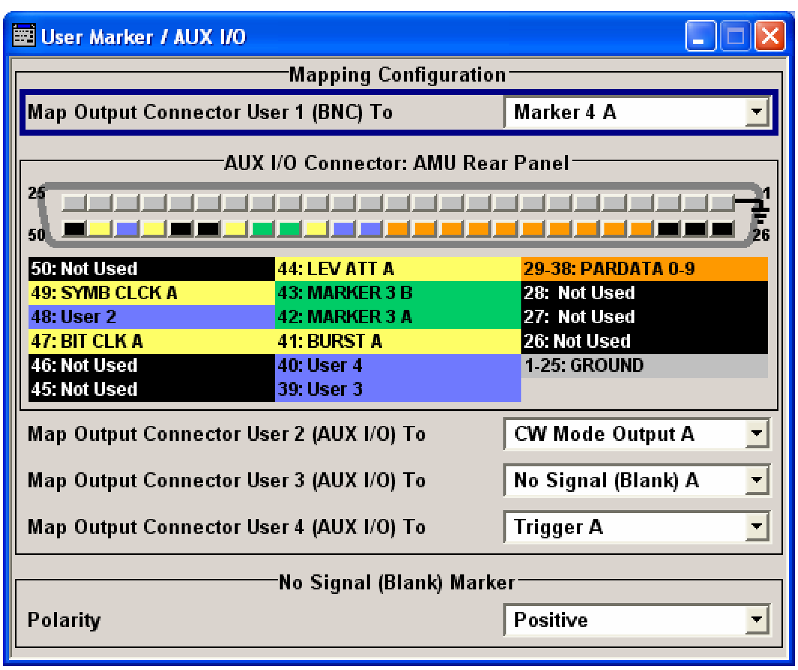
- **Marker 4** (output path A or B). A broad selection of suitable marker signals is offered in the marker menus of the **Baseband** function. In addition, they can be freely configured in the Control List Editor (**Custom Dig Mod**) and Slot Marker Editor (**GSM/EDGE**). The selected markers are activated when switching on the **Baseband** function. When using markers defined in a control list (Marker = CList) the related control list must be loaded in addition (**Custom Dig Mod**).
- CW Mode Out (output path A or B). This signal marks the CW mode in which digital modulation (Custom Dig Mod) is deactivated and the RF signal is output in unmodulated form. The CW signal is defined in a control list and activated by loading the control list and setting the Modulation⇔ CW Switching State to On in the More sub menu.
  With standards where it is possible to change between various modulation modes, the signal indicates the active modulation mode (standard GSM: signal high (1) = modulation mode GMSK and signal low (0) = modulation mode 8PSK EDGE). In this cases, the signal is generated automatically when the standard is switched on.
- **Trigger** (output path A or B). This signal marks the trigger event caused by the selected trigger signal (internally or externally) of path A or B. The trigger is defined in the respective trigger submenu of the **Baseband** block menus.

Additional signals for path B are available in two-path instruments. The corresponding signals for path A are applied at the pins of the AUX I/O interface and at the BNC connector CLOCK.

- **Clock Out** (output path B; bit or symbol clock pulse). This signal corresponds to the clock signal for digital modulations. The signal is generated automatically when the standard is switched on.
- **LEV ATT** (input/output path B). With active envelope curve control, this signal determines whether or not the signal level is attenuated. With external envelope curve control, the interface is input, otherwise output. The envelope curve control is activated in the **Power Ramp Control** submenu in the **Custom Digital Modulation** menu. The internal LEV ATT control signal is defined in a control list which must be loaded in the main menu.
- **BURST** (input/output path B). This signal corresponds to the control signal for envelope curve control. With external envelope curve control, the interface is input, otherwise output. The envelope curve control is activated in the **Power Ramp Control** submenu in the **Custom Digital Modulation** menu. The internal BURST control signal is defined in a control list which must be loaded in the main menu.

The **User Marker - AUX I/O** menu can be opened using the SETUP key under **Environment - User Marker / AUX I/O,** in the **Trigger/Marker** submenu or in the **Clock** submenu of the **GSM/EDGE** menu in the **Baseband A/B** function block.

The signals are assigned to the USER interfaces in the Mapping Configuration section.The pin assignment of the AUX I/O connector is also displayed. An adapter between the AUX I/O interface and coaxial BNC connections is available as an accessory (Accessories for R&S SMU-Z5, see data sheet).



User Marker AUX I/O - Setup Environment

An illustration of the AUX I/O interface is shown. The pins are color-coded. The inputs are indicated by a "depressed" pin, outputs by a non-depressed pin.

The assignment is shown in tabular form underneath the interface. The colors indicate the signal type. A distinction is made between control signals (yellow), marker signals (green), data (orange), freely selectable signals at the user pins (blue), ground (gray), and unused pins (black).

If no path letter is specified, a pin is usually assigned to the signals of path A. Pins with signals from path B are indicated by a "B" to the right of the signal name.

Connection	Description
1... 25 - ⊥	Ground
26 - FHOP_CLK	Pin reserved for future use.
27 - FHOP_DATA	Pin reserved for future use.
28 - BURST_GATE_A	Pin reserved for future use.
29 - PARDATA0 ... 38 - PARDATA9	Parallel data input/output 0...D with 10-bit word width for digital modulation. If the data source "external parallel" is selected, these pins are the data inputs. If a different data source is selected, the data is output here (**Custom Digital Modulation**, path A).
39 - USER 3	USER input/output which can be configured for various purposes. The following signals can be applied to the connector: - Marker 4 (output path A or path B) - CW Mode Out (output path A or path B) - **FHOP_STRB** (output path A or B). This signal marks the trigger for frequency hopping by processing of ARB sequences. - Trigger (output path A or path B). This signal marks the trigger event caused by the selected trigger signal (internally or externally) of path A or B. Additional signals for path B are available in two-path instruments. The signals corresponding to path A are applied at the pins of the AUX I/O interface (Clock Out). - **Clock Out** (output Path B; bit or symbol clock pulse). This signal corresponds to the clock signal for digital modulations. - **LEV ATT** (input/output path B). - BURST (input/output path B).
40 - USER 4	USER input/output which can be configured for various purposes (see above).
41 - BURST	Signal output/input for controlling the burst ramp, path A. With external envelope curve control (**Custom Digital Modulation** only), the pin is the input for the control signal BURST_RAMP. With internal envelope curve control, the control signal BURST_RAMP is output for path A. With two-path instruments, the signal for path B can be applied to one of the user interfaces.
42 - MARKER 3A	Output for the freely programmable marker signal 3 of path A. The output is permanently assigned.
43 - MARKER 3 B	Output for the freely programmable marker signal 3 of path B. The output is permanently assigned.

Connection	Description
44 - LEV ATT	Signal input/output for controlling the level attenuation (path A only). With external envelope curve control (**Custom Digital Modulation** only), the pin is the input for the control signal LEV_ATT. With internal envelope curve control, the control signal LEV_ATT is output for path A. With two-path instruments, the signal for path B can be applied to one of the user interfaces.
45 - FHOP_STRB	Pin reserved for future use.
46 - BURST_GATE_B	Pin reserved for future use.
47 - BITCLK	Output Bit clock for internal mode (path A only). With two-path instruments, the signal for path B can be applied to one of the user interfaces.
48 - USER 2	USER input/output which can be configured for various purposes (see above).
49 - SYMBCLK	Symbol clock output for internal mode (path A only). With two-path instruments, the signal for path B can be applied to one of the user interfaces.
50 - not used TX_PARDATA	Pin is not used.

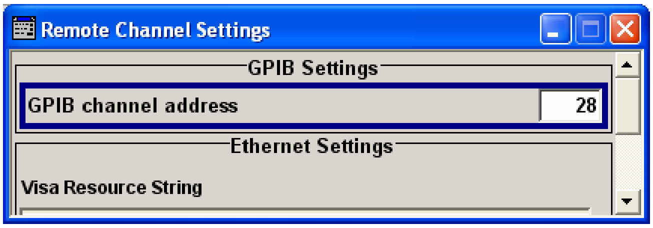
User Connector Signal - AUX IO Configuration

Selects the signal for USER interface 1 (BNC), 2, 3 or 4 (AUX I/O). The signals which are available for selection are given above.

Remote-control command:
`OUTP:USER2:SOUR AMAR`

GPIB, Ethernet - Setup-Remote

The **Remote GPIB and Ethernet ...** menu provides access to the GPIB and Ethernet settings. The **Remote GPIB and Ethernet...** menu is opened using the SETUP or MENU key under **Remote**.



GPIB channel address - Setup Remote

Sets the IEC/IEEE bus address of the instrument.

Remote-control command:
`SYST:COMM:GPIB:SELF:ADDR 28`

Visa Resource String - Setup Remote

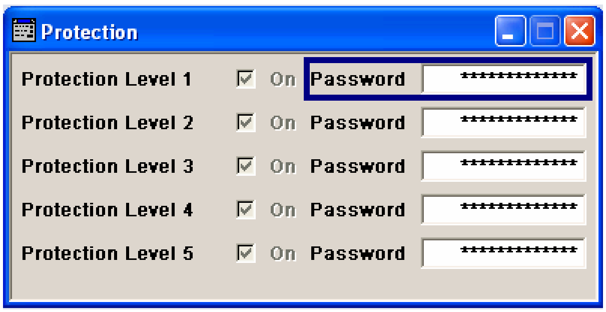
Indicates the visa resource string. This string is used for remote control of the instrument.

Remote-control command:
`SYST:COMM:NET:RES?`
Response: `TCPIP::127.0.0.1::INSTR`

Protection - Setup-Protection

The **Protection** menu provides access to the unlocking of protected service functions (authorized personnel of R&S Service Departments only). To unlock the lock-out, the correct password has to be entered. After the instrument has been switched on, the lock-out 2 to 5 is automatically activated.

Protection Level 1 can be activated to lock-out internal adjustment. The password is 123456.



Remote-control command:
`SYST:PROT1:STAT ON`
`SYST:PROT1:STAT OFF, 123456`

Save/Recall... - Setup-Settings

The **Save/Recall** submenu can also be called up with the FILE key and is therefore described in the section on this key (see section "*Storing and Loading Instrument Data - File Key*", page 4.24).

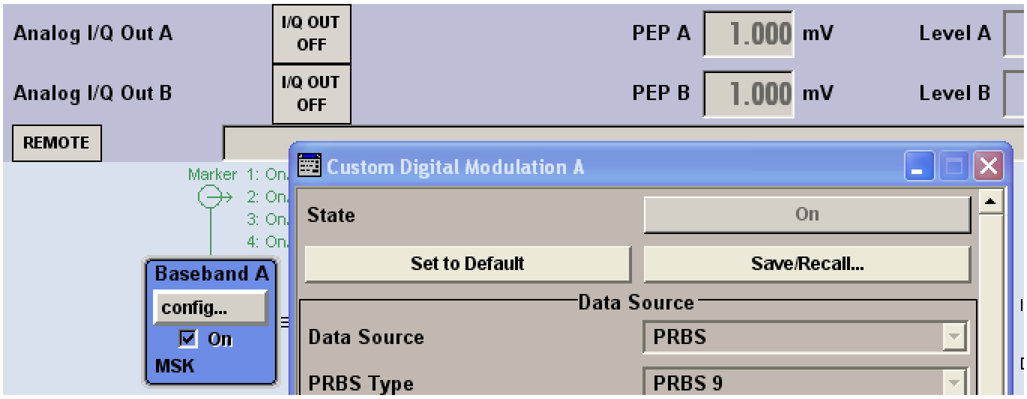
Help Menu

The **Help** menu offers comprehensive online help for the R&S AMU. A desired topic can be selected via the table of contents (select **Manual**) or the index (select **Index**).

For context-sensitive information about a marked parameter, press the HELP key. For a description of the **Help** menu, refer to the section covering to the HELP key (see section "*Help System - Help Key*", on page 4.22)

Switching to Manual Operation - Local Key

In remote control mode a status message appears in the display header. The rest of the display remains unchanged and shows the current instrument status, i.e. the status which exists under the remote control settings. The instrument can be operated (e.g. menus can be opened). However, it is not possible to enter or change values.



The status message additionally indicates whether the [LOCAL] key is disabled or enabled (see also chapter 5 , section *"Switch-Over to Remote Control"*).

If the **REMOTE** status message is shown, the [LOCAL] key switches the instrument from remote control to manual operation. The current command must be fully processed before the mode is switched, otherwise the instrument switches immediately back to remote control.

If the **REM-LLO** status message is displayed, the instrument can be switched from remote control to manual operation by means of remote control only (e.g. with the Visual Basic command `CALL IBLOC (generator%)`); the [LOCAL] key is disabled. The key is disabled by remote control with the command LLO.

The status **LOC-LLO** indicates that the instrument has been switched from remote control to manual operation. With the next activating of the remote control mode, the instrument cannot be switched to manual operation by the operator. The status information changes to REM LLO. The instrument can be switched to manual operation by means of remote control only (e.g. with the Visual Basic command `CALL IBLOC (generator%)`).

When switching from remote to manual operation, the display update suppression function, if active ([SETUP]- **GUI Update is Off**), is automatically deactivated ([SETUP]- **GUI Update is On**).

Generating a Hardcopy of Display - Hcopy Key

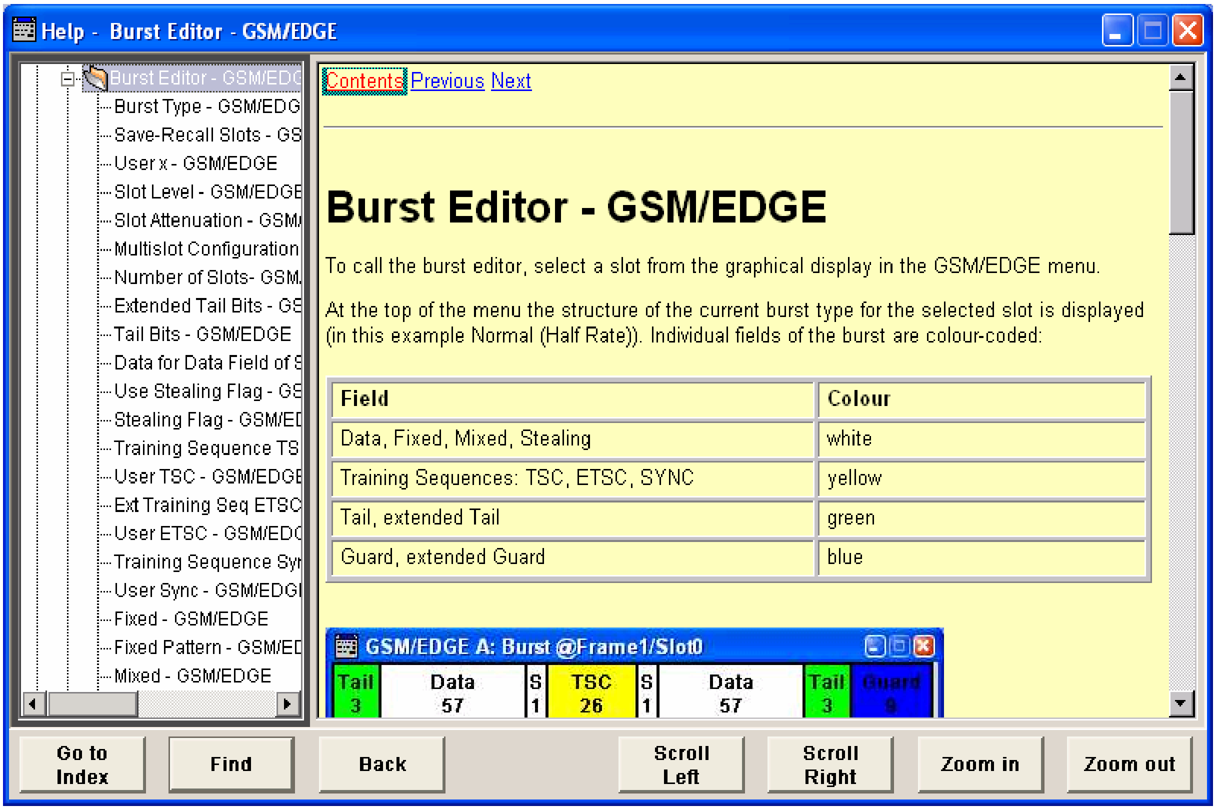
The [HCOPY] key is without function for the R&S AMU.

Messages - Info Key

The [INFO] key opens a window containing a detailed description of every message displayed in the info bar, see chapter 3, section *"Info and Status Bar"* and chapter 9, section *"Error Messages"*.

Help System - Help Key

The HELP key opens a browser window containing a context-sensitive description of the highlighted parameter.



The context-sensitive page which is opened with the HELP key is part of a comprehensive help system. It is possible to move from this context-sensitive page to any page of the help system. The following navigation aids are available:

- **Internal links in the text**
  They open pages which are directly linked to the described function. In this way it is possible, for example, to call up the description of the GPIB command for any particular function.

- **Previous/Next links**
  The Previous/Next links allow scroll through the help pages. The sequence of the described functions corresponds to their position in the menus.

- **Back softkey**
  The Back softkey calls up the page last viewed.

- **Contents in the navigation panel**
  The contents list is used to open the individual help pages. It has a hierarchical structure. The highlighted line indicates where the currently displayed page is within the contents list.

- **Index in the navigation panel**
  The index is used to call up all pages which contain the selected entry. The index has an alphabetical structure and also contains all GPIB commands.

- **Text search softkey**
  The text search allows you to look for freely selectable terms in all help pages. A list of the pages containing the entered term is displayed as the search result. The search can be limited to words in the page title to increase the number of hits.

The softkeys are used to determine the entry focus for front panel operation, to select the content of the navigation window and to change the font size. To determine the entry focus for front panel operation the Cursors UP/Down are used. The links are highlighted in blue, and can be selected and called up using the rotary knob.

Index / Tree - Help

Switches the navigation window display between the contents tree and index entries. The input focus must be in the left-hand navigation window.

Remote-control command : -

Contents tree:

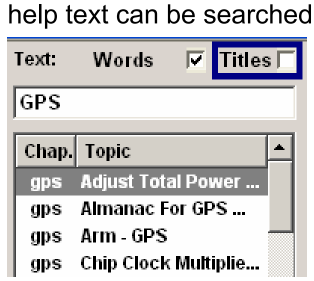
The contents tree is the contents list of the help system. The cursor always highlights the entry which is currently being displayed in the right-hand help window. The associated page can be opened by selecting an entry.

Index:

The index contains an alphabetical list of all terms which refer to functions of the instrument. For example, it contains all parameter names and all GPIB commands. The associated help page can be opened by selecting an entry.

Find - Help

Opens the search panel. The content of the titles only or the complete help text can be searched for the entered term.



Remote-control command: -

Scroll Left / Scroll Right - Help

Shifts the indicated area of the navigation window.

Remote-control command: -

Zoom in / Zoom out - Help

Increases and reduces the font size of the help text.

Remote-control command: -

Storing and Loading Instrument Data - File Key

The R&S AMU allows complete instrument settings to be stored in files on the hard disk. Defined and complex instrument settings can then be reproduced at any time by loading this data. If required, these settings can be loaded to various signal generators.

The FILE key opens the menu used to store and load instrument settings in a file. The data can be stored on the hard disk in a data directory. Additionally there are three intermediate memories in which the current instrument setting can be stored and then called up again by pressing a key. This makes it possible to switch quickly between defined instrument settings.

All settings which differ from the preset plus the configuration data for the operating elements (e.g. window positions) are stored. When loaded, these referenced settings are implemented and all non-referenced parameters are set to the associated preset value. As a result the files remain relatively small since they only contain the relevant information. Furthermore, this also allows instrument settings to be transferred easily between different signal generators since once again only the settings which differ from the preset values have to be adjusted.

If a data list, e.g. a list of frame or channel configurations is used for a digital standard, a reference to this list is stored too. The list is loaded when the associated instrument setting is loaded. If the list has been deleted in the meantime (or it is not available on a different instrument), an error message appears if an attempt is made to access this list after the instrument setting has been loaded. The associated setting or operating mode is only started after the user has selected an existing list. If the list has been overwritten in the meantime, the new entries will be used.

Note:
Lists are stored and loaded in the corresponding menus. For example, the GSM frame definitions are created and stored in the GSM menu.

When loading an instrument setting, it is possible to select whether the current frequency and level setting is to be retained or whether the stored settings are to be activated. It is possible to delete stored instrument settings. A file can be copied by loading it with "Recall" and then storing it under a new name.

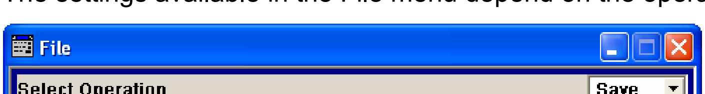
Settings can be transferred easily between instruments with different equipment options and/or firmware versions because only the settings which differ from the preset values are affected. When settings are loaded, only those which are possible on the instrument are implemented. Error messages indicate the settings which cannot be implemented.

The stored file is transferred from one instrument to another using the memory stick or by means of a network drive.

General file management functions such as copying and moving data are available in the **File Manager** submenu.

File Menu

The settings available in the File menu depend on the operation selected under **Select Operation**.



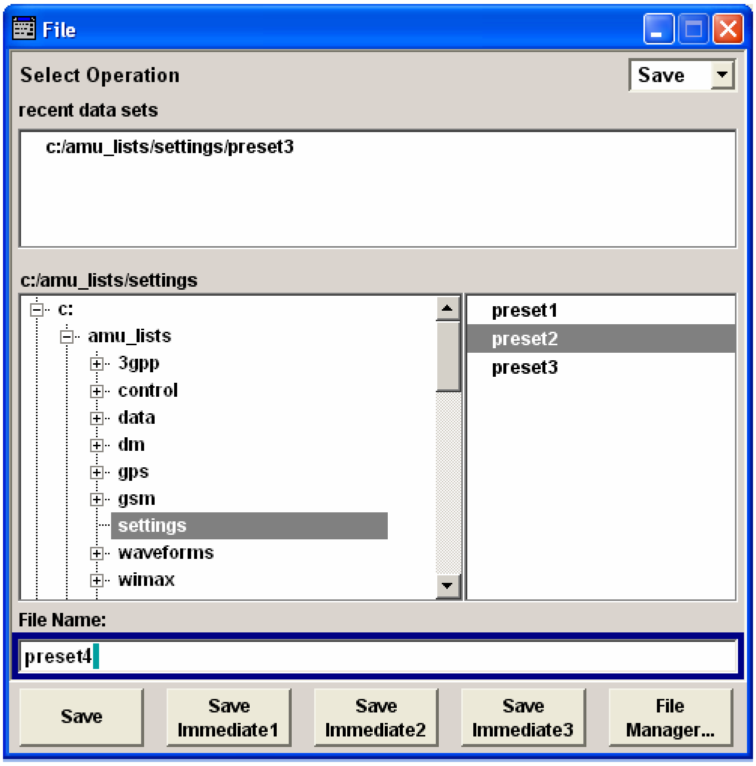
Select Operation - File Selects the file function.

Save... Calls the menu for storing the current instrument setting.

Recall... Calls the menu for calling up a stored instrument setting.

Storing Instrument Settings - File

If **Save** is selected under **Select Operation**, the File menu provides options for storing the current instrument setting in a file.



Recent data sets - File

Displays the files last used. The entire path is shown in plain text (e.g. c:/amu_lists/settings/preset3).

Remote-control command: n.a.

Directory - File

Selects the directory in which the file is to be stored.

The window opposite lists all settings files in this directory.

A new directory can be created in the File Manager (**File Manager** button).

Remote-control command:
`MMEM:CDIR "D:\user"`
(The path can also be entered when the file is stored.)

File List - File

Displays the files which are in the selected directory.

If a file is highlighted, it is overwritten when the file is stored.

Remote-control command:
`MMEM:CAT?`

File Name - File

Enter the file name of the file without file extension. This file is then created.

Remote-control command: n.a.
(The file name is entered when the file is stored.)

Save - File

Stores the current instrument settings under the specified path.

Remote-control command:
`MMEM:STOR:STAT 0,'test'`

Save Immediate x- File

Stores the current instrument setting in one of the three intermediate memories.

These instrument settings are retained until a different instrument setting is stored in the intermediate memory. When the instrument is switched off, the contents of the intermediate memories are retained.

Remote-control command:
`*SAV 1`

File Management- File

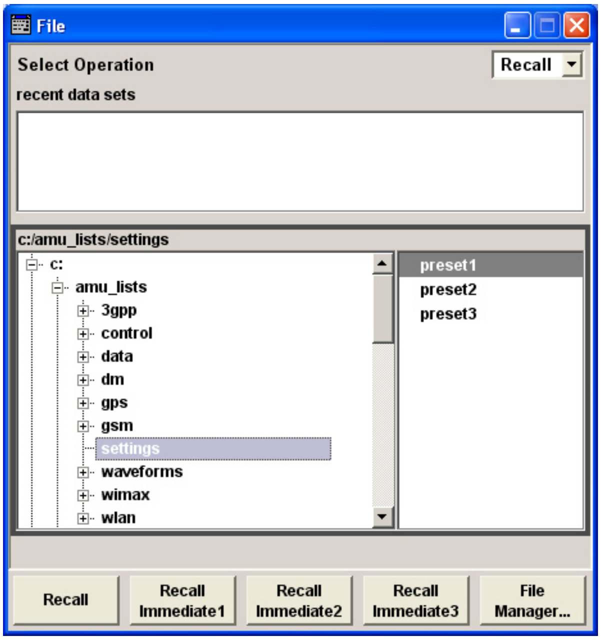
Calls the **File Management** menu.

Directories can be created and files managed in this menu (see the section "*File Manager - File*" on page 4.27).

Remote-control command: -

Loading Instrument Settings - File

If **Recall** is selected under **Select Operation**, the **File** menu provides options for loading complete instrument settings. Here it is possible to select whether the current or stored frequency and level settings are to be used.



Recent data sets - File

Displays the files last used. The entire path is shown.

If the desired file is in the list, it can be selected in this window.

Remote-control command: n.a.

Directory - File

Enter the directory in which the file with the instrument setting to be loaded is located.

The **Selected file** window lists all the files in this directory.

Remote-control command:
`MMEM:CDIR "D:\user"`

File List - File

Selects the file with the desired instrument configuration.:

Remote-control command:
`MMEM:CAT?`

Recall - File

Load the selected configuration.

If an instrument setting in which a sweep was activated is stored, the sweep is started when the recall command is called.

If an instrument setting which accesses lists is stored, this list is also loaded.

If the list has been deleted in the meantime, an error message appears when the instrument setting is loaded. If the list has been overwritten in the meantime, the new entries will be used.

Remote-control command:
`MMEM:LOAD:STAT 0,'test'`

Recall Intermediate x- File

Loads the selected configuration from one of the three intermediate memories.

If an instrument setting in which a sweep was activated is stored, the sweep is started when the recall command is called.

If an instrument setting which accesses lists is stored, this list is also loaded.

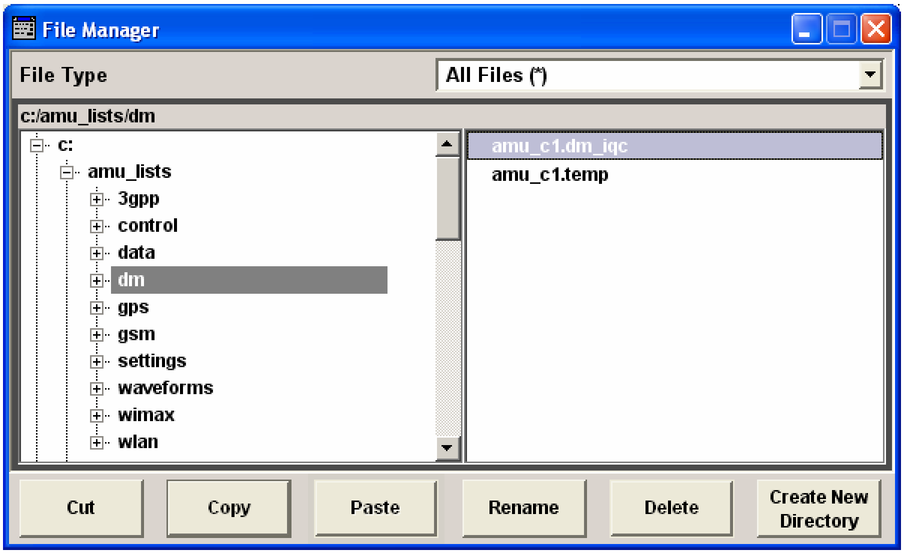
If the list has been deleted in the meantime, an error message appears when the instrument setting is loaded. If the list has been overwritten in the meantime, the new entries will be used.

A message appears if no instrument configuration is stored in this memory.

Remote-control command:
`*RCL 1`

File Manager - File

The **File Management** menu provides all the functions required for file management. Directories can be created, and files copied, deleted and moved between the directories on the drives (hard disk, memory stick and network drives).



File Type - File Manager

Selects the file types to be indicated. If a file type with a specific file extension (e.g. Control List (*.dm_iqc)) is selected only files with this extension are indicated in the selected directory.

Remote-control command: n.a.

Directory - File Manager

Selects the directory in which the file to be deleted or copied is located. The window to the right lists all files in this directory. The file to be deleted or copied can be highlighted. The path is indicated above the directory window.

Remote-control command:
`MMEM:CDIR "D:\user"`

File Name - File Management

Selects the file.

Remote-control command: n.a.

Cut - File Management

Cuts the selected file. It can be pasted into a different directory using the **Paste** button.

Remote-control command:
`MMEM:DEL 'E:\test.savercl'`

Copy - File Management

Copies the selected file. It can be pasted into a different or the same directory using the **Paste** button. When pasting the file into the same directory file name "Copy of <filename>" is given automatically. When pasting the file into a different directory, the original filename is kept.

Remote-control command:
`MMEM:COPY "D:\user\set1.wv","D:\user\set2.wv"`

Paste - File Management

Pastes the file that has been copied or cut before.

Remote-control command: n.a.

Rename - File Management

Renames the selected file or directory. The new name can be entered in the **New Filename** window.

Remote-control command:
`MMEM:MOVE "test02.dm_iqd","set2.dm_iqd"`

Delete - File Management

Deletes the selected file. Before the file is deleted, a message appears prompting the user to confirm deletion of the file.

Remote-control command:
`MMEM:DEL 'E:\test.savercl'`

Create New Directory - File Management

Creates a new directory. The name of the new directory can be entered in the **New Directory** window.

The directory is created as a subdirectory in the selected level.

Remote-control command:
`MMEM:MDIR 'D:\user\test'`

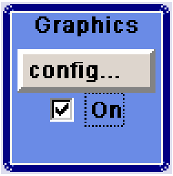
Note:
When the subdirectory is entered, it is possible to enter an absolute path name (e.g. "`D:\USER\MEAS`") or the path relative to the current directory (e.g. "`..\MEAS`").

Graphical Display - Graphics

Graphical Display of Signal Characteristics

The R&S AMU can be used to graphically display the generated baseband signal. A selection of different signal displays assists the user in assessing and checking the increasingly complex modulation signals.

Most graphical displays are possible both for internally generated and externally applied baseband signals.



The Graphics function block is available for instruments with the option R&S AMU-B13 (Baseband Main Module) and one of the options R&S AMU-B9/B10/B11 (UniCod + ARB), R&S AMU-B17 (Baseband input) or R&S AMU-B62 (Noise Generator).

It is the baseband signal actually generated that is recorded and displayed, and not a signal calculated on the basis of the set parameters.

This graphical display allows the user to quickly view and check the current signal characteristics and also gives an overview of the changes in the signal over time. The signal quality can be permanently monitored. The results of parameter changes on the signal, such as a change in modulation mode, or the effects of certain configurations, e.g. the activation of several base stations in the case of (W)CDMA signals, can be analyzed directly in the display. Freezing the signal and then zooming permits a detailed evaluation of any signal segment. The definition and display of one or more reference curves makes it possible to compare various signals (i.e. by comparing the CCDF (Complementary Cumulative Distribution Function) with different channelization codes, or the spectra if different filter parameters are selected).

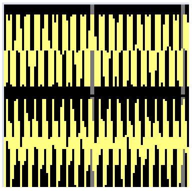
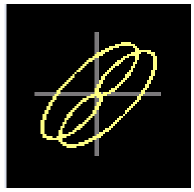
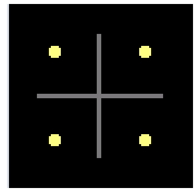
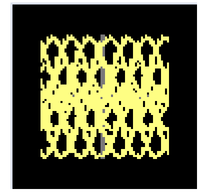
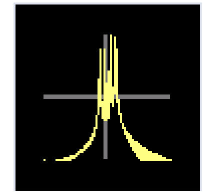
An externally applied signal can be checked with respect to the anticipated signal characteristics.

The displayed signal segment can be influenced by selecting the trigger that defines the time for recording to start. With automatic triggering, the signal is tapped at the point in the signal path that is best for the respective display. The displayed signal segment is selected internally depending on the signal such that the signal characteristics of interest (e.g. the useful signal) are displayed. This selection is appropriate for a representative display of the complete signal.

In addition, a user-definable trigger is available with which the displayed signal segment can be limited.

The time resolution can be set either automatically or manually, whereby for manual setting the bandwidth for which the trace is to be displayed is selected. The transient recorders used for signal recording have a variable recording depth which is specified under the respective display.

In addition to the large graphics window, the display can also be shown in a small window ("smart graphics"). This window is fitted into the block diagram as a block, and can be used for basic checking purposes (e.g. whether the signal is still being generated).

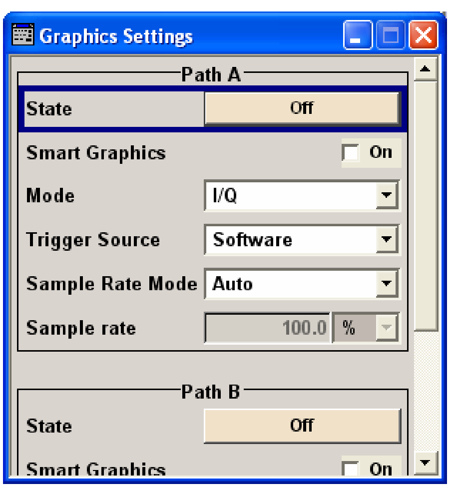
In the case of two-path instruments, the baseband signals of both paths can be displayed simultaneously.

Graphics Settings Menu

The **Graphics Settings** menu for selecting the graphical display of the output signal is opened either in the **Graphics** function block or in the menu with the same name which is opened using the MENU key.

The signal display can be selected and activated in the menu.

With two-path instruments, the settings for the two paths can be entered separately. The signals can be displayed simultaneously in two separate windows.



The signal display can be selected and activated in the menu.

With two-path instruments, the settings for the two paths can be entered separately. The signals can be displayed simultaneously in two separate windows.

Status - Graphics Settings

Activates the selected graphical display.

After activation, the diagram selected with **Mode** is displayed in the block diagram.

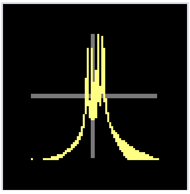
At the bottom of each graphics window there are several buttons for freezing and zooming the display and for activating a reference curve (see the following section "*Softkey Bar of Graphics Window*", page *4.33*).

Remote-control command: n.a.

Smart Graphics - Graphics Settings

Activates the "smart graphics".

The graphic is displayed in a small window which is roughly the size of a block. These windows are displayed permanently in the block diagram until they are deactivated, and allow basic checking of the signal. They do not contain any buttons.



Remote-control command: n.a.

Mode - Graphics Settings

Selects the graphical signal display. The display is not shown until it has been activated with **Status On**.

The individual signal displays are described in the section "Signal Displays - Graphics" on page 4.36.

Remote-control command: n.a.

Trigger Source - Graphics Settings

Defines the trigger for the starting time of the graphic recording.

Remote-control command: n.a.

Software

Recording of signals is started automatically in specified intervals.

This asynchronous method is appropriate when a representative display of the complete signal is desired, as recording starts in a random time reference to the signal.

Marker 1

The starting point for recording signals is determined by marker 1 in the menu of the active standard.

This synchronous method is appropriate when specific signal segments are to be shown in greater detail. With periodic signals, a static image is obtained by selecting a period length of marker 1 that is equal to the signal period.

The displayed signal segment can be shifted as needed by entering a marker delay in the Trigger/Marker menu of the active standard.

Scrambling Code - Graphics Settings
(only if Code Domain (3GPP FDD DL) is selected)

Sets the scrambling code if the **Code Domain** display is selected. Since it is possible to select a different scrambling code in the menu for each of the 4 base stations and it is also possible to display an external signal, the scrambling code for which the display is to be generated must be explicitly specified here.

Remote-control command: n.a.

Sample Rate Mode - Graphics Settings

Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a display covering the entire signal bandwidth. The higher the resolution is, the shorter the length of the displayed signal segment will be for the specified recording depth.

Auto
The resolution is set to an optimum value on the basis of the signal and display type.

Remote-control command: n.a.

Full Bandwidth
The resolution is set such that the display covers the entire signal bandwidth.

Remote-control command: n.a.

User
Under **Graphics Sample Rate**, the user can determine the resolution by setting the signal bandwidth for which the display is to be generated.

Remote-control command: n.a.

Graphics Sample Rate - Graphics Settings

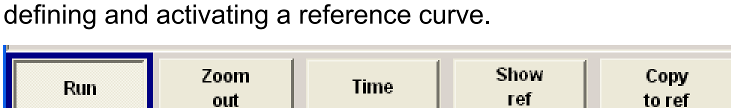
With **Auto** and **Full Bandwidth**:
Displays the signal bandwidth for which the display is to be generated.

With **User**:
Selects the signal bandwidth for which the display is to be generated. The setting range moves between the minimum and maximum bandwidth which is possible for the selected display. The selection is made graphically by moving the pointer.

Remote-control command: n.a.

Softkey Bar of Graphics Window

At the bottom of each graphics window there are buttons for freezing and zooming the display and for defining and activating a reference curve.



Run

Freezes the current display.

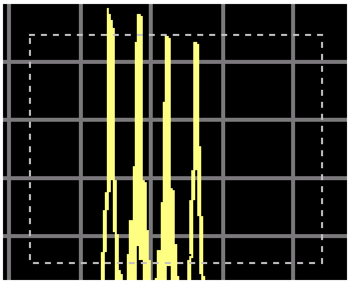
Clicking on the button again reactivates the normal, permanently updated display.

Freezing the display allows it to be analyzed more easily. Zooming the display at the same time permits detailed evaluation of any signal segment.

Remote-control command: n.a.

Zoom in
(only possible with mouse)

The mouse can be used to freely select any section to be zoomed. This section is selected by pressing the left-hand mouse key and dragging a rectangular marquee. In this way a display can be zoomed in several steps. The zoom is cancelled by clicking on the **Zoom Out** button.



Remote-control command: n.a.

Zoom out

Cancels the zoom.

Remote-control command: n.a.

Time
(only I/Q mode)

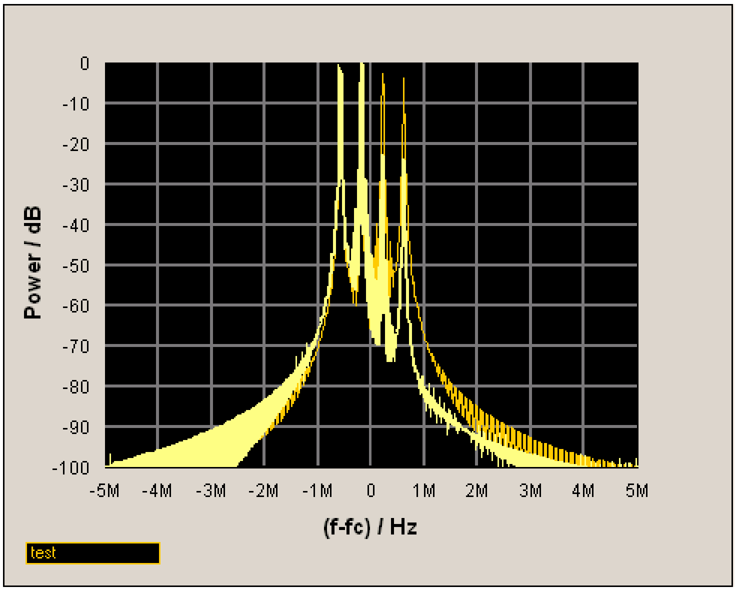
Switches to seconds for time representation on the X axis of the I/Q diagram.

Remote-control command: n.a.

Show ref

Displays the reference curve(s). All defined reference curves are displayed simultaneously (see the description of the **Copy to ref** button).

The reference curves are displayed together with the current signal. They allow visual comparison of two or more signals with different settings, e.g. with different filters.



Clicking on the button again hides the reference curves.

The reference curves must be defined beforehand using the **Copy to Ref** button.

Remote-control command: n.a.

Copy to ref

Defines the current curve as the reference curve.

A window opens in which the curve can be given a comment and a color.

First of all the desired color is highlighted in the top window. If this color has already been assigned to a reference curve, this curve is overwritten. The command is entered in the bottom **Comment** section. This comment then appears next to the highlighted color.

Up to 5 reference curves can be defined and displayed simultaneously in different colors together with the current signal.

Each reference curve is available until it is deleted.

Remote-control command: n.a.

Display area

The comments entered for the defined reference curve are shown in the display area next the assigned color. A maximum of five colors (and reference curves) are available. If no reference curve is assigned to a particular color, the comment <empty> is displayed.

Remote-control command: n.a.

Comment

Enters a comment for the current curve which is to be defined as the reference curve. This comment then appears next to the highlighted color in the display area.

Remote-control command: n.a.

Delete

Deletes the curve highlighted in the display area.

Curves which are no longer required can be deleted to reduce the number of reference curves displayed simultaneously.

Remote-control command: n.a.

Assign Defines the current curve as the reference curve.

The new reference curve is shown together with the entered comment next to the selected color in the display area.

Remote-control command: n.a.

Signal Displays - Graphics

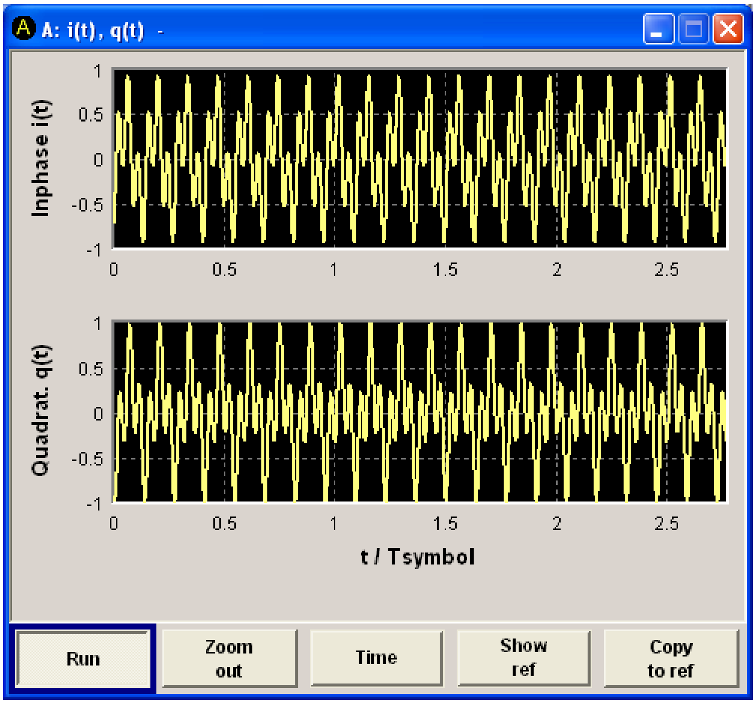
All signal displays which are used for analyzing a baseband signal can be selected. A number of signal displays are available only if the corresponding signal is generated, e.g. Code Domain is available only for (W)CDMA signals.

I/Q Diagram - Graphics

The I/Q diagram displays the inphase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time.

The diagram is displayed in a window with two separate coordinate systems. The coordinate systems have identical X and Y axes. The time (in number of symbols, chips or samples depending on the signal) is plotted on the X axes, and the amplitude scaled to the peak envelope power (PEP) is plotted on the Y axes (minimum scaled amplitude = -1; maximum scaled amplitude = +1). The recording depth is 1kSamples.

This signal is picked off at the output of the baseband main module (**Impairment** function block). Fading and impairment of the signal as defined by the user and the addition of noise is contained in the displayed signal. Also, an added external (Baseband Input) or internal signal (from the second path) is included.

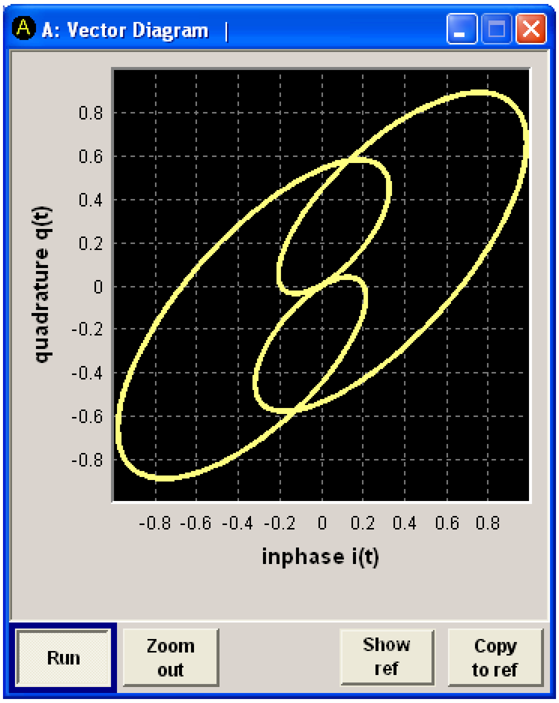


Vector Diagram - Graphics

The Q component is displayed over the I component in the vector diagram. Each point is determined by a vector. The amplitudes of the signal components scaled to the peak envelope power (PEP) are plotted on the X and Y axis (minimum scaled amplitude = -1; maximum scaled amplitude = +1).

This display shows the curves between the various states of modulation mapping. The recording depth is 1kSamples.

This signal is picked off at the output of the baseband main module (**Impairment** function block). Fading and impairment of the signal as defined by the user and the addition of noise is contained in the displayed signal. Also, an added external (Baseband Input) or internal signal (from the second path) is included.



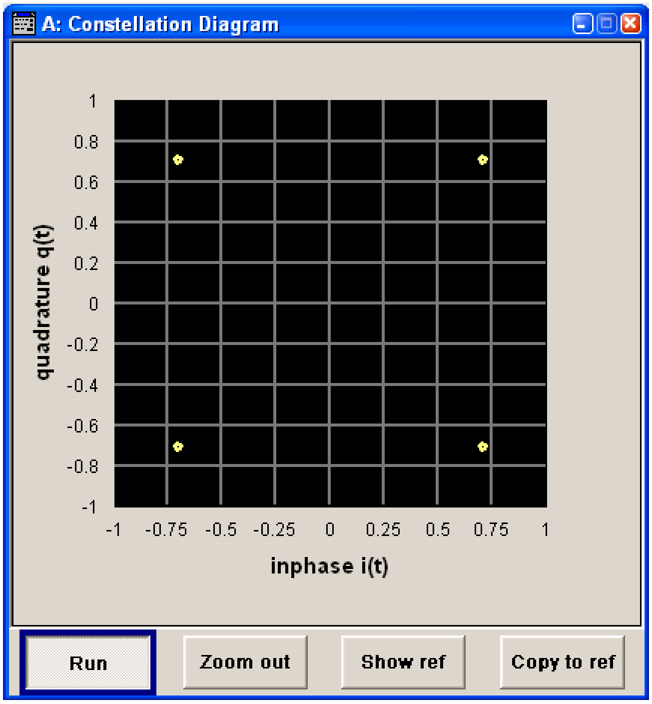
Constellation Diagram - Graphics

In the constellation diagram, the Q component is also displayed over the I component. However, only the values at the constellation points (signal value at the ideal scanning instant of the symbol) are displayed, i.e. for each symbol only 1 value in the form of a circle is shown for the I and Q component.

The amplitudes of the signal components scaled to the peak envelope power (PEP) are plotted on the X and Y axis (minimum scaled amplitude = -1; maximum scaled amplitude = +1). The recording depth is 2kSamples.

This signal is picked off at the output of the unicoder (**Baseband** function block) upstream of baseband filtering. Fading and impairment of the signal as defined by the user and the addition of noise is not effective in this signal because signal impairment and noise addition occur further down the signal path. Also, an added external (Baseband Input) or internal signal (from the second path) is not included.

This display shows the various states of modulation mapping which occur in the signal. The example shows the constellation diagram of a QPSK modulation signal.



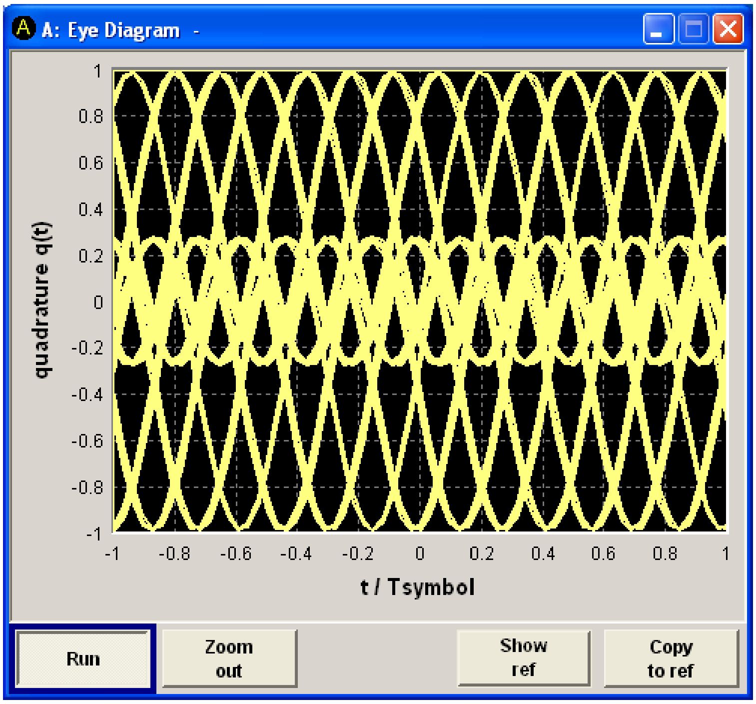
Eye Diagram - Graphics

The eye diagram displays synchronized and superimposed sections of either the inphase or quadrature components of the signal.

The display width (eye length) is set at 2 symbols; several hundred curve segments are superimposed. The time (in the range -/+ 1 symbol) is plotted on the X axis, and the amplitude scaled to the peak envelope power (PEP) is plotted on the Y axis (minimum scaled amplitude = -1; maximum scaled amplitude = +1). The beginning of recording is synchronous to the symbol and chip clock pulse. The recording depth is 2kSamples.

This signal is picked off at the output of the unicoder (**Baseband** function block) downstream of baseband filtering. Fading and impairment of the signal as defined by the user and the addition of noise is not effective in this signal because signal impairment and noise addition occur further down the signal path. Also, an added external (Baseband Input) or internal signal (from the second path) is not included.

The exactness of the superimpositions and therefore the size of the eye gaps depend on the used filter.



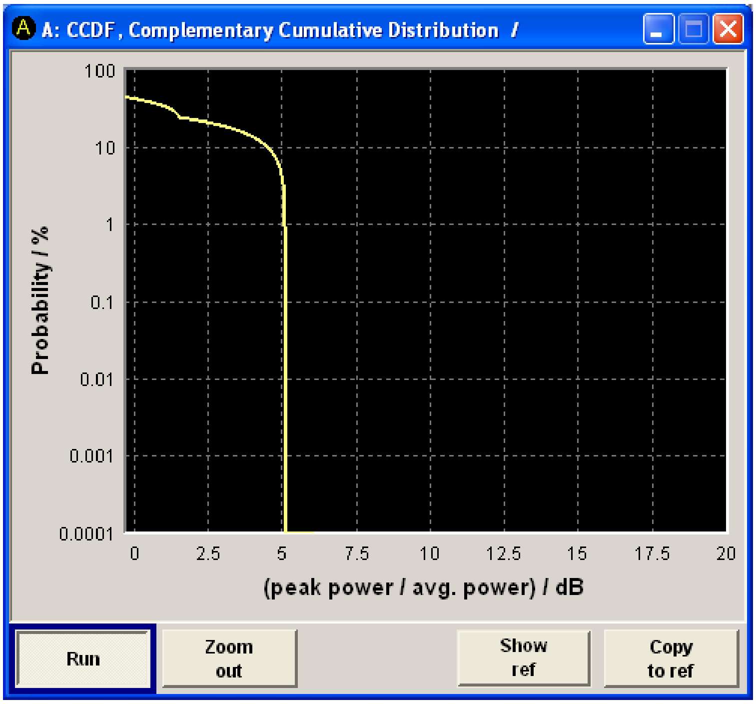
CCDF Display - Graphics

The **C**omplementary **C**umulative **D**istribution **F**unction shows the probability with which the output signal will exceed the average power.

The level over the average power is plotted from 0 to 20 dB on the X axis; the average power (rms) corresponds to the origin. The probability of exceeding the average power is plotted between 0.0001% and 100% on the Y axis. The recording depth is 8kSamples.

This signal is picked off at the output of the baseband main module (**Impairment** function block). Fading and impairment of the signal as defined by the user and the addition of noise is not effective in this signal because signal impairment and noise addition occur further down the signal path. Also, an added external (Baseband Input) or internal signal (from the second path) is not included.

The point at which the CCDF curve intersects the X axis gives the crest factor of the signal.



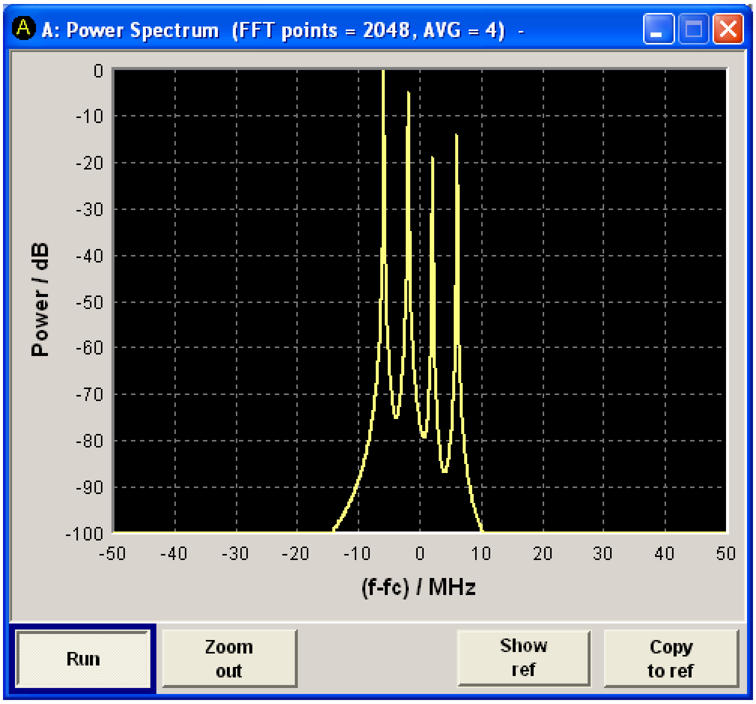
Power Spectrum - Graphics

With the spectrum display, the signal spectrum is calculated from the I/Q signal by means of Fast Fourier Transform (FFT).

The power density over frequency is displayed. The power density is plotted on the Y axis, and the frequency is plotted symmetrically on the X axis (-sampling rate/2 to +sampling rate/2). FFT Points indicates the number of I/Q value pairs which are used for calculating a (part-)FFT. AVG indicates the number of subspectra used for averaging. The recording depth is 8kSamples.

This signal is picked off at the output of the baseband main module (**Impairment** function block). Fading and impairment of the signal as defined by the user and the addition of noise is contained in the displayed signal. Also, an added external (Baseband Input) or internal signal (from the second path) is not included.

The spectrum display of the output signal is particularly suitable for checking multicarrier signals.



Bit and Block Error Rate Measurements - BERT Block

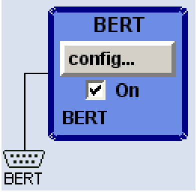
Introduction - Bit and Block Error Rate Measurements

The R&S AMU contains an integrated bit error rate tester which makes it possible to evaluate a signal demodulated and decoded by a DUT by measuring the bit error rate. A known PRBS-modulated data sequence (PRBS = pseudo random binary sequence) is sent to the DUT. The PRBS data sequence is decoded by the DUT and sent to the R&S AMU in the form of clock and data signals.
The bit error rate tester of the R&S AMU synchronizes to the known PRBS sequence and counts the bit errors. The quotient obtained by dividing the number of error bits by the total number of bits is the BER.

In addition, a block error rate measurement can be used to verify CRC checksums. The ratio of errored blocks to total blocks yields the block error rate.

The settings are shown in the block diagram in the **BERT** function block and in the menu of the same name that is accessed via the MENU key.

The equipment layout for the basic unit (option R&S AMU-B9/B10/B11) includes the option K80 (Bit Error Rate Tester).



The **BERT** interface is located on the rear panel. Besides the data and clock input, it provides other inputs with which the user data containing the PRBS sequence can be masked. The interface description can be found in chapter 8, section "*BERT Interface*".

Test setup

The following figure shows the test setup for the bit/block error rate measurement. The data used to drive the DUT can be generated by the R&S AMU or an user-defined external source. The R&S AMU can generate any externally computed modulation signals that were created using e.g. **WinIQSIM** software (see section "*Arbitrary Waveform Generator*").

A known PRBS sequence must be used for the bit error rate measurement.

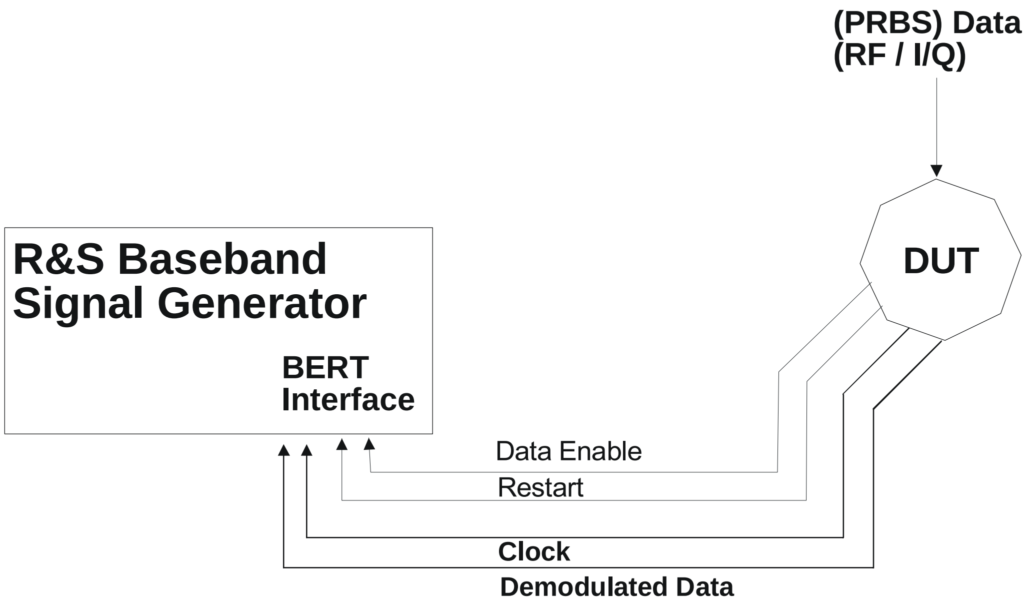


Fig. 4-1 Test setup for bit or block error rate measurement. The DUT is driven using a known data sequence. It demodulates the data and sends it together with a clock signal to the R&S AMU. The Data Enable signal marks the user data of the signal. The restart signal for restarting the PRBS calculation is only important for the bit error rate measurement.

PRBS data - bit error rate measurement

To be able to detect faulty bits by a BER measurement, the data generation polynomial must be known. PRBS sequences are therefore used as the method for computing the data (see section "*Internal PRBS-Data and Data Pattern*"). These quasi-random bit sequences are repeated periodically, depending on the polynomial selected. A randomly selected initial status yields exactly one subsequent status. The initial status and therefore the subsequent status occur only once in the whole sequence.

Hence an advantage of the PRBS data is that the bit error detector must know only the polynomial but not the entire sequence. At the start of a measurement, the feedback shift register is filled once with the applied data sequence (which corresponds to the synchronization time) and is subsequently switched from "fill" to "feedback". This creates a defined initial status and generates exactly the same data that the applied data stream should have. Faulty bits can thus be identified and counted by comparing the received data with the results obtained from the shift register.

Creating a defined initial status makes it possible to start the analysis anywhere in the bit stream, i.e. the bit-stream source and the analyzer need not be synchronized. Delays of the DUT and transmission over long air paths, where the transmitter and the receiver are located at separate sites, therefore do not present a problem.

CRC polynomial - block error rate measurement

In the block error rate measurement, the checksum (CRC) that contains the data signal fed to the DUT is compared with the checksum that the block error rate tester calculates from the feedback data. If the two checksums differ, a block error is counted. The quotient obtained by dividing the number of faulty blocks by the total number of blocks is the block error rate.

At the beginning of the data, the shift register is initialized with 0. All user data bits are then shifted through the shift register. The CRC component is then read into a second register and compared bit by bit with the result of the calculation.

CCITT CRC 16 : $G(x) = x^{16} + x^{12} + x^5 + x^1$ is the CRC polynomial supported.

The user data is marked by a signal that comes from the DUT and is fed to the **Data Enable** input of the BERT interface.

Clock signal

Usually the clock signal is provided by the DUT. If not, the bit clock can be extracted from the CLOCK output connector (only with **Custom Dig Mod** signals in realtime). If signals complying with other digital standards are generated or if ARB waveforms are used, a marker signal can be used as a clock. As the DUT causes a delay, the ratio of clock-to-data travel times must always be taken into account and checked with an oscilloscope if necessary. The R&S AMU indicates the status of the clock and data lines and of the synchronization in the menus.

Ending the measurement

The measurement results usually lie in the range of 10^{-2} to 10^{-9} for the bit error rate, and in the range of 10^{-2} to 10^{-4} for the block error rate. This means that a very large number of bits or blocks may have to be tested before a faulty bit or block occurs. Because of the large number of bits/blocks involved, the measurement time is usually very long. Since 32-bit-wide counters are used for the total number of bits/blocks and the number of error bits, the maximum measurement time is 4.29×10^9 bits.

To keep the measurement times short for both small and large bit/block error rates, the R&S AMU provides a number of ways to end the measurement. In addition to manually interrupting the count, two termination criteria can be selected: 1) reaching a user-defined number of checked data bits/blocks; 2) a maximum number of detected errors. The measurement stops as soon as one of the two criteria has been met. The display shows which of the two criteria caused the measurement to stop.

Note:

The BER/BLER measurement measures statistical bit/block errors, i.e. errors which do not occur at regular intervals but at random. Although a single measurement determines the exact number of errors in the measured interval, a statistically reliable BER/BLER can only be obtained when a sufficient number of errors occurs in the observed interval. This is the only way to ensure that the single BER/BLER measurement result approaches the true error rate with high probability.

Bit error rates of approximately 50 % indicate a faulty measurement.

Interrupt-free measurement - bit error rate measurement

In the case of continuously generated signals that contain whole-number multiples of the PRBS sequence, the measurement occurs without interruption. Only the data and clock lines of the BERT interface are used for the measurement. The length of the random sequence is 2 to the power of the degree of the polynomial minus 1. For example, PRBS9 has a length of 511 (2^9 equals 512 minus 1).

Restart function - bit error rate measurement

The **Restart** function makes it possible to perform BER measurements with short signals or with signals that are not continuously generated (and therefore do not contain any whole-number multiples of PRBS sequences). An external signal at the BERT input halts the measurement and restarts it when the data sequence begins, and the BER results of the relevant (sub)sequences are integrated.

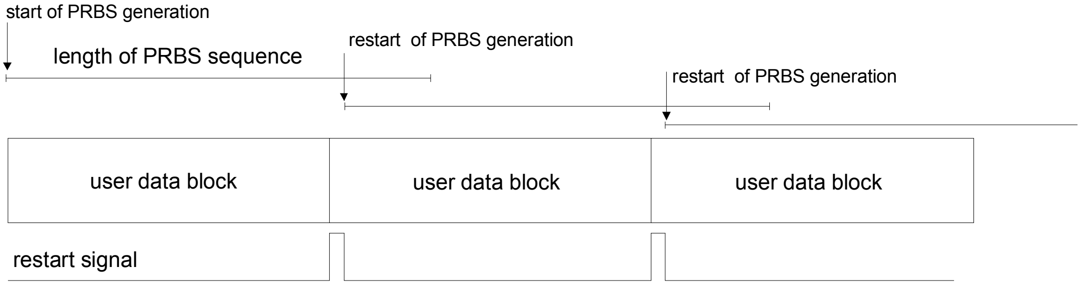


Fig. 4-2 The length of the signal is too short for a complete PRBS sequence; PRBS generation is restarted by the **Restart** signal when the signal begins anew.

Frames generated by the R&S AMU or the **WinIQSIM** software contain continuous PRBS data, i.e. the PRBS sequence is continuously written to the user data fields. Consequently, if the R&S AMU is used as a data source, a restart is only necessary if (e.g. when using a waveform) the total length of the signal does not equal a whole-number multiple of a PRBS sequence.

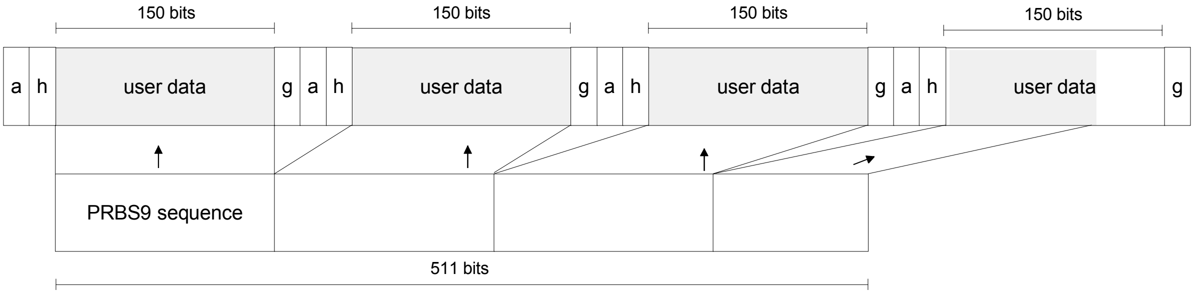


Fig. 4-3 TDMA signal generated by the R&S AMU with user data that contains the PRBS data sequence. The PRBS sequence is continuously written to the user data fields.

Data Enable

In the case of the **bit error rate measurement**, the data signals usually contain not only PRBS data but also other data (e.g. sync and preambles, see figure) that would result in bit errors. The BER measurement for this data can then be interrupted using the **Data Enable** signal. The **Data Enable** signal is fed in at the BERT input.

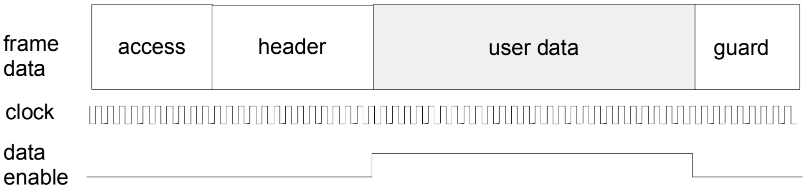


Fig. 4-4 TDMA signal with user data that contains the PRBS data sequence and various check fields which should be ignored for the bit error rate measurement. Below that are the associated clock and **Data Enable** signals.

In the case of the **block error rate measurement**, the **Data Enable** signal masks the user data (see following figure).

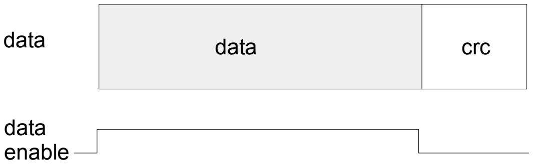


Fig. 4-5 **Data Enable** signal with block error rate measurement.

Pattern Ignore - bit error rate measurement

Bit sequences of 32 bits or more with only "1" or "0", which some mobile radio standards provide instead of frame data when faulty frames are detected, can also be excluded from the measurement using the **Pattern Ignore** function (see figure).

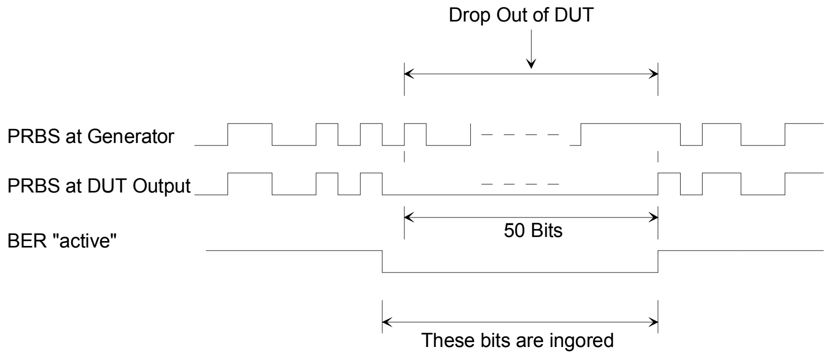
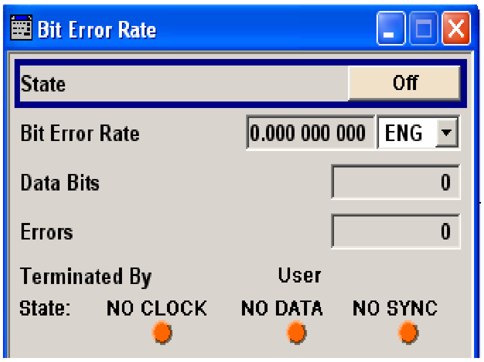


Fig. 4-6 Example of functionality of **Pattern Ignore**: 50 bits were set to "0" by the DUT. These 50 bits plus the preceding "0" are ignored in the bit error rate measurement.

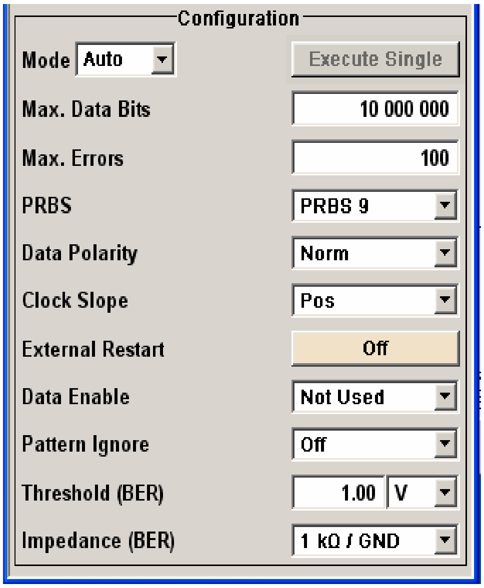
Bit Error Rate Menu

The **Bit Error Rate** menu for configuring the bit error rate measurement is called either in the **BERT** function block or via the MENU key under **BERT**.

The **Bit Error Rate** menu is divided into the following sections:



The top section is used to switch on the bit error rate measurement and display the results and current status of the measurement.



The **Configuration** section is used to select the type of measurement the data source and the termination criteria.

If the data is not cyclically continued, the measurement can be selectively interrupted and restarted. Certain data sections and frames that have been marked as faulty can be excluded from the measurement.

The top section is used to switch on the bit error rate measurement and display the results and current status of the measurement.

State - Bit Error Rate

Switches the bit error rate measurement on/off.

Depending on the selection in the **Mode** box, either a continuous measurement (**Auto**) or a single measurement (**Single**) is carried out. A single measurement must be started by clicking on the **Execute Single** button.

Remote-control command:
`BERT:STAT ON`

Bit Error Rate - Bit Error Rate

Displays the measured bit error rate.

The bit error rate is the ratio of occurred errors to transmitted data bits.

Remote-control command:
`BERT:RES?`
Response (the 3rd value indicates the error rate):
`"1000,5,5E-4,1,1,1,1"`

The display unit can be selected in the box to the right of the value.

ENG The bit error rate is output in exponential notation with the exponent –3 or –6.

Remote-control command:
`BERT:UNIT ENG`

SCI The bit error rate is output in scientific notation, i.e. standardized to one place to the left of the decimal.

Remote-control command:
`BERT:UNIT SCI`

% The bit error rate is output in percent.

Remote-control command:
`BERT:UNIT PCT`

ppm The bit error rate is output in parts per million.

Remote-control command:
`BERT:UNIT PPM`

Data Bits - Bit Error Rate

Displays the current number of data bits checked.

Remote-control command:
`BERT:RES?`
Response (the 1st value indicates the number of data bits checked):
`"1000,5,5E-4,1,1,1,1"`

Errors - Bit Error Rate

Displays the current number of occurred errors.

Remote-control command:
`BERT:RES?`
Response (the 2nd value indicates the number of occurred errors):
"1000,5,5E-4,1,1,1,1"

Terminated By - Bit Error Rate

Displays the termination criterion for the measurement.

These criteria can be entered to keep the duration of the measurement short for low as well as high bit error rates.

The last measurement result is displayed after the measurement has been terminated.

Remote-control command:
`BERT:RES?`
Response (the 4th value indicates whether the measurement has been terminated: 1 = terminated): `"1000,5,5E-4,1,1,1,1"`

User The measurement was manually terminated by the user switching the state to off.

Remote-control command:
`BERT:STAT OFF`
`BERT:STOP`

Number of Data Bits The measurement was terminated because the specified number of data bits was reached.

Number of Errors The measurement was terminated because the specified number of errors was reached.

State - Bit Error Rate

Displays the status of the measurement.

This enables the user to check whether the measurement functions. The status of the data and clock lines and of synchronization is checked and displayed.

If a faulty status is displayed, the signals can be checked at the BERT interface using an oscilloscope.

Remote-control command:
`BERT:RES?`
Response (the 4th value indicates whether the measurement has been terminated: 1 = terminated): `"1000,5,5E-4,1,1,1,1"`

Clock The applied clock signal was detected.

Remote-control command:
`BERT:RES?`
Response (the 5th value indicates the status of the clock line: 1 = active, 0 = not active):
`"1000,5,5E-4,1,1,1,1"`

No Clock The applied clock signal was not detected.

Possible causes are:

- Clock recovery is not available (e.g. with tests of RF components).
  If the signal is generated using the R&S AMU, the bit clock can be extracted from the CLOCK output connector (only with **Custom Dig Mod** signals in realtime). If signals complying with other digital standards are generated or if ARB waveforms are used, a marker signal can be used as a clock. As the DUT causes a delay, the ratio of clock-to-data travel times must always be taken into account and checked with an oscilloscope if necessary.
- The wrong impedance for the applied clock rate was selected (see **Impedance** parameter).
- The wrong threshold for the applied clock signal was selected (see **Threshold**).

Data

The applied data signal was detected.

Remote-control command:
BERT:RES?
Response (the 6th value indicates the status of the data line: 1 = active, 0 = not active):
"1000,5,5E-4,1,1,$\boxed{1}$,1"

No Data

The applied data signal was not detected.

Only clocked-in signals are detected; if the clock signal is missing, then data changes will also not be detected.

If the data is not detected despite the detected clock signal, this may be caused by the following:

- The signal from the DUT is missing.
- The wrong impedance for the applied clock rate was selected (see **Impedance** parameter).
- The wrong threshold for the applied data signal was selected (see **Threshold** parameter).

Sync

The measurement is synchronized.

Remote-control command:
BERT:RES?
Response (the 7th value indicates the status of the synchronization: 1 = successful, 0 = unsuccessful):
"1000,5,5E-4,1,1,1,$\boxed{1}$"

No Sync

The measurement is not synchronized.

Generally, a measurement cannot be synchronized until a clock and a data signal have been detected. If synchronization still does not occur, this may be caused by the following:

- The selected PRBS is not correct. For the bit error rate measurement, the PRBS sequence on which the data is based must be set on the bit error rate tester. If the PRBS is not correct, the BER measurement cannot synchronize to the data (due to the incorrect polynomial).
- A wrong clock slope is used, which violates setup or hold times (see **Clock Slope** parameter).
- The travel times of clock and data are unfavorable (e.g. clock slope at data change). Check the relationship of clock to data using an oscilloscope and optimize the travel times (e.g. clock slope when the data signal applied is stable).
- Reflections on the clock line occur, clocking the data signal into the BER measurement twice, e.g. on lines without termination. The

input of the R&S AMU input is **not** terminated.

- Incorrect polarity of data signal (or **Data Enable** signal).
  In this case the PRBS cannot synchronize. Note that an inversion of the output signal specified for some cases by the PRBS standard is performed automatically upon PRBS selection. Manual inversion of the data signal is therefore not required.

No Sync status and an error rate of approx. 50%:

1. A bit error occurs during synchronization (e.g. nine data bits with PRBS9). The BER measurement is set up incorrectly. This fault is internally detected and automatically corrected.
2. If data that is not cyclically continued (i.e. when a break in the sequence occurs at the memory wrap-around), the measurement will not be started at the right time.
   The signal on the **Restart** line enables the measurement to be started optimally at the beginning of the sequence.

The **Configuration** section is used to select the type of measurement, the data source and the termination criteria. If the data is not cyclically continued, the measurement can be selectively interrupted and restarted. Certain data areas and frames that have been marked as faulty can be excluded from the measurement.

Mode - Bit Error Rate Selects the type of measurement: single or continuous measurement.

Auto Continuous measurement of bit error rate.

If either or both of the termination criteria are met, the measurement in progress is terminated and immediately a new one is started automatically. Depending on the settings made, a measurement may take considerable time. During the first measurement, intermediate results are displayed. For the measurements that follow, only the final results are shown. The parameters **Data Bits** and **Errors** are continuously updated and indicate the relative values for the measurement in progress.

Remote-control command:
`BERT:SEQ AUTO`

Single

Single measurement of bit error rate.
The measurement is started by clicking on the **Execute Single** button.

If a measurement is in progress, the current values for **Bit Error Rate**, **Errors** and **Data Bits** are cyclically displayed. The measurement is terminated when either or both of the termination criteria have been reached. To start a new measurement, the **Execute Single** button must be clicked again.

Remote-control command:
`BERT:SEQ SING`
`TRIG:BERT:IMM`

Max Data Bits - Bit Error Rate

Enter the number of transmitted data bits to be checked before the measurement is terminated.

This criterion terminates the BER measurement after the specified number of data bits, even if very few errors or none at all have been detected. With a low number of bit errors, the measurement result may be statistically unreliable.

If the measurement is terminated because the number of data bits entered here were checked, **Number of Data Bits** appears to the right of **Terminated By**.

Data excluded from the measurement by **Data Enable** or **Pattern Ignore** is not counted.

Remote-control command:
`BERT:SET:MCO 1000`

Max Errors - Bit Error Rate

Enter the number of bit errors to occur before the measurement is terminated.

This criterion terminates the measurement relatively quickly if the error rate is high. The measurement result is statistically reliable, since many errors were already counted.

If the measurement is terminated because the number of bit errors entered here was reached, **Number of Errors** appears to the right of **Terminated By**.

Remote-control command:
`BERT:SET:MERR 1E4`

PRBS - Bit Error Rate

Selects the PRBS sequence. The data generated by the PRBS generator is used as a reference for the measurement.

Note:
Standard-compliant data inversion for PRBS15 and PRBS23 is performed automatically when the PRBS is selected. ***Data Polarity*** *remains unaffected.*

Remote-control command:
`BERT:SET:TYPE PRBS15`

Data Polarity - Bit Error Rate

Sets the polarity of the feedback data bits.

Note:
Standard-compliant data inversion for PRBS15 and PRBS23 is performed automatically when the PRBS is selected. ***Data Polarity*** *remains unaffected.*

Norm

High level stands for a logic 1, low level for a logic 0.

Remote-control command:
`BERT:SET:DATA:POL NORM`

Inv

Low level stands for a logic 1, high level for a logic 0.

Remote-control command:
`BERT:SET:DATA:POL INV`

Clock Slope - Bit Error Rate

Sets the polarity of the active slope of the feedback clock.

Pos

The positive slope of the clock signal is active.

Remote-control command:
`BERT:SET:CLOC:POL RIS`

Neg

The negative slope of the clock signal is active.

Remote-control command:
`BERT:SET:CLOC:POL FALL`

Impedance - Bit Error Rate

Sets the input impedance of the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**.

For high clock rates, 50 ohms should be selected.

Remote-control command:
`SOUR:INP:BERT:IMP G50`

Threshold - Bit Error Rate

Sets high/low threshold in volts for the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**.

The variable threshold makes it possible to align the BERT interface with the level of different input signals. In addition, reflections and other interference can be suppressed by selecting the appropriate threshold.

Remote-control command:
`SOUR:INP:BERT:THR 1.0`

External Restart - Bit Error Rate

Activates/deactivates an external restart of the BER measurement.

On

The reset signal for the BER measurement is fed via the **Restart** input of the BERT interface.

If the PRBS cannot be continued uninterruptedly, the BER measurement must be stopped at the end of the data sequence and subsequently restarted at the beginning of the new data sequence. The measurement is stopped and started via a 0-1-0 slope of the restart signal. A transition from logic 0 to 1 causes a partial result to be generated and the measurement to be stopped. A transition from 1 to 0 starts the measurement for the next subinterval. This measurement is synchronized anew.

If the R&S AMU is used as a data source, a signal in which a single 1 was coded at the end of the data sequence can be used as a restart signal at the R&S AMU marker output. This causes the BER measurement to stop briefly at the end of the data sequence and start again.
Partial results (number of data and error bits) are added up until the predefined total number of data or error bits is reached or exceeded.

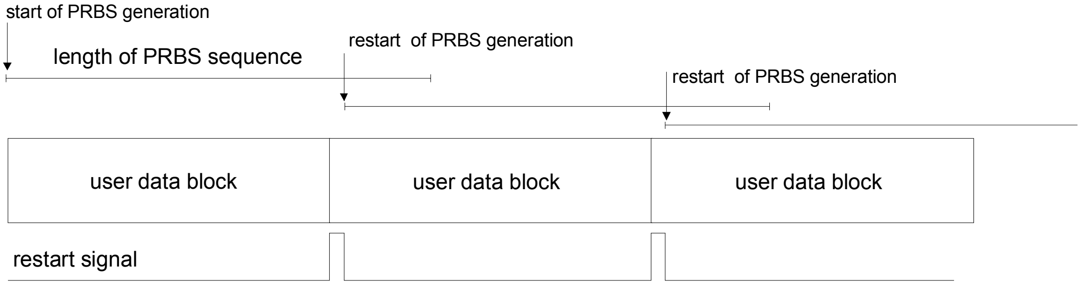
The measurement is reset by **Pattern Ignore** or **Data Enable**, regardless of its status.

Remote-control command:
`BERT:SET:REST:STAT ON`

Off

The reset signal for the BER measurement is generated internally.
This setting is suitable for PRBS sequences that run continuously and thus ensure uninterrupted repetition.

Remote-control command:
`BERT:SET:REST:STAT OFF`



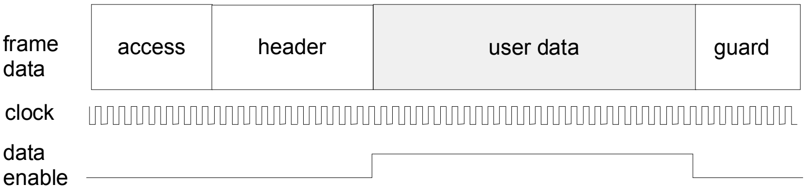
The length of the signal is too short for a complete PRBS sequence; PRBS generation is restarted by the **Restart** signal when the signal begins anew.

Data Enable - Bit Error Rate

Activates/deactivates the use of the Data Enable signal and sets the polarity of this signal if it is used.

The Data Enable signal marks the data that is actually to be evaluated for the BER measurement. Any data in addition to the PRBS sequence is masked and thus not evaluated (e.g. sync, preambles, other channels, etc that are present in the data bits supplied by the DUT).
The signal is fed in at the Data Enable input of the BERT interface. It is generated by the DUT but can also be provided by the R&S AMU in the form of a marker signal.

Note:
If the data is not enabled, the BER measurement is stopped completely. The identification circuit for Pattern Ignore as well as the PRBS generator of the BER measurement wait as long as data is not enabled. If the data is enabled, the measurement is continued.



The figure shows a TDMA signal with user data that contains the PRBS data sequence and various check fields which should be ignored for the bit error rate measurement. Below that are the associated clock and Data Enable signals.

Not Used

Any signal at the **Data Enable** input is ignored; all data at the BERT data input is used for the measurement.

Remote-control command:
`BERT:SET:DEN OFF`

High

The **Data Enable** signal is used. The only data measured is the data at the BERT data input during a **high level** of the Data Enable signal. The measurement is interrupted during a low level of the Data Enable signal.

Remote-control command:
`BERT:SET:DEN HIGH`

Low

The **Data Enable** signal is used. The only data measured is the data at the BERT data input during a **low level** of the Data Enable signal. The measurement is interrupted during a high level of the Data Enable signal.

Remote-control command:
`BERT:SET:DEN LOW`

Pattern Ignore - Bit Error Rate

Activates/deactivates ignoring of pure "0" or "1" bit sequences at least 32 bits long. Activating **Pattern Ignore** excludes faulty frames from the measurement.

In the case of some mobile radio standards, pure "0" or "1" bit sequences are generated when errors (e.g. an incorrect checksum) are detected within a frame. These sequences, instead of the frame data, are provided for the BER measurement and signal that the frame in question should not be used for the measurement.

The R&S AMU ignores sequences of 32 bits or longer.

Note:

While ignoring the bits, the PRBS generator for the BER measurement keeps running. Following the "0" or "1" sequence, the BER measurement is continued as if the ignored sequence had contained PRBS data.

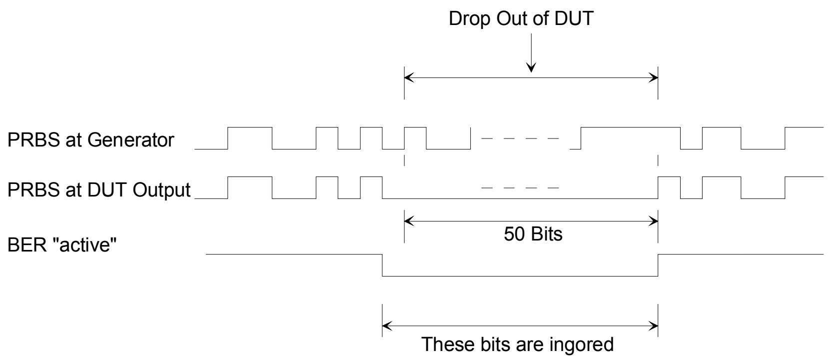
*If **Pattern Ignore** is switched on, synchronization time is 32 bits longer.*

*If **Pattern Ignore** and **External Restart** are active at the same time, the measurement terminates **immediately** when the restart signal is applied. None of the 32 bits within the **Pattern Ignore** detector is evaluated.*

*If **Data Enable** and **Pattern Ignore** are active at the same time, **Data Enable** is given priority, i.e. bits that are not enabled are not examined for "0" or "1" sequences.*

Example:

50 bits were set to "0" by the DUT. These 50 bits plus the preceding "0" are ignored in the bit error rate measurement.



Off — **Pattern Ignore** is not active.

Remote-control command:
`BERT:SET:IGN OFF`

All 1 — Bit sequences consisting of 32 or more consecutive "1" data are not used (i.e. ignored) for the BER measurement.

Remote-control command:
`BERT:SET:IGN ONE`

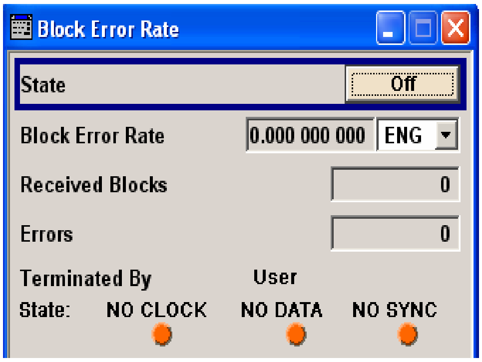
All 0 — Bit sequences consisting of 32 or more consecutive "0" data are not used (i.e. ignored) for the BER measurement.

Remote-control command:
`BERT:SET:IGN ZERO`

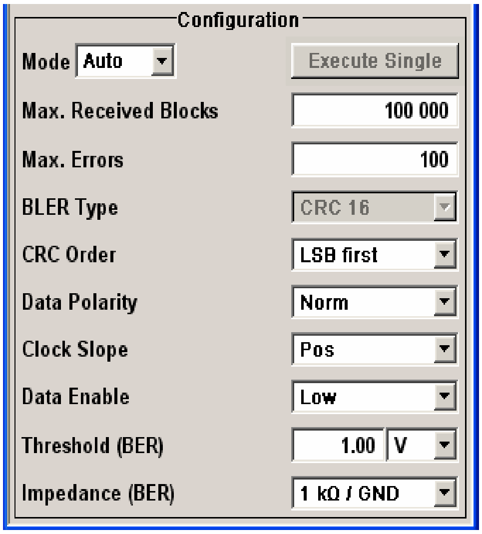
Block Error Rate Menu

The **Block Error Rate** menu for configuring the block error rate measurement is called either in the **BERT** function block or via the MENU key under **BERT**.

The **Block Error Rate** menu is divided into the following sections:



The top section is used to switch on the block error rate measurement and display the results and current status of the measurement.



The **Configuration** section is used to select the type of measurement and the termination criteria and to set the polarity of the input signals.

The top section is used to switch on the block error rate measurement and display the results and current status of the measurement.

State - Block Error Rate

Switches the block error rate measurement on/off.

Depending on the setting in the **Mode** box, either a continuous measurement (**Auto**) or a single measurement (**Single**) is carried out. A single measurement must be started by clicking on the **Execute Single** button.

Remote-control command:
`BLER:STAT ON`

Block Error Rate - Block Error Rate

Displays the measured block error rate.

The block error rate is the ratio of faulty blocks to total blocks.

Remote-control command:
`BLER:RES?`
Response (the 3rd value indicates the error rate):
`"1000,5,`$\boxed{\texttt{5E-4}}$`,1,1,1,1"`

The display unit can be selected in the box to the right of the value.

ENG	The block error rate is output in exponential notation with the exponent –3 or –6. Remote-control command: `BLER:UNIT ENG`
SCI	The block error rate is output in scientific notation, i.e. standardized to one place to the left of the decimal. Remote-control command: `BLER:UNIT SCI`
%	The block error rate is output in percent. Remote-control command: `BLER:UNIT PCT`
ppm	The block error rate is output in parts per million. Remote-control command: `BLER:UNIT PPM`

Received Blocks - Block Error Rate

Displays the current number of data blocks checked.

Remote-control command:
`BLER:RES?`
Response (the 1st value indicates the number of data blocks checked): `"`$\boxed{\texttt{1000}}$`,5,5E-4,1,1,1,1"`

Errors - Block Error Rate

Displays the current number of occurred errors.

Remote-control command:
`BLER:RES?`
Response (the 2nd value indicates the number of occurred errors):
`"1000,`$\boxed{\texttt{5}}$`,5E-4,1,1,1,1"`

Terminated By - Block Error Rate

Displays the termination criterion for the measurement.

These criteria can be entered to keep the duration of the measurement short for low as well as high block error rates.

The last measurement result is displayed after the measurement has been terminated.

Remote-control command:
`BLER:RES?`
Response (the 4th value indicates whether the measurement has been terminated: 1 = terminated): `"1000,5,5E-4,`$\boxed{1}$`,1,1,1"`

User

The measurement was manually terminated by the user switching the state to off.

Remote-control command:
`BLER:STAT OFF`
`BLER:STOP`

Number of Data Blocks

The measurement was terminated because the specified number of data blocks was reached.

Number of Errors

The measurement was terminated because the specified number of errors was reached.

State - Block Error Rate

Displays the status of the measurement.

A green LED indicates a correct status, a red LED a critical status.

This allows the user to check whether the measurement functions. The status of the data and clock lines and of synchronization is checked and displayed.

If a faulty status is displayed, the signals can be checked at the BERT interface using an oscilloscope.

Remote-control command:
`BLER:RES?`
Response (the 4th value indicates whether the measurement has been terminated: 1 = terminated): `"1000,5,5E-4,`$\boxed{1}$`,1,1,1"`

Clock

The applied clock signal was detected.

Remote-control command:
`BLER:RES?`
Response (the 5th value indicates the status of the clock line: 1 = active, 0 = not active):
`"1000,5,5E-4,1,`$\boxed{1}$`,1,1"`

No Clock

The applied clock signal was not detected.

Possible causes are:

- Clock recovery is not available (e.g. with tests of RF components).
  If the signal is generated using the R&S AMU, the bit clock can be extracted from the CLOCK output connector (only with **Custom Dig Mod** signals in realtime). If signals complying with other digital standards are generated or if ARB waveforms are used, a marker signal can be used as a clock. As the DUT causes a delay, the ratio of clock-to-data travel times must always be taken into account and checked with an oscilloscope if necessary.
- The wrong impedance for the applied clock rate was selected (see **Impedance** parameter).
- The wrong threshold for the applied clock signal was selected (see **Threshold** parameter).

Data

The applied data signal was detected.

Remote-control command:
`BLER:RES?`
Response (the 6th value indicates the status of the data line: 1 = active, 0 = not active):
`"1000,5,5E-4,1,1,1,1"`

No Data

The applied data signal was not detected.

Possible causes are:

- The signal from the DUT is missing.
- The wrong impedance for the applied clock rate was selected (see **Impedance** parameter).
- The wrong threshold for the applied data signal was selected (see **Threshold** parameter).

Sync

The measurement is synchronized.

Remote-control command:
`BLER:RES?`
Response (the 7th value indicates the status of the synchronization: 1 = successful, 0 = unsuccessful):
`"1000,5,5E-4,1,1,1,1"`

No Sync

The measurement is not synchronized.

Generally, a measurement cannot be synchronized until a clock and a data signal have been detected. If synchronization still does not occur, this may be caused by the following:

- A wrong clock slope is used, which violates setup or hold times (see **Clock Slope** parameter).

- Reflections on the clock line occur and clock the data signal into the BER measurement twice, e.g. on lines without termination. The input of the R&S AMU is **not** terminated.
- The travel times of clock and data are unfavorable (e.g. clock slope with data change).
  Check the relationship of clock to data using an oscilloscope and optimize the travel times (e.g. clock slope when the data signal applied is stable).

The **Configuration** section is used to select the type of measurement and the termination criteria and to set the polarity of the input signals.

Mode - Block Error Rate Selects the type of measurement: single or continuous measurement.

Auto Continuous measurement of block error rate.

If either or both of the termination criteria are met, the current measurement is terminated and immediately a new one is started automatically. Depending on the settings made, a measurement may take considerable time. During the first measurement, intermediate results are displayed. For the measurements that follow, only the final results are shown. The parameters **Received Blocks** and **Errors** are continuously updated and indicate the relative values for the measurement in progress.

Remote-control command:
`BLER:SEQ AUTO`

Single Single measurement of bit error rate.
The measurement is started by clicking on the **Execute Single** button.

If a measurement is in progress, the current values for **Block Error Rate**, **Errors** and **Received Blocks** are cyclically displayed. The measurement is terminated when either or both of the termination criteria have been reached. To start a new measurement, the **Execute Single** button must be clicked again.

Remote-control command:
`BLER:SEQ SING`
`TRIG:BLER:IMM`

Max Received Blocks - Block Error Rate

Enter the number of transmitted data blocks to be checked before the measurement is terminated.

This criterion will terminate the BLER measurement after the specified number of data blocks, even if very few errors or none at all have been detected. With a low number of block errors, the measurement result may be statistically unreliable.

If the measurement is terminated because the number of data blocks entered here were checked, **Number of Data Blocks** appears to the right of **Terminated By**.

Remote-control command:
`BLER:SET:MCO 1000`

Max Errors - Block Error Rate

Enter the number of block errors to occur before the measurement is terminated.

This criterion terminates the measurement relatively quickly if the error rate is high. The measurement result is statistically reliable, since many errors were already counted.

If the measurement is terminated because the number of block errors entered here was reached, **Number of Errors** appears to the right of **Terminated By**.

Remote-control command:
`BLER:SET:MERR 1E4`

CRC Order - Block Error Rate

Selects the byte order of the checksum (CRC).

LSB The checksum starts with the least significant byte.

Remote-control command:
`BLER:SET:CORD LSB`

MSB The checksum starts with the most significant byte.

Remote-control command:
`BLER:SET:CORD LSB`

BLER Type - Block Error Rate

Displays the CRC polynomial used. CCITT CRC 16 : $G(x) = x^{16} + x^{12} + x^5 + x^1$ is the CRC polynomial supported.

Remote-control command:
`BLER:SET:TYPE?`
Response: `'CRC16 '`

Data Polarity - Block Error Rate

Sets the polarity of the feedback data blocks.

Remote-control command:
`BLER:SET:DATA:POL NORM`

Clock Slope - Block Error Rate

Sets the polarity of the active slope of the feedback clock.

Remote-control command:
`BLER:SET:CLOC:POL RIS`

Impedance - Block Error Rate

Sets the input impedance of the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**.

For high clock rates, 50 ohms should be selected.

Remote-control command:
`SOUR:INP:BERT:IMP G50`

Threshold - Block Error Rate

Sets high/low threshold in volts for the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**.

The variable threshold makes it possible to align the BERT interface with the level of different signals. In addition, reflections and other interference can be suppressed by selecting the appropriate threshold.

Remote-control command:
`SOUR:INP:BERT:THR 1.0`

Data Enable - Block Error Rate

Sets the polarity of the **Data Enable** signal.

The **Data Enable** signal marks the user data of the signal.

The signal is generated by the DUT and fed in at the **Data Enable** input of the BERT interface.

High

If the **Data Enable** signal is at a high level, the data bits at the BERT data input are interpreted as user data. During a low level of the **Data Enable** signal, they are interpreted as checksum bits.

Remote-control command:
`BLER:SET:DEN HIGH`

Low

If the **Data Enable** signal is at a low level, the data bits at the BERT data input are interpreted as user data. During a high level of the **Data Enable** signal, they are interpreted as checksum bits.

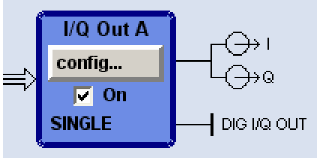
Remote-control command:
`BLER:SET:DEN LOW`

Output of Digital and Analog Baseband Signal - I/Q Out

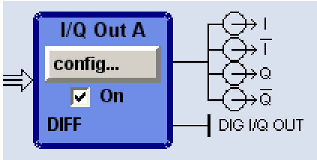
Introduction I/Q Out

The R&S AMU 200A Baseband Signal Generator and Fading Simulator provides various outputs of the baseband signals. The digitally modulated signals can either be output directly or converted to analog I/Q baseband output signals. The analog signal can be output single-ended or differential (non-inverted).

The settings for the analog and digital output are available in the block diagram in the "**I/Q Out**" function block of each path as well as in the "**I/Q Out**" menus which are opened using the MENU key.

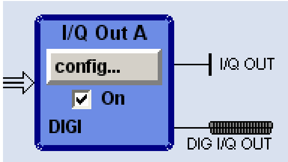


The **analog** baseband signal is output at the I/Q output connectors **I Out A/B** and **Q Out A/B** on the front panel of the instrument.



The differential output of the **analog** baseband signal requires the option R&S AMU-B16, Differential I/Q Out. The signal is output at the connectors **I Out /I Out BAR** and **Q Out /Q Out BAR** on the front panel of the instrument.

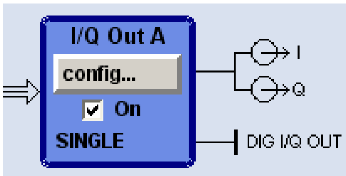
The output of the analog baseband signal at the real panel of the instrument requires an option for real panel connectors (option R&S AMU-B81, I/Q Rear Connectors). This option is recommended for use of the instrument in a 19" rack. Installing the instrument in a 19" rack requires a rack adapter or an adapter for telescopic sliders.

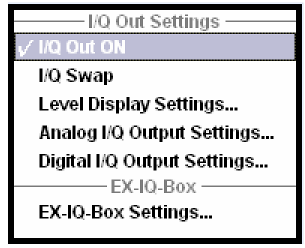


The output of the **digital** baseband signal requires the option R&S AMU-B18, Digital I/Q Out. The signal is output at the digital interface on the rear panel.

The differential output of the baseband signal in **two-path instruments** requires a second option R&S AMU-B16, Differential I/Q Out and, for digital output a second option R&S AMU-B18, Digital I/Q Out respectively.

Depending on the settings in the I/Q Out dialogs the activated outputs of the currently selected path are switched on in the I/Q Out Settings menu of the corresponding path as well as by ticking the checkbox **On** of the I/Q Out function block.





BASEBD ON/OFF

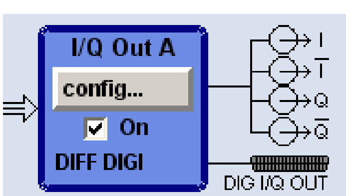
Note:

With the aid of the BASEBD ON/OFF *key the active baseband output signals of both paths can be switched on and off. The* BASEBD ON/OFF *key is located on the front panel of the instrument. For manual remote control the* BASEBD ON/OFF *key can be substituted by a key emulation (see chapter 1, section "Front Panel Key Emulation").*

Switches **Off** all active I/Q outputs of **both** paths. A second stroke restores the status that was active before the last switch-off. I/Q OUT Off is displayed in the status bar.

The outputs can be activated in the dialogs Analog and Digital I/Q Out Settings of the I/Q Out block.

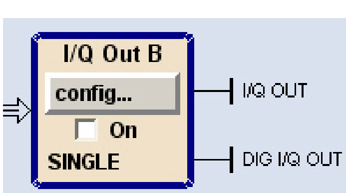
Remote-control command:
`OUTP:IQ:ALL:STAT OFF`



On

Switches on the active I/Q outputs of the corresponding **I/Q Out** block. The status line in the block displays the currently active output types, e.g. **DIFF DIGI** denotes that the I/Q baseband signal is provided at the analog (in differential mode) and at the digital I/Q output. The output symbols display the active state.

Remote-control command:
`SOUR:IQ:OUTP:STAT ON`



Off

Switches off the I/Q output signal of the corresponding I/Q Out block. Vertical lines replace the output symbols to denote that the outputs are inactive.

Remote-control command:
`SOUR2:IQ:OUTP:STAT OFF`

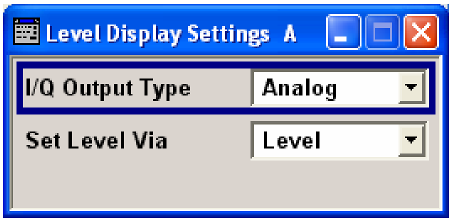
I/Q-Swap - I/Q Out Settings

Activates swapping of the I and Q signal components, which mirrors the spectrum at the f=0 line and inverts the sign of the frequency.

The I/Q swap may be needed for compliance with CDMA2000 standards (see section "*Digital Standard CDMA2000*").

Remote-control command:
`SOUR:IQ:OUTP:SWAP:STAT ON | OFF`

Level Display Settings



I/Q-Output Type - Level Display Settings

Selects the output type (analog/digital) for which the signal level of the corresponding path is set in the status bar.

After selecting the I/Q output types the status line of the I/Q Out block displays "**SINGLE**" or "**DIFF**" for the analog signal output and "**DIGI**" for the digital output signal.

Analog

The signal level is set for the **analog** signal output. Depending on the selected analog output type, i.e. **Single Ended** or **Differential**, the corresponding level entry fields are displayed in the status bar.

Remote-control command:
`SOUR:IQ:OUTP:DISP ANAL`

Digital

The signal level is set for the **digital** signal output. The level entry fields are displayed in the status bar.

Remote-control command:
`SOUR:IQ:OUTP:DISP DIG`

Set Level Via - Level Display settings

Selects the level type (PEP/Level) that is used to set the signal level of the currently selected path. The level entry fields and the corresponding units are displayed and activated in the status bar. The value can be edited directlyEither the PEP or the Level entry field can be edited in a path.

Note:
The signal level of the active signal is set via this selected level type. That affects both the digital and the analog signal output (see also section "Set Level Via - Analog I/Q Out Level Settings" on page 4.71) and "Set Level Via - Digital I/Q Out Signal Output" on page 4.78).

PEP

The signal level is expressed in terms of a peak envelope power value (PEP).

Remote-control command:
`SOUR:IQ:OUTP:POW:VIA PEP`

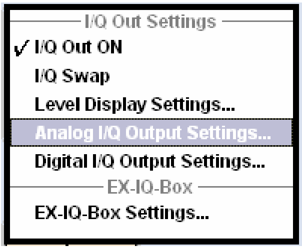
Level

The signal level is expressed in terms of a rms value.

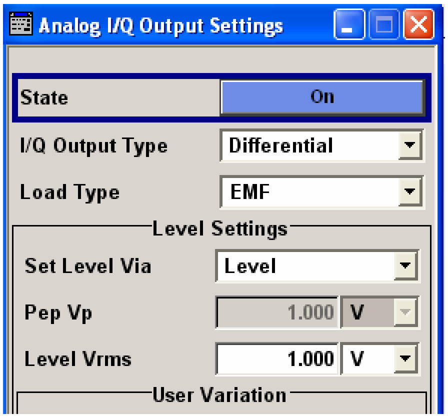
Remote-control command:
`SOUR:IQ:OUTP:POW:VIA LEV`

Analog I/Q Output

The analog baseband signal is output at the I/Q output connectors **I OUT A/B** and **Q OUT A/B** of the corresponding path (path A and path B). The settings for the analog output are available in the block diagram in the "**I/Q Out**" function block of each path as well as in the "**I/Q Out**" menu which is opened using the MENU key.



Analog I/Q Output Settings opens the submenu to set the output type and voltages. The menu is only available with the option R&S AMU-B16, Differential I/Q Out.



State - Analog I/Q Output Settings

Switches On / Off the analog I/Q output signals.

On

Switches on the analog I/Q signal output of the currently selected path, e.g. path A.

Remote-control command:
`SOUR:IQ:OUTP:ANAL:STAT ON`

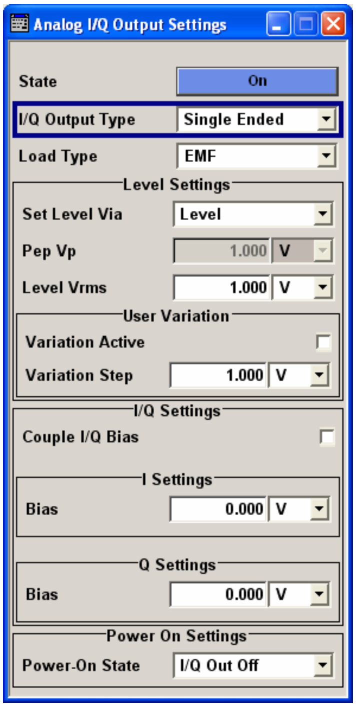
Off

Switches off the I/Q signal output of the currently selected path, e.g. path B.

Remote-control command:
`SOUR2:IQ:OUTP:ANAL:STAT OFF`

I/Q Output Type - Analog I/Q Output Settings

Selects the type of analog output. The signal output types **Single Ended** or **Differential** (non-inverted) are available. The menu changes depending on the selection.

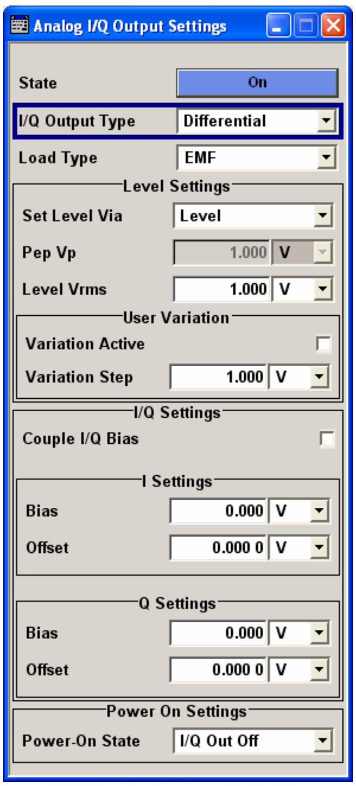


Single Ended

Single-ended output at **I OUT** and **Q OUT**.

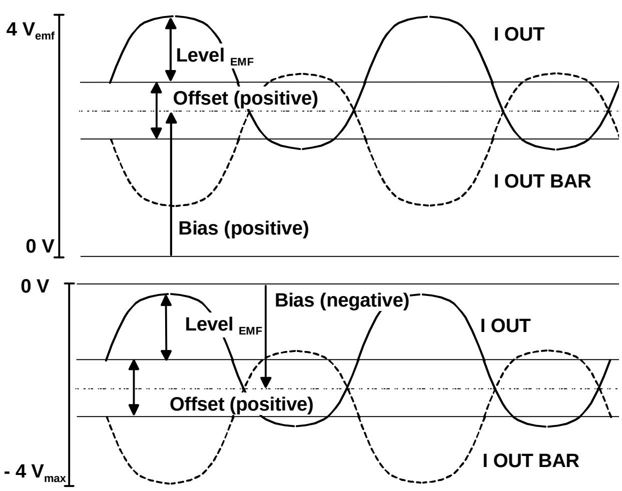
A bias between I/Q OUT and ground can be defined (requires the option R&S AMU-B16, Differential I/Q Output).

Remote-control command:
`SOUR:IQ:OUTP:ANAL:TYPE SING`



Differential

Differential output at **I OUT** and **I OUT BAR** / **Q OUT** and **Q OUT BAR**. The analog I/Q signal components are output at I/Q OUT and I/Q OUT BAR. A bias to set the operating point of DUT can be defined. In addition an offset between inverting and non-inverting output can be set to balance a difference of the best operating points.



Remote-control command:
`SOUR:IQ:OUTP:ANAL:TYPE DIFF`

Single Ended

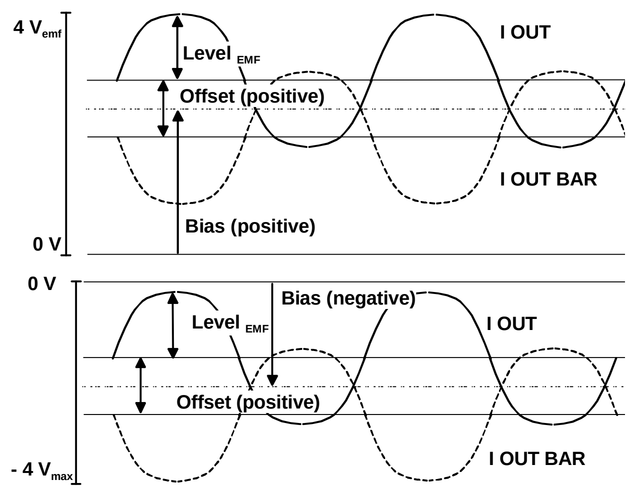
Single-ended output at **I OUT** and **Q OUT**.

A bias between I/Q OUT and ground can be defined (requires the option R&S AMU-B16, Differential I/Q Output).

Remote-control command:
`SOUR:IQ:OUTP:ANAL:TYPE SING`

Differential

Differential output at **I OUT** and **I OUT BAR** / **Q OUT** and **Q OUT BAR**. The analog I/Q signal components are output at I/Q OUT and I/Q OUT BAR. A bias to set the operating point of DUT can be defined. In addition an offset between inverting and non-inverting output can be set to balance a difference of the best operating points.



Remote-control command:
`SOUR:IQ:OUTP:ANAL:TYPE DIFF`

Load Type - Analog I/Q Output Settings

Selects the load type of the analog output signal. Depending on the analog I/Q output settings (single ended or differential), different load types are available.

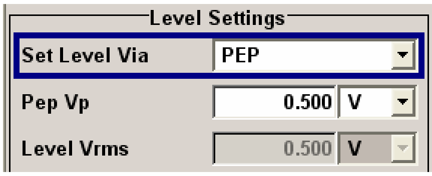
Single ended Output:

Possible load type parameters for the single ended output are EMF and 50 Ohm.

Differential Output:

Possible load type parameters for the differential output are EMF and 100 Ohm.

Remote-control command:
`SOUR:IQ:OUTP:ANAL:LOAD EMF`



Set Level Via - Analog I/Q Out Level Settings

Selects the level type (PEP/Level) that is used to set the signal level. Depending on the selected level type either the Pep Vp or the Level Vrms entry field can be edited.

Note:
The signal level of the active signal is set via this selected level type. That affects both the digital and the analog signal outputs (see also section "Set Level Via - Level Display settings" on page 4.67 and "Set Level Via - Digital I/Q Out Signal Output" on page 4.78).

Remote-control command: see "*Set Level Via - Level Display settings*"

Pep Vp - Analog I/Q Out Level Settings

Sets the output peak envelope voltage for both signal components (I and Q).

PEP Vp refers to the load resistance. Setting EMF the entire value range is available. Using 50 Ohm or 100 Ohm, the value range decreases and the PEP setting must be adjusted to the load type. The range of values changes proportional to the load type.

Single ended Output:

Value range: 20 mV ... 2 V EMF.

The maximum overall output voltage is:
(PEP EMF + |Bias|) ≤ 3.7 V
(for the load type 50 Ohm the limit is 1.85 V).

Differential Output:

Value range: 40 mV ... 4 V EMF.
The maximum overall output voltage is:
(0.5 · PEP EMF + |Bias| + 0.5 · Offset) ≤ 3.7 V
(for the load type 100 Ohm the limit is 1.85 V).

Remote-control command:
`SOUR:IQ:OUTP:ANAL:POW:PEP 0.1`

Level Vrms - Analog I/Q Out Level Settings

Sets the output rms voltage for both signal components (I and Q).

Level Vrms refers to the load resistance. When changing the load type, the level setting must be adjusted.

Single ended Output:

Value range: 20 mV ... 2 V EMF.

The maximum overall output voltage is:

(Level EMF + |Bias|) ≤ 3.7 V

(for the load type 50 Ohm the limit is 1.85 V).

Differential Output:

Value range: 40 mV ... 4 V EMF.

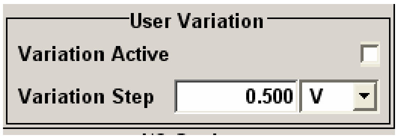
The maximum overall output voltage is:

(0.5 · PEP EMF + |Bias| + 0.5 · Offset) ≤ 3.7 V

(for the load type 100 Ohm the limit is 1.85 V).

Remote-control command:
`SOUR:IQ:OUTP:ANAL:POW:LEV 0.25`

If the level is set using the rotary knob, the step width is defined in the **User Variation** section.



Variation Active - Analog I/Q Out User Variation

Activates the user-defined step width used when varying the level value with the rotary knob.

On The level value set with the rotary knob is varied using the user-defined step width which is entered under **Variation Step**.

Remote-control command:
`SOUR:IQ:OUTP:ANAL:POW:STEP:MODE USER`

Off The level value set with the rotary knob is varied in steps of one unit at the cursor position (standard operating mode).

Remote-control command:
`SOUR:IQ:OUTP:ANAL:POW:STEP:MODE DEC`

Variation Step - Analog I/Q Out User Variation

Sets the user defined step width for entering the level value using the rotary knob. Level variation with this step width must be activated with **Variation Active ON**.

Variation steps refers to the load resistance. When changing the load type, the level setting must be adjusted.

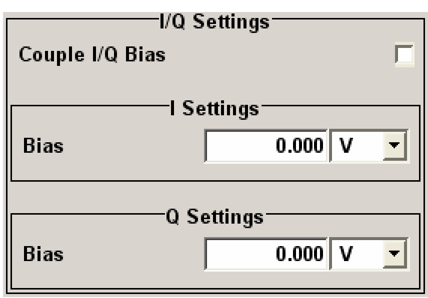
Remote-control command:
`SOUR:IQ:OUTP:ANAL:POW:STEP:INCR 50 mV`

Couple I/Q Bias - Analog I/Q Out I/Q Settings

Activates/deactivates the coupling of bias setting of the I-signal and Q-signal components. For activated coupling, the setting can be done for the I-signal component, it automatically applies to the Q-signal component as well. The fields for setting the Q-signal component are shaded.

Remote-control command:
`SOUR:IQ:OUTP:ANAL:BIAS:COUP:STAT ON`

In the menu areas **I Settings** and **Q Settings** bias and offset values can be set.



Bias - Analog I/Q Out - Settings

(EMF) Sets the bias. A DC voltage is superimposed upon the I or Q signal. The bias refers to the load resistance. When changing the load type, the bias setting must be adjusted.

Value range: -3.6 V ... +3.6 V EMF. The maximum overall output voltage is 3.7 V.

This way, the operating point of a DUT can be set.

Remote-control command:

```
SOUR:IQ:OUTP:ANAL:BIAS:I -0.5V
SOUR:IQ:OUTP:ANAL:BIAS:Q 0.5V
```

Offset - Analog I/Q Out - Settings
(Differential output only)

Sets an offset between the inverting and the non-inverting output. The offset refers to the load resistance. Changing the load type, the offset setting must be adjusted.

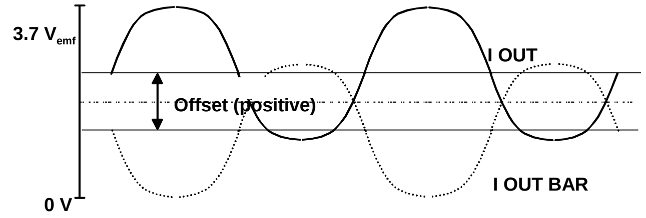
Value range: -300 mV ... +300 mV EMF.

The value range is dynamically adjusted in order to respect the following constrains:
The maximum overall output voltage is:
(0.5 · Level EMF + |Bias| + 0.5 · Offset) ≤ 3.7 V.

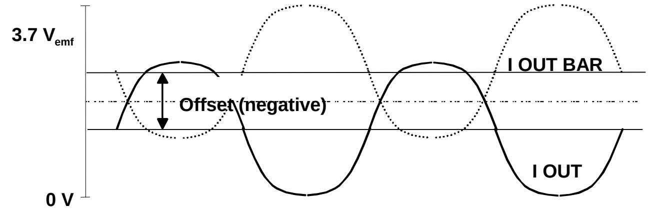
The set value is set half in the positive and half in the negative direction.

A positive offset is set with half of the value in positive direction at the non-inverting outputs, in negative direction at the inverting outputs, respectively.

For example, if a 100.0 mV offset value is set for the **I** signal component, the output signal at **I OUT** will have a 50.0 mV offset and the output signal at **I OUT BAR** will have a - 50.0 mV offset.



A negative offset is set with half of the value in negative direction at the non-inverting outputs, in positive direction at the inverting outputs, respectively.



Remote-control command:
`SOUR:IQ:OUTP:ANAL:OFFS:I 0.01V`
`SOUR:IQ:OUTP:ANAL:OFFS:Q 0V`

The power on behaviour of the R&S AMU is set in the **Power On Settings** section.

Power-On State - Analog I/Q Out Power On Settings

Selects the state which the analog I/Q Output is to resume after the instrument is switched on.

I/Q Out Off

The output is deactivated when the instrument is switched on.

Remote-control command:
`SOUR:IQ:OUTP:ANAL:PON OFF`

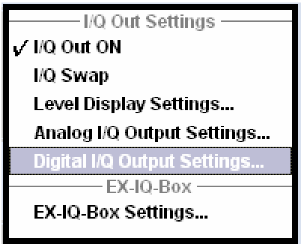
Previous Setting

When the instrument is switched on the analog I/Q output resumes to the status that was active before the last switch off.

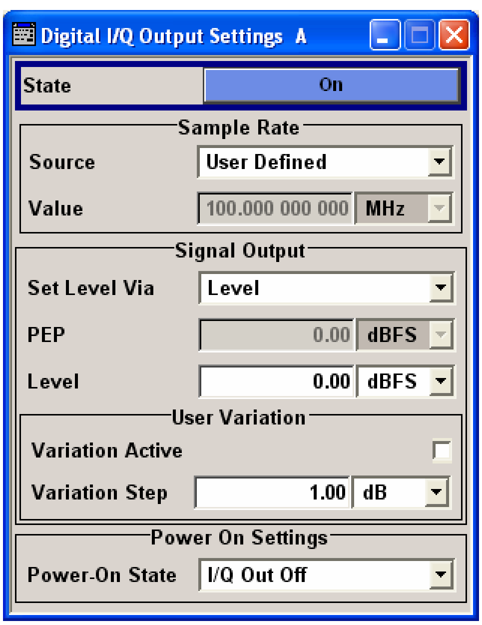
Remote-control command:
`SOUR:IQ:OUTP:ANAL:PON UNCH`

Digital Output

The digital baseband signal is output at a standardized (LVDS) digital I/Q interface. The settings for the digital output are available in the block diagram, function block **I/Q Out** using the **config...** button as well as in the "**I/Q Out**" menu which is opened using the MENU key.



Digital I/Q Output Settings opens the dialog to select the clock source and set the signal output level. The output of the digital baseband signal is only available with the option R&S AMU-B18, Digital I/Q Out. Two-path instruments require a second option R&S AMU-B18, Digital I/Q Out for digital output.



State - Digital I/Q Output Settings

Switches On/Off the digital I/Q output signals.

On Switches on the digital I/Q output signal of the currently selected path, e.g. path A.

Remote-control command:
`SOUR:IQ:OUTP:DIG:STAT ON`

Off Switches off the I/Q output signal of the currently selected path, e.g. path B.

Remote-control command:
`SOUR2:IQ:OUTP:DIG:STAT OFF`

Sample Rate Source - Digital I/Q Output Settings (Internal Clock Source only)

Selects the source for the sample rate of the digital I/Q output signal.

Note:
*The section **Sample Rate** shows the permitted sample rate of the digital I/Q output signal. Currently the entry fields **Source** and **Value** are firmly set to **User defined** and **100 MHz** and in read-only mode.*
*For future upgrades the sample rate is intended to be automatically estimated via the menu item **Digital I/Q In** or defined by the user via the menu item **Digital I/Q Out**.*

User Defined

The internally generated clock reference signal is used. The sample rate is calculated and displayed in the field **Value**.

Note:
*Only the source **User defined** is currently available.*

Remote-control command:
`SOUR:IQ:OUTP:SRAT:SOUR USER`

Digital I/Q In

An external clock reference signal is used. The clock signal is fed in via a Baseband Input Module (option R&S AMU-B17). The sample rate is estimated and displayed in the field **Value**.

Note:
This mode is intended for future upgrades.

Remote-control command:
`SOUR:IQ:OUTP:SRAT:SOUR DIN`

Digital I/Q Out

An external clock reference signal is used. The clock signal is directly fed in via pin **CLK2** of the digital output interface (option R&S AMU-B18, Digital I/Q Out). The sample rate is displayed in the field **Value**.

Note:
This source is intended for future upgrades.

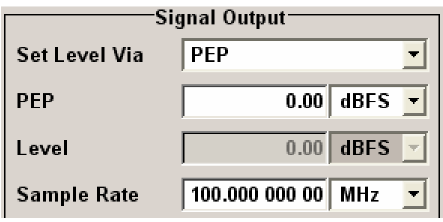
Remote-control command:
`SOUR:IQ:OUTP:SRAT:SOUR DOUT`

Sample Rate Value - Digital I/Q Output Settings
(Internal Clock Source only)

Sets or displays the sample rate of the digital I/Q output signal, depending on the selected Sample Rate Source.

Note:
*The section **Sample Rate** shows the sample rate of the digital I/Q output signal. Currently, the entry fields **Source** and **Value** are firmly set to **User defined** and **100 MHz** and in read-only mode. For future upgrades the sample rate is intended to be automatically estimated or defined by the user.*

Remote-control command:
`SOUR:IQ:OUTP:DIG:SRAT 100 MHZ`



Set Level Via - Digital I/Q Out Signal Output

Selects the level type (PEP/Level) that is used to set the signal level. Depending on the selected level type either the PEP or the Level entry field can be edited.

Note:
The signal level of the active signal is set via this selected level type. That affects both the digital and the analog signal outputs (see also section "Set Level Via - Level Display settings" on page 4.67 and "Set Level Via - Analog I/Q Out Level Settings" on page 4.71).

Remote-control command: see "*Set Level Via - Level Display settings*"

PEP - Digital I/Q Out Signal Output

The signal level is expressed in terms of a peak envelope power value (PEP).
The level entry fields and the corresponding units are displayed in the status bar. The level display always refers to both signal components ($\sqrt{(I^2+Q^2)}$).

Remote-control command:
`SOUR:IQ:OUTP:DIG:POW:PEP -10 DBFS`

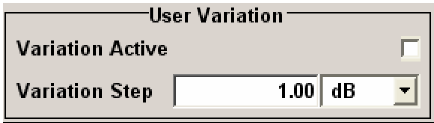
Level - Digital I/Q Out Signal Output

The signal level is expressed in terms of a rms level value.

The level entry fields and the corresponding unit are displayed in the status bar. The level display always refers to both signal components ($\sqrt{(I^2+Q^2)}$).

Remote-control command:
`SOUR:IQ:OUTP:DIG:POW:LEV -10 DBFS`

If the level is set using the rotary knob, the step width is defined in the **User Variation** section.



Variation Active - Digital I/Q Out User Variation

Activates the user-defined step width that is used by varying the level value with the rotary knob.

On

The level value set with the rotary knob is varied using the user-defined step width which is entered under **Variation Step**.

Remote-control command:
`SOUR:IQ:OUTP:DIG:POW:STEP:MODE USER`

Off

The level value set with the rotary knob is varied in steps of one unit at the cursor position (standard operating mode).

Remote-control command:
`SOUR:IQ:OUTP:DIG:POW:STEP:MODE DEC`

Variation Step - Digital I/Q Out User Variation

Sets the user defined step width for entering the level value using the rotary knob. Level variation with this step width must be activated with **Variation Active ON**.

Remote-control command:
`SOUR:IQ:OUTP:DIG:POW:STEP:INCR 2 dB`

The power on behaviour of the R&S AMU is set in the **Power On Settings** section.

Power-On State - Digital I/Q Out Power On Settings

Selects the state which the digital I/Q Output is to resume after the instrument is switched on.

I/Q Out Off

The output is deactivated when the instrument is switched on.

Remote-control command:
`SOUR:IQ:OUTP:DIG:PON OFF`

Previous Setting

When the instrument is switched on the digital I/Q output resumes to the status that was active before the last switch off.

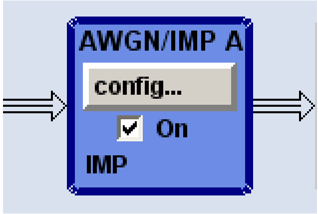
Remote-control command:
`SOUR:IQ:OUTP:DIG:PON UNCH`

Impairment of Digital I/Q Signal and Noise Generator - AWGN-IMP Block

Introduction - Impairments and AWGN

The R&S AMU allows the digital I/Q signal to be impaired before it is passed to the I/Q output, and also noise to be added to the signal. The noise generator can also be used to generate a pure noise signal.

These settings are available in the block diagram in the "**AWGN/IMP**" function block of each path as well as in the **AWGN/IMP** menus which are opened using the MENU key.



The equipment options for the basic unit (R&S AMU with frequency option R&S AMU-B9/B10/B11) include the option R&S AMU-B13 (Baseband Main Module) for **Impairments** and the option R&S AMU-K62 (Noise Generator) for **AWGN**.

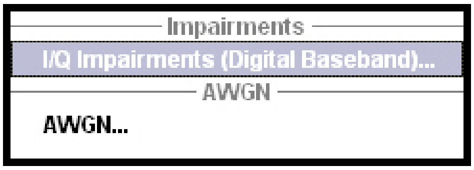
Two-path instruments require a second option R&S AMU-B9/B10/B11 (Baseband Generator) and a second option R&S AMU-B13 option (Baseband Main Module) for impairment of a signal on path B. Noise can be generated alternately for both paths using the option R&S AMU-K62 (Noise Generator). Simultaneous noise generation on both paths requires a second option.

Impairments

Impairment of the digital I/Q signal can be used, for example, to compensate the distortion of a test object or to check the effect of a disturbed signal on a test object. For this purpose, the I/Q signal can be output at the **I/Q Out** outputs.

Impairment Settings Menu

The **Impairment Settings** menu for setting the digital I/Q impairments is opened either in the **AWGN/IMP A/B** function block or using the MENU key under **AWGN/IMPA/B**.



I/Q impairment is activated and set in the **I/Q Impairments** menu. The signal levels and the crest factor of the baseband signal at the I/Q outputs connectors are indicated under **Baseband Signal Level** in the bottom section.

This information is needed by the user, for example, in order to use the I/Q signal externally and to adjust the level correctly there, or to see how the signal is modulated.

State - Digital Impairments

Activates/deactivates digital I/Q impairment.
When activated, the settings for carrier leakage, I/Q imbalance and quadrature offset become effective.

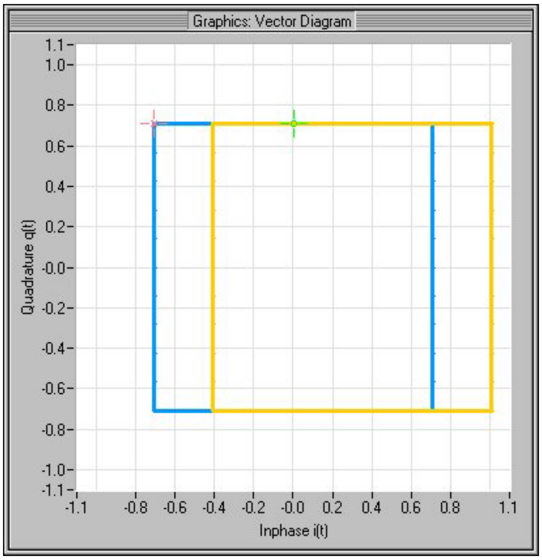
Remote-control command:
`SOUR:BB:IMP:STAT ON`

I/Q Offset - Digital Impairments

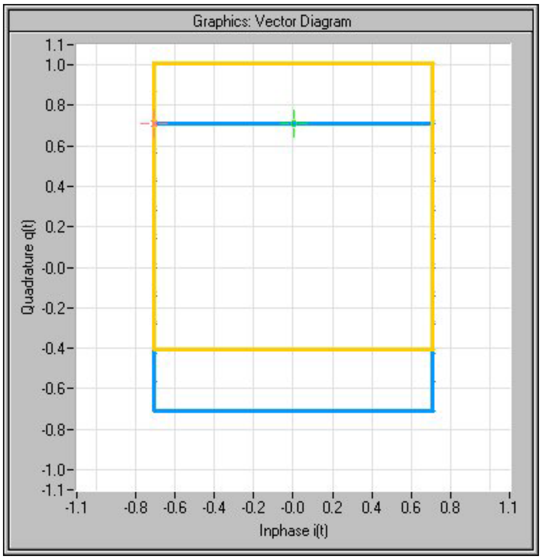
Sets the carrier leakage (in percent) of the amplitudes (scaled to the peak envelope power (PEP)) for the I and/or Q signal component.

An ideal I/Q modulator suppresses the carrier leakage completely (offset = 0 percent). If an offset is entered for a component, a carrier leakage with fixed amplitude is added to the signal. In the diagram, all I values or Q values are offset by a fixed amplitude value depending on the entered percentage.

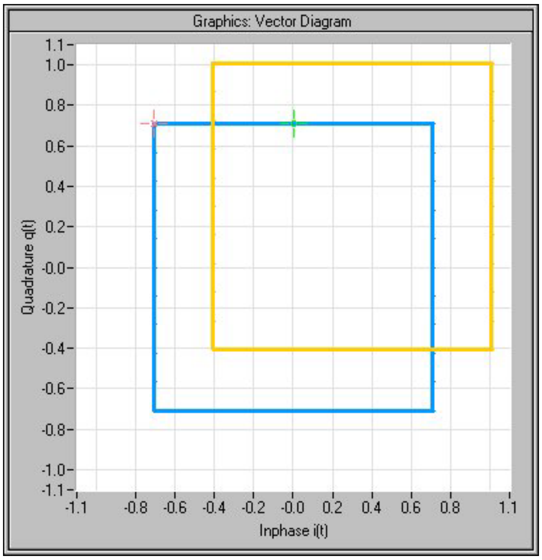
Effect of offset for the I component:



Effect of offset for the Q component:



Effect of an identical offsets for both signal components:



Remote-control command:
`SOUR:BB:IMP:LEAK:I 6PCT`
`SOUR:BB:IMP:LEAK:Q 6PCT`

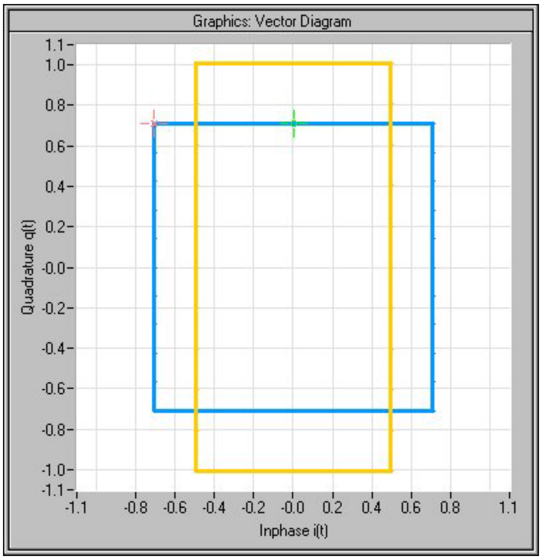
Gain Imbalance - Digital Impairments

Sets the imbalance of the I and Q vector.

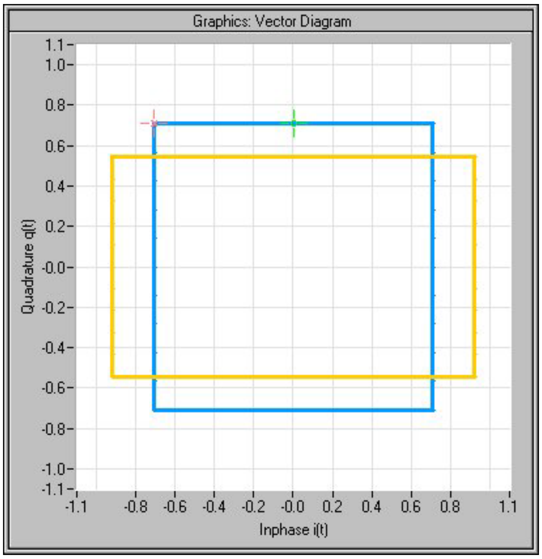
The entry is made in dB (default) or %, where 1 dB offset is roughly 12 % according to the following:
Imbalance [dB] = 20 log ($|Gain_Q|$ / $|Gain_I|$)

An ideal I/Q modulator amplifies the I and Q signal path by exactly the same degree. The imbalance corresponds to the difference in amplification of the I and Q channel and therefore to the difference in amplitude of the signal components. In the vector diagram, the length of the I vector changes relative to the length of the Q vector.

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage:



Negative values mean that the I vector is amplified more than the Q vector by the corresponding percentage:



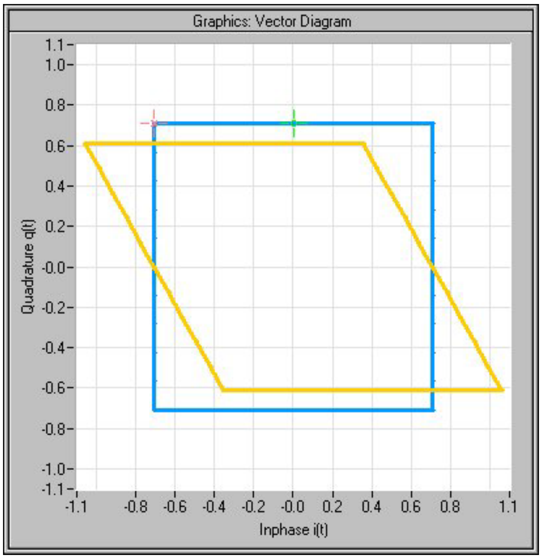
Remote-control command:
`SOUR:BB:IMP:IQR 0.1`

Quadrature Offset - Digital Impairments

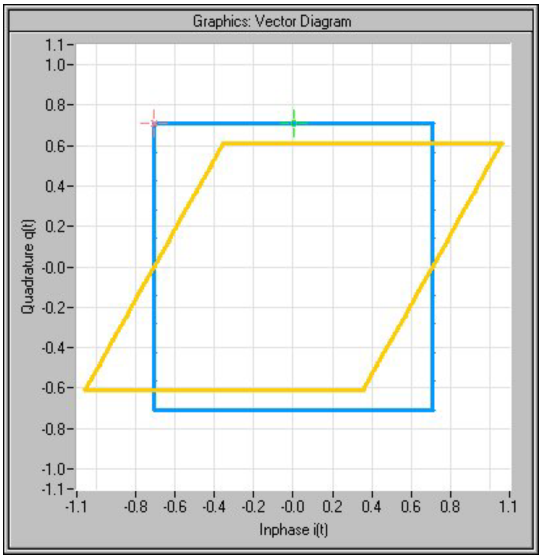
Sets the quadrature offset.

An ideal I/Q modulator sets the phase angle to exactly 90 degrees. With a quadrature offset, the phase angle between the I and Q vector deviates from the ideal 90 degrees, the amplitudes of both components are of the same size. In the vector diagram, the quadrature offset causes the coordinate system to shift.

A positive quadrature offset means a phase angle greater than 90 degrees:



A negative quadrature offset means a phase angle less than 90 degrees:



Remote-control command:
`SOUR:BB:IMP:QUAD:ANGL 5DEG`

The signal levels and the crest factor of the baseband signal at the I/Q-output connectors are indicated in the bottom section.

Crest Factor - Digital Impairments

Indicates the crest factor of the baseband signal.

The crest factor is calculated from the two level parameters as follows:

Crest / dB = Peak_Level/dBFs - Signal_Level/dBFs

Remote-control command:
`SOUR:BB:CFAC?`

Peak Level - Digital Impairments

Indicates the peak level of the baseband signal relative to full scale (in terms of dB full scale).

Remote-control command:
`SOUR:BB:POW:PEAK?`

Signal Level (rms)- Digital Impairments

Indicates the rms level of the baseband signal relative to full scale (in terms of dB full scale).

Remote-control command:
`SOUR:BB:POW:RMS?`

Noise Generator - AWGN

The noise generator generates an AWGN signal (Additive White Gaussian Noise) in the digital baseband, i.e. the noise power density has a Gaussian distribution and is distributed evenly across the frequency. This noise signal superimposes the (interference-free) useful signal (**Additive Noise** mode) . Typical applications for the noise generator are bit-error or block-error measurements, depending on the set S/N ratio.

The Gaussian noise is generated by means of feedback shift registers with subsequent probability transformation. The switching configuration is such that virtually ideal statistical characteristics are achieved:

- I and Q paths are decorrelated from each other.
- The crest factor of 18 dB allows very small probabilities to be realized.
- The period of the noise signal depends on the selected system bandwidth. The relationship of period P to system bandwidth B_{sys} is approximated:
- **$P \approx 1*10^{13} / B_{sys}$.**

This results in periods between 317 years with minimum bandwidth and approximately 2 days with maximum bandwidth.

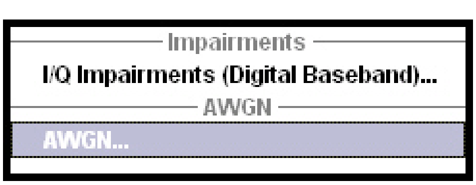
This results in a period of approximately one month for 3GPP FDD with a bandwidth of 3.84 Mcps, and a period of 427 days for GSM with 270.833 ksps.

Scalable low-pass filters are used to produce a noise level with both a broad dynamic range and a broad bandwidth range (from 1 kHz to 60 MHz).

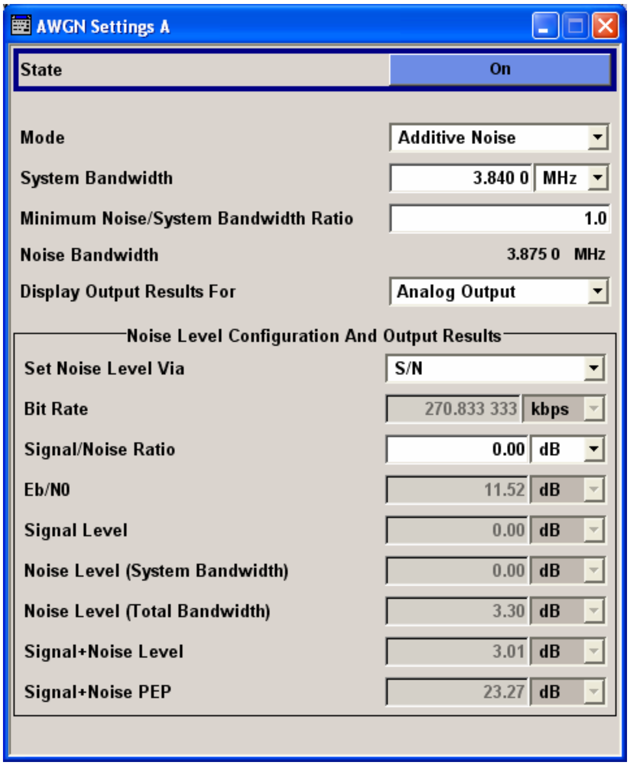
Apart from the **Additive Noise** mode, there are also the **Noise Only** and the **CW Interferer** mode. In the **Noise Only** mode a pure noise signal is generated and modulated to the carrier. In the **CW Interferer** mode, a sinusoidal signal with an adjustable frequency offset to the baseband signal is generated and added to the baseband signal by means of a counter instead of a shift register.

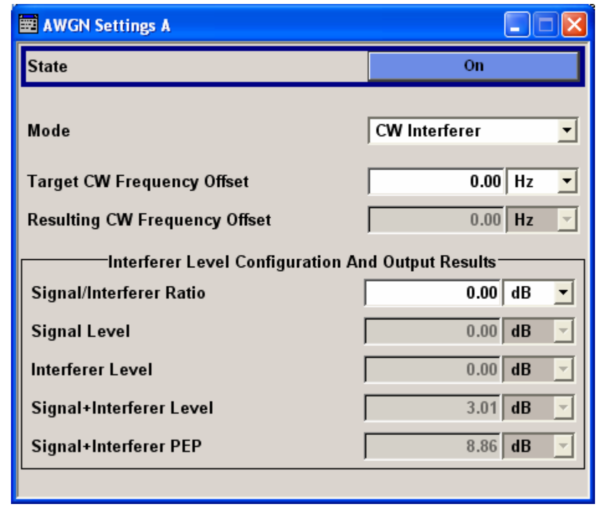
AWGN Settings Menu

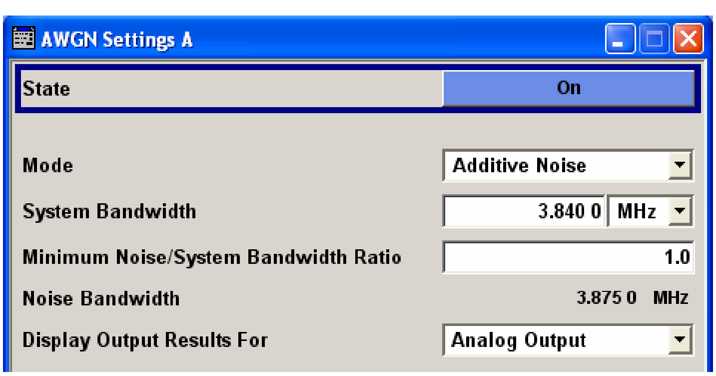
The **AWGN Settings** menu for setting the noise generator is opened either in the **AWGN / IMP** function block or in the menu tree of the MENU key under **AWGN Settings**.



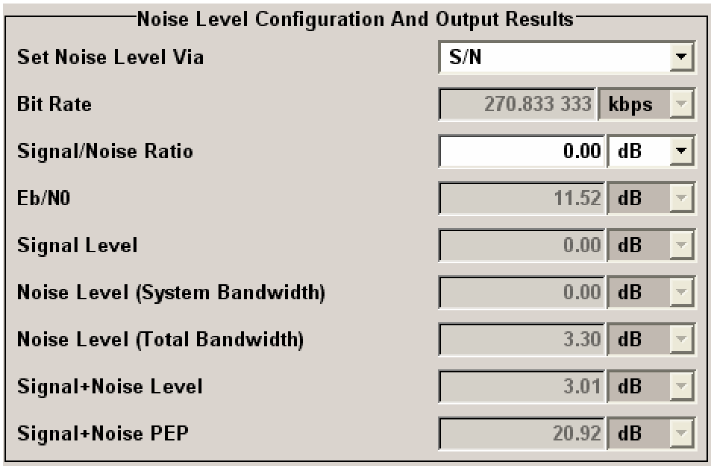
The **AWGN Settings** menu is divided into the following sections.







The signal generator is activated, the mode selected and the interfering signal is configured in the top section of the menu.



The level of the interfering signal is configured in the section **Noise Level Configuration and Output Results**.

In **Additive Noise** and **CW Interferer** mode, the interfering level can be defined and the resulting total level displayed here.

In **Noise Only** mode, only the noise level can be set here.

The signal generator is activated, the mode selected and the interfering signal is configured in the top section of the menu.

State - AWGN

Activates/deactivates the signal generator. The interferer (AWGN or CW interferer, depending on the selected mode) is generated as after the generator is activated.

Remote-control command:
`SOUR:AWGN:STAT ON`

Mode - AWGN

Selects the mode for generating the interfering signal.

Additive Noise

The AWGN noise signal with selectable system bandwidth is added to the baseband signal.

Remote-control command:
`SOUR:AWGN:MODE ADD`

Noise Only

The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted.

Remote-control command:
`SOUR:AWGN:MODE ONLY`

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-control command:
`SOUR:AWGN:MODE CW`

System Bandwidth - AWGN
(Additive Noise and Noise Only)

Sets the RF bandwidth to which the set signal/noise ratio relates. Within this frequency range, the signal is superimposed with a noise signal whose level corresponds exactly to the set S/N ratio.

Note:
The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth.

Remote-control command:
`SOUR:AWGN:BWID 1.23 MHz`

Minimum Noise/System Bandwidth Ratio - AWGN
(Additive Noise and Noise Only)

Sets the ratio of minimum noise bandwidth to system bandwidth.

The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth.

With this parameter the minimum real noise bandwidth can be set as required by some standards. It does not influence the calculation of level from the set S/N ratio in relation to system bandwidth.

The overall bandwidth "System BW x Minimum Noise/System BW Ratio" may not exceed 80 MHz.

Remote-control command:
`SOUR:AWGN:BWID:RAT 2`

Noise Bandwidth - AWGN
(Additive Noise and Noise Only)

Indicates the real noise bandwidth. The value is only indicated for **State On**.

Note:
The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth.

Remote-control command:
`SOUR:AWGN:BWID:NOIS?`

Display Output Results For - AWGN
(Additive Noise and Noise Only)

Selects the display of output results for the analog (DACIF) or the digital (BBOUT) signal path.

Note:
This selection field is only available with the option R&S AMU-B18, Baseband Digital I/Q Out. If the instrument is not equipped with this option the parameters of the analog signal path are displayed.

Analog Output Displays the parameters of the analog signal path.

Remote-control command:
`SOUR:AWGN:DISP:MODE ANAL`

Digital Output Dislays the parameters of the digital signal path.

Remote-control command:
`SOUR:AWGN:DISP:MODE DIG`

Target CW Frequency Offset - AWGN
(CW Interferer only)

Sets the desired frequency of the sine in **CW Interferer** mode.

Remote-control command:
`SOUR:AWGN:FREQ:TARG 3.4 MHz`

Resulting CW Frequency Offset - AWGN
(CW Interferer only)

Indication of the actual CW frequency of the sinusoidal signal in **CW Interferer** mode. The actual frequency may differ from the desired frequency, since the resolution is limited to 0.7 Hz.

Note:
The desired frequency constellation can be precisely set with an accuracy of up to 0.01 Hz by selecting a suitable frequency offset of the baseband source (e.g. Custom Dig Mod) and by correcting the RF frequency by the difference between Resulting and Target CW Frequency.

Remote-control command:
`SOUR:AWGN:FREQ:RES?`

The interfering signal is configured in the section **Noise Level Configuration and Output Results**.

Set Noise Level Via - AWGN
(Additive Noise only)

Selects the mode for setting the noise level.

S/N

The noise level is set on the basis of the value entered for the signal/noise ratio.
With digital modulation, the associated Eb/N_0 value is determined and displayed.

Remote-control command:
`SOUR:AWGN:POW:MODE SN`

Eb/N_0

The noise level is set on the basis of the value entered for the ratio of bit energy to noise power density.
The associated S/N value is displayed. The correlation between the two values is as follows:

$$\frac{S}{N} = \frac{E_b}{N_0} \cdot \frac{f_{bit}}{B_{sys}}$$

f bit = Bit rate (Symbol rate x Modulation value)
Bsys = System bandwidth

With **Custom Dig Mod** signals, the bit rate used for calculation is defined by the selected standard in the **Custom Digital Mod** dialog.

With **Digital Standard** signals, the bit rate to be used for calculating the E_b/N_0 can be entered at **Bit Rate**.
Some test cases with the 3GPP base station tests (TS 25.141) specify, for example, E/N settings that apply to channel-coded data or block segments.

Remote-control command:
`SOUR:AWGN:POW:MODE EN`

Bit Rate - AWGN
(Additive Noise only)

Sets or indicates the bit rate used for converting S/N to E_b/N_0.

Custom Digital Mod
With **Custom Digital Mod** signals, the bit rate used is indicated only. It is defined by the choice of the standard in the **Custom Digital Mod** menu.

Digital Standard
With **Digital Standard** signals, the bit rate used for converting S/N to E_b/N_0 is set here.
When generating a **Digital Standard**, it is thus possible to select which bit rate is to be used for calculating the ratio of bit energy to noise power density, e.g. the bit rate before or after channel coding.

Remote-control command:
`SOUR:AWGN:BRAT 3.4E6`

Signal/Noise Ratio / Signal/Interferer Ratio - AWGN
(Additive Noise / CW Interferer)

Mode Additive Noise:
Sets the signal/noise ratio by selected **Set Noise Level Via S/N**.

If **Set Noise Level Via Eb/N0** is selected, the associated S/N value is displayed here and read only.

Mode CW Interferer:
Sets the signal/interferer ratio.

Remote-control command:
`SOUR:AWGN:SNR 10 dB`

Eb/N0 - AWGN
(Additive Noise only)

Sets the ratio of bit energy to noise power density by selected **Set Noise Level Via Eb/N0**.

If **Set Noise Level Via S/N** is selected, the associated Eb/N0 value is displayed here and read only.

Remote-control command:
`SOUR:AWGN:ENR 10 dB`

Signal Level - AWGN
(Additive Noise and CW Interferer)

Displays the power level of the useful signal.

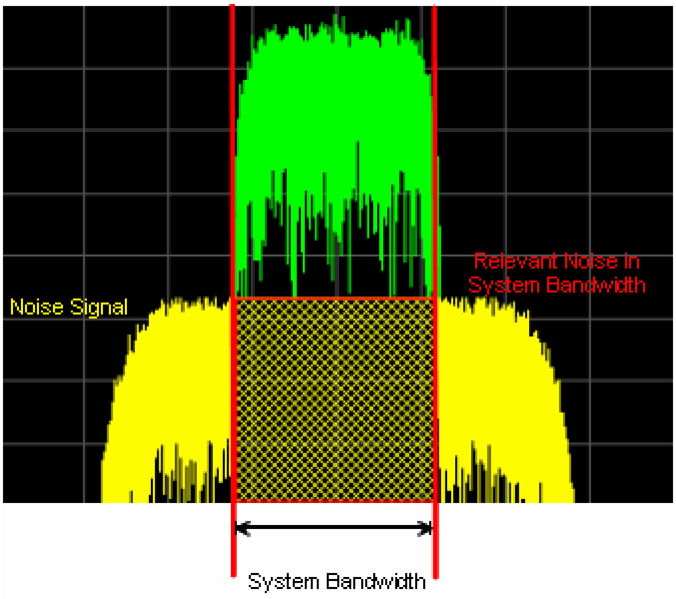
Remote-control command:
`SOUR:AWGN:POW:SIGN?`

Noise Level (System Bandwidth) / Interferer Level - AWGN
(Additive Noise and Noise Only / CW Interferer)

Displays the level of the noise / interferer signal.

In this mode, this value corresponds to the level entered in the **Level** header.

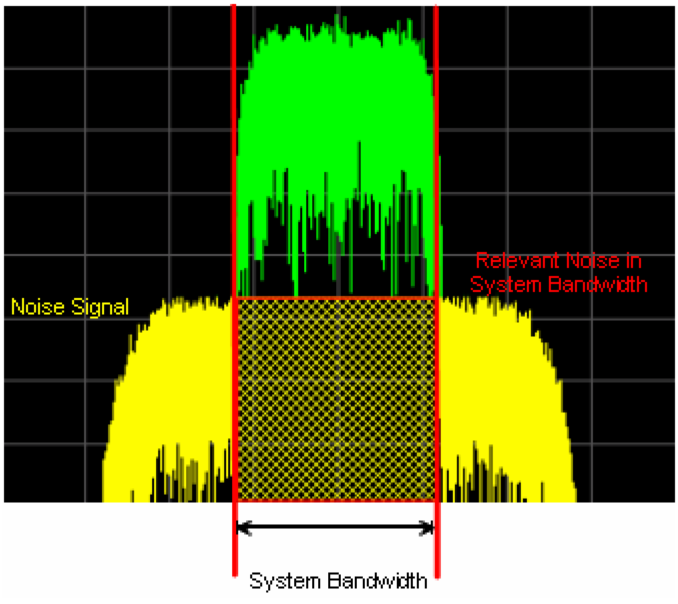
Note:
The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. This means that the total measurable noise level (see below) usually exceeds the value displayed here. Correct measurement of the noise level within the system bandwidth is possible by means of channel power measurement using a signal analyzer.



Remote-control command:
`SOUR:AWGN:POW:NOIS 10 dBm`

Noise Level (Total Bandwidth) - AWGN
(Additive Noise and Noise Only)

Displays the level of the noise signal in the total bandwidth.



Note:

The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. This means that the total measurable noise level usually exceeds the value of the noise level in the system bandwidth. Correct measurement of the noise level within the system bandwidth is possible by means of channel power measurement using a signal analyzer.

Display Output Results For *the analog or digital signal path has to be set before.*

Remote-control command:
`SOUR:AWGN:POW:NOIS:TOT?`
`Response: 19 dB`

Signal + Noise Level / Signal + Interferer Level - AWGN
(Additive Noise and CW Interferer)

Displays the overall level of the noise / interferer signal plus useful signal.

Note:

In the mode Additive Noise the ***Display Output Results For*** *(analog or digital) has to be set before.*

Remote-control command:
`SOUR:AWGN:POW:SUM?`

Signal + Noise PEP / Signal + Interferer PEP - AWGN (Additive Noise and CW Interferer)

Displays the peak envelope power of the overall signal comprised of the noise / interferer signal plus useful signal.

Notes:

The peak envelope power (PEP) specified in the header corresponds to the PEP value of the signal.

*In the mode Additive Noise the **Display Output Results For** (analog or digital) has to be set before.*

Remote-control command:
`SOUR:AWGN:POW:SUM:PEP?`

Fading Simulation - Fader Block

Introduction - Fading Simulation

The R&S AMU 200A Baseband Signal Generator and Fading Simulator allows the user to superimpose fading on the baseband signal at the output of the baseband block in realtime. When fitted with all of the possible options, up to 40 fading paths are available for a single fader, or 20 fading paths each in case of dual-channel fading. The two channels can be configured differently for different test scenarios. Using the same input signal and two separate output signals, for example, frequency diversity can be simulated. Using separate input signals which are summed after fading, a network handover can be simulated, for example.

A wide range of presets based on the test specifications of the major mobile radio standards simplifies the use of the fader in research, development, and quality assurance involving mobile radio equipment. For more complex tests, all of the parameters of the supplied fading configurations can be user-defined as required.

To ensure the repeatability of the tests, the fading process is always initiated from a defined starting point. A restart can be triggered manually or using configurable internal or external trigger signals.

Frequency hopping which builds upon the prior fading process after a frequency hop allows realistic simulation of frequency hopping conditions.

Graphical presentation of the defined fading paths, along with a path delay wizard, provide support to the user when setting up the desired fading channel.

During transmission of a signal from the transmitter to the mobile receivers, diverse fading effects occur which can be simulated by the fading simulator separately or in combination.

In the **Standard Delay** and **Fine Delay 30/50MHz** stationary fading configurations, up to 40 fading paths are simulated with different delays as occur on a transmission channel due to different propagation paths. Several fading profiles are available for each path. **Pure Doppler Fading** simulates a direct transmission path on which Doppler shift is occurring due to movement of the receiver. **Rayleigh Fading** simulates a radio hop which arises as a result of scatter caused by obstacles in the signal path (buildings, etc.). **Rice Fading** simulates a Rayleigh radio hop along with a strong direct signal. These profiles are fast fading profiles, and they simulate fast fluctuations of the signal power level which arise due to variation between constructive and destructive interference during multipath propagation. **Lognormal** and **Suzuki Fading** are slow fading profiles which simulate slow level changes which can occur, say, due to shadowing effects (e.g. tunnels).

In the dynamic configurations **Birth Death Propagation** and **Moving Propagation**, dynamic propagation conditions are simulated in conformity with test cases 25.104xxx, annex B3 and annex B4 from the 3GPP Standard. Delay variations (whether sudden or slow) do not become important until we reach the fast modulation standards such as 3GPP. The reason is that in this case the delay variations can be on the order of magnitude of the transmitted symbols so that transmission errors can arise.

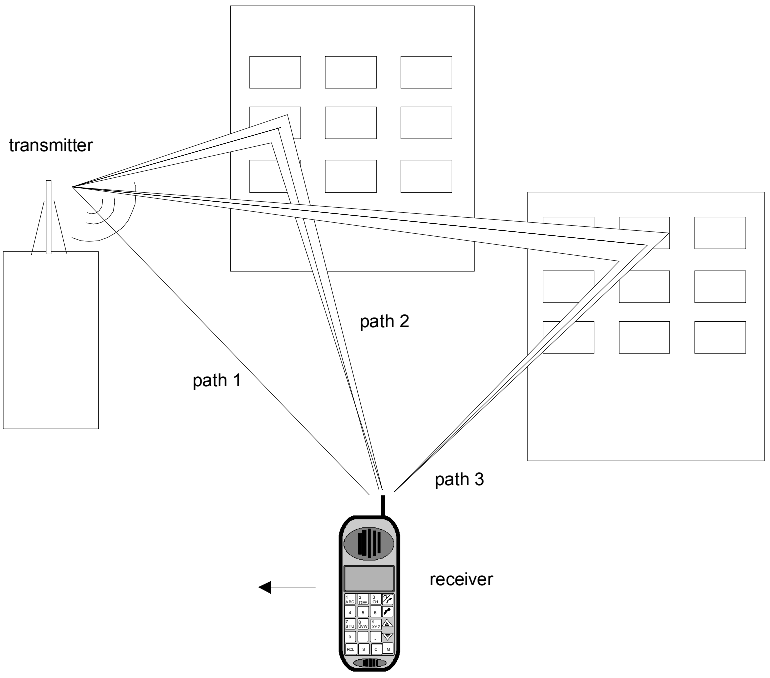
In the dynamic configuration **2 Channel Interferer**, the MediaFlo test cases 5 and 6 are simulated.

The following figure gives an example of single-channel fading with three transmission paths.

Path 1 represents the discrete component, i.e. a direct point-to-point transmission between the transmitter and receiver (pure Doppler fading profile).

Paths 2 and 3 represent the distributed components, i.e. signals which are scattered due to obstacles (Rayleigh fading profile).

When the Rice fading profile is selected, a combination of distributed and discrete components is generated in a path (see also the display of the spectrum of a QPSK signal which is subjected to Rician fading at the end of the parameter description).

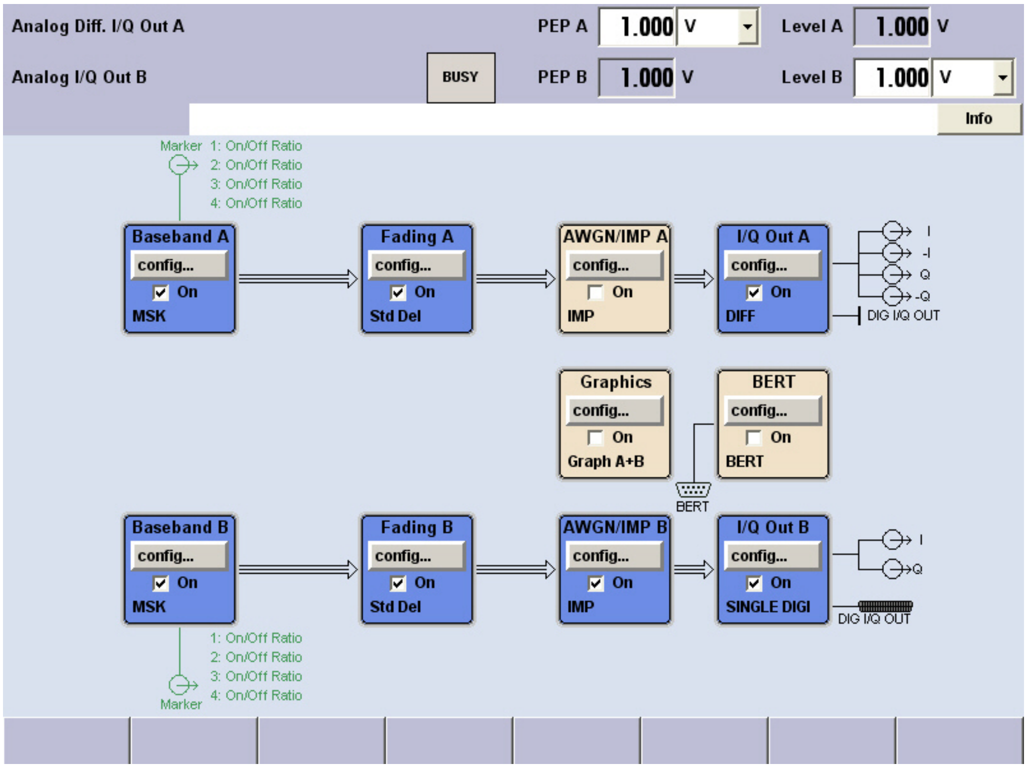


The fading process increases the crest factor of the signal, and this increase must be taken into account in the drive at the baseband level. When multiple paths are superimposed or in case of statistical influences on a path, an insertion loss is useful for providing a drive reserve. If the full drive level is reached nevertheless, the I/Q signals are limited to the maximum available level (clipping). The mode for determining the range for insertion loss is selectable (**Insertion Loss Configuration**). The insertion loss is automatically adjusted within this range to keep the output power constant. However, the maximum available output power of the R&S AMU is reduced by up to 18 dB.

If statistically correlated processes occur, such as the fading of modulation signals with symbol rates approximating the delay differences of the fading paths, correct automatic adaptation of the insertion loss is not possible. In this case, the output power must be measured again.

During further signal routing, it is possible to additionally offset the faded signals or to apply noise to them (see the sections "*Impairment Settings Menu*" and "*AWGN Settings Menu*").

The fading settings are summarised in the block diagram in the **Fading** functional block as well as in the menu with the same name for the MENU key.



Options for the base unit with the Frequency option (B10x) include the following: Baseband Main Module (B13), Baseband Generator (B10), and Fading Simulator for **Standard Delay** configuration (B14). Additional configurations - dynamic fading (**Birth Death**, **Moving Propagation**, **and 2 Channel Interferer**) and enhanced resolution (**Fine Delay** configurations) - require option K71.

The Path Extension option (B15) is used to double the number of fading paths from 20 to 40 or to configure dual-channel fading with 20 paths per channel.

In dual-path instruments where the Fading Simulator Option (B14) is fitted, only fader A or fader B can be switched on at one time, i.e. the 20 fading paths are available either for baseband path A or B.

If the Path Extension option (B15) is fitted additionally, either 40 fading paths are available for one of the two faders or 20 fading paths for each of the two faders (**dual-channel fading**).

Signal Routing – Fading Simulator

In the **Fading** functional block, the Fading menu is called up to configure the fading and a selection is made about how to route the faded baseband signal at the output of the fader.

Signal Routing

Selects the signal routing for the fading signal at the output of the fading simulator.

The input signal to the fading simulator is specified in the routing menu of the respective baseband block (see the section "*Signal Routing and Frequency Offset*"). When fitted with two faders and two baseband blocks, the faders can be fed the signal from a single baseband block, the summation signal from both baseband blocks or each a signal from one of the two baseband blocks.

Note:
The processing time for the baseband signal is always the same for the two faders, regardless of the status of the faders (On or Off). The only exception is fading with 40 fading paths. In this case, the processing times are different: the signal from the 40-path fader has a longer processing time than the signal from the fader which is switched off.

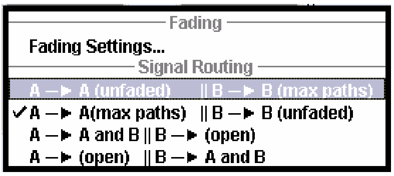
The proposed routes for the fading output signal differ also depending on the options fitted in the instrument:

Instruments with the Fading Simulator (option B14)

For a single-path instrument, the output signal is always output on path A.

Remote-control command: n.a.

In dual-path instruments, the fader output signal can be assigned either to path A , path B, or to both paths. Only one of the faders, A or B, can be operated. In Standard Delay mode, 20 fading paths are available for this fader. The signal of the other fader is either output unfaded (selection (max paths) - (unfaded)) or the signal flow is interrupted (selection A and B - (open)). The following table describes the possible routing settings.

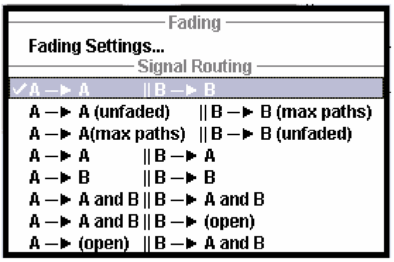


Remote-control command:
`SOUR:FSIM:ROUT FAMAXA| FAMAXAB| FBMAXB| FBMAXAB`

Instruments with the Fading Simulator (option B14) and Path Extension (option B15)

For a single-path instrument, the output signal is always output on path A. In **Standard Delay** mode, **40** fading paths are available.

For dual-path instruments with two baseband modules (2 x option B13) and one or two baseband sources (1/2 x option B10) a selection menu for signal routing is offered:



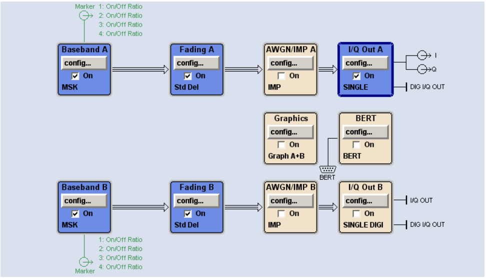
The following table shows all of the possible routing settings for dual-path instruments in a configuration with both fader options (B14 and B15).

A to A/ B to B

Dual-channel fading. The fading signal from fader A is output on baseband path A and the fading signal from fader B is output on baseband path B. In **Standard Delay** mode, **20** fading paths are available for each fader.

When fitted with a second baseband generator, the generator can be operated like two instruments; two independently configured signals are present at the I/Q outputs.

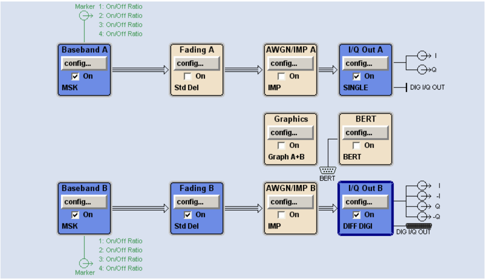
When using only a single baseband generator, the receiving conditions of a receiver (e.g. high-quality car radio, UMTS base station) with two antennas can be simulated (transmit or receive diversity). It is possible to correlate the paths of the two faders (the two fading channels) and thus simulate conditions which occur if a receiver has two antennas which receive statistically correlated signals (e.g. a car with two antennas in which the two received signals exhibit a certain degree of correlation due to a similar environment such as an underpass, hill, etc.)



Remote-control command:
`SOUR:FSIM:ROUT FAAFBB`

A to A (unfaded) / B to B (max. paths)

The fading signal from fader B is output on baseband path B. Fader A cannot be activated. In **Standard Delay** mode, **40** fading paths are available for fader B.

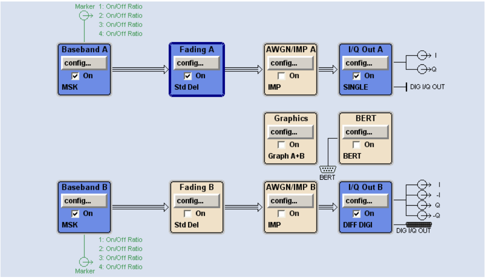


Note:
The signal from the 40-path fader has a longer processing time than the signal from the fader which is switched off.

Remote-control command:
`SOUR:FSIM:ROUT FBMAXB`

A to A (max. paths) / B to B (unfaded)

The fading signal from fader A is output on baseband path A. Fader B cannot be activated. In **Standard Delay** mode, **40** fading paths are available for fader A.



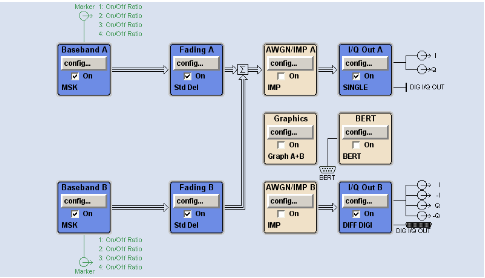
Note:
The signal from the 40-path fader has a longer processing time than the signal from the fader which is switched off.

Remote-control command:
`SOUR:FSIM:ROUT FAMAXA`

A to A/B to A

Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path A. In **Standard Delay** mode, **20** fading paths are available for each fader.

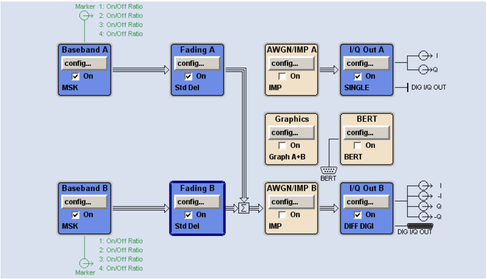
When fitted with a second baseband generator, for example, the conditions can be simulated for a mobile radio network handover in the handheld device or for filtering out the own signal in case of simultaneous presence of a strong signal from another standard. To do this, each baseband signal is configured according to the desired standard and passed to one fader in each case. After fading, the two signals with widely divergent signal strengths are output on a common I/Q output.



Remote-control command:
`SOUR:FSIM:ROUT FAAFBA`

A to B / B to B

Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path B. In **Standard Delay** mode, **20** fading paths are available for each fader.

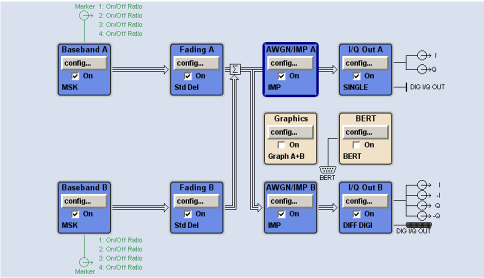


Remote-control command:
`SOUR:FSIM:ROUT FABFBB`

A to A and B / B to A and B

Dual-channel fading. The fading signal from fader A and the fading signal from fader B are output on baseband path A and baseband path B. In **Standard Delay** mode, **20** fading paths are available for each fader.

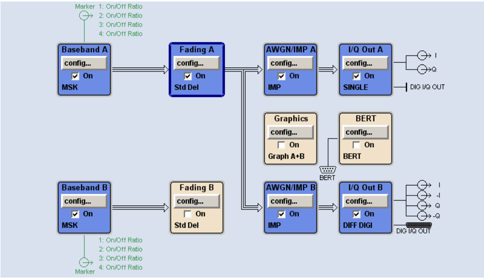
The possible applications are basically analogous to **A to A** / **B to A** routing, but here due to the splitting of the fader output signal among two paths, these two paths can also be processed differently after the fading. For example, a further degradation of the receiving conditions can be simulated for comparison purposes on a path by superimposing noise on the signal and distorting it.



Remote-control command:
`SOUR:FSIM:ROUT FAABFBAB`

A to A and B / B (open)

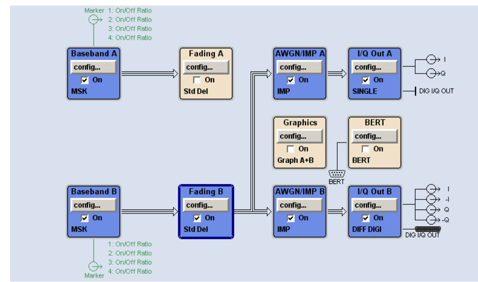
The fading signal from fader A is output on baseband path A and baseband path B. The signal from fader B is not output, the signal flow of baseband B is interrupted. In **Standard Delay** mode, **40** fading paths are available for fader A.



Remote-control command:
`SOUR:FSIM:ROUT FAMAXAB`

A (open)/ B to A and B

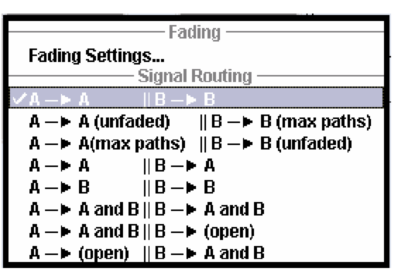
The fading signal from fader B is output on baseband path A and baseband path B. The signal from fader A is not output, the signal flow of baseband A is interrupted. In **Standard Delay** mode, **40** fading paths are available for fader A.



Remote-control command:
`SOUR:FSIM:ROUT FBMAXAB`

Fading Menu

The **Fading** menu is used to configure multipath fading signals. It is called it up either in the **Fader** block or using the MENU key.



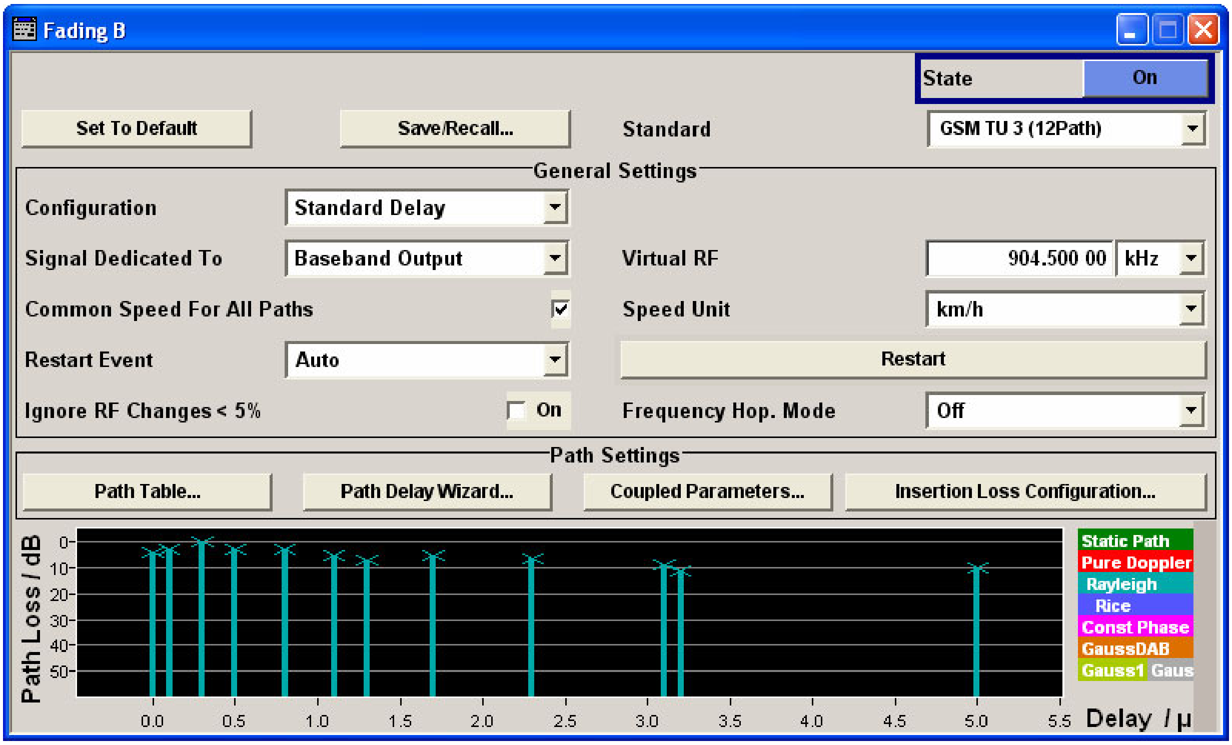
The **Fading** menu is divided into several sections:

The Fading Simulator is switched on in the upper section. By selecting a standard, a preset corresponding to different test cases from the common mobile radio standards is called up. Fading settings can be saved, recalled or reset to the default values.

In the **General Settings** section the configuration and the unit for the speed is selected. A user-definable RF frequency (virtual frequency) can be set for computing the Doppler shift. This virtual RF frequency is then used to set the modulation frequency of an external I/Q modulator.

The parameters are defined which determine under what conditions a restart of the fading simulation is triggered.

The **Path Settings** sections offers different submenus for the configuration of the fading paths depending on the selected fading configuration. The fading settings are displayed graphically.



Basic Settings - Fading

The Fading Simulator is switched on in the upper section. By selecting a standard, a preset corresponding to different test cases from the common mobile radio standards is call up. Fading settings can be saved, recalled or reset to the default values.

In the **General Settings** section the configuration and the unit for the speed is selected. A user-definable RF frequency (virtual frequency) can be set for computing the Doppler shift. This virtual RF frequency is then used to set the modulation frequency of an external I/Q modulator.

The parameters are defined which determine under what conditions a restart of the fading simulation is triggered.

State - Fading

Powers the fading simulator on or off.

When powered on, the fading process is initiated for the paths which are switched on.

A selectable trigger (**Restart Event**) can be used to restart the fading process. The fading process always begins at a fixed starting point after each restart. This helps to achieve repeatable test conditions.

Remote-control command:
`SOUR:FSIM:STAT ON`

Set to Default - Fading

Activates the default settings of the fading simulator.

By default, a path is activated with a Rayleigh profile and a slow speed. All of the other paths are switched off.

The following table provides an overview of the settings. The preset value is indicated for each parameter in the description of the remote-control commands.

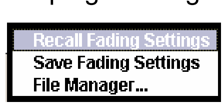
Remote-control command:
`SOUR:FSIM:PRES`

Parameter	**Value**
State	Off
Standard	User
Configuration	Standard Delay
Signal Dedicated to	Baseband Output
Speed Unit	km/h
Restart Event	Auto
Insertion Loss	
Insertion Loss Mode	Normal
Coupled Parameters	
All States	Off
Path Configuration	
State of path 1	On
State of all other paths	Off
Profile	Rayleigh
Delays	0
Speed of path 1	Slow
Speed of all other paths	0

Save/Recall - Fading

Calls up the **Save/Recall** menu.

In the **Save/Recall** menu, the desired **File Select** window for loading and saving fading configurations as well as the **File Manager** for keeping tracking of files can be called up.



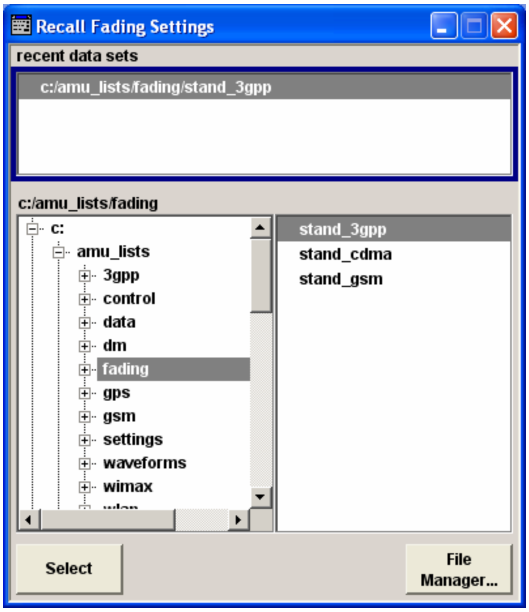
Fading configurations are saved with the file ending ***.fad**. The file name and the directory to store it can be chosen.

The entire settings of the **Fading** menu are always saved and loaded. When fitted with two faders, only the settings of the selected fader are stored.

Recall Fading Settings

Opens the **File Select** window for loading a saved **Fading** configuration.

Press the **Select** button to load the configuration of the selected (marked) file.



Remote-control command:
`:MMEM:CDIR 'F:\amu\amu_lists\fading'`
`SOUR:FSIM:CAT?`
Response:
`'stand_cdma,stand_gsm,stand_3gpp'`

`SOUR:FSIM:LOAD "stand_3gpp"`

Save Fading Settings

Opens the **File Select** window for saving the current **Fading** configuration.

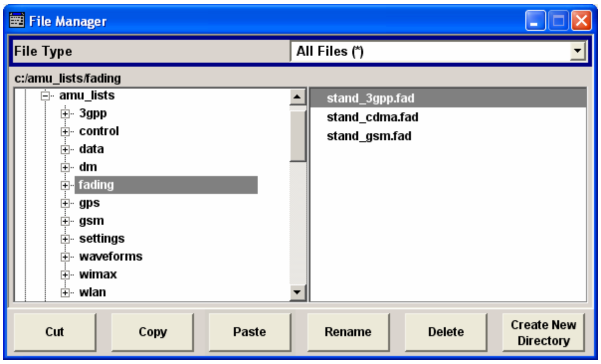
The name of the file is entered in the **File Name** input field, and the directory in the **save into** field. Press the **Save** button to save the file.

Remote-control command:
`:MMEM:CDIR 'F:\amu\amu_lists\fading'`

`SOUR:FSIM:STOR 'stand_nadc'`

File Manager Calls up the **File Manager**.

File Manager is used to perform general file operations such as copy, paste, rename, delete, and to create new directories.



Remote-control commands:
`:MMEM:CDIR 'F:\amu\amu_lists\fading'`

`SOUR:FSIM:DELETE 'stand_nadc'`

Standard / Test Case - Fading

Selects predefined fading settings.

These settings correspond to the test scenarios stipulated in the common mobile radio standards.

If one of the predefined parameters is modified, **User** is displayed. **User** is also the default setting.

File **fading_standard.pdf** on the CD-ROM provides a listing of the predefined standards along with the underlying test scenarios and the settings which are made.

Remote-control commands:
`SOUR:FSIM:STAN G6TU3`
`SOUR:FSIM:STAN:REF?`
Response: `'GSM_TS8916B'`

Configuration - Fading

Selects the fading configuration.

Note:
The selection of fine delay and dynamic configurations is only possible with option K71.

For classical fading with simulation of the level fluctuations, the user can choose from three delay configurations:

- Standard Delay,
- Fine Delay 30 MHz and
- Fine Delay 50 MHz.

These delay configurations occur in the received signal as a result of a typical multipath propagation and the propagation conditions, which vary depending on the location and timing.

For classical fading with simulation of the level fluctuations which occur in the received signal as a result of Typeical multipath propagation and propagation conditions which vary depending on the location and timing, the user can choose from three delay configurations: Standard Delay, Fine Delay 30 MHz and Fine Delay 50 MHz.

The delay configurations differ in terms of the number of paths, the resolution of the path-specific delay, and the available RF bandwidth.

The paths are arranged in groups in the delay configurations. Each group is characterized by a common group delay (Basic Delay). The paths are assigned a path-specific delay (Additional Delay). The total delay of a path is calculated by adding the two values (Resulting Delay).

The number of groups is the same for all three configurations. This number doubles from 4 to 8 when the instrument is fitted with the Path Extension option (B15). There is a maximum of 40 fading paths available in 8 groups for Standard Delay.

For fading with delays which change dynamically, there are three configurations: Birth Death Propagation, Moving Propagation, and 2 Channel Interferer.

Depending on which configuration is selected, the lower sections of the fading menu will change, particularly the path table.

Important:
A separate path table is associated with each configuration, i.e. when changing the delay configuration not only the bandwidth is switched but a completely new path table is loaded.
*Changing the configuration causes an interruption in the fading process, followed by a restart after about one second since the FPGAs in the instrument are rebooted and loaded with the modified configuration. Therefore, the interruption applies to **both** faders if the instrument is fitted with two faders (options B14 and B15).*

Standard Delay

In the **Standard Delay** configuration, each group consists of five paths. This means that 20 or 40 paths can be simulated for a fading channel. The resolution for the path-specific delay is 10 ns (see section "*Delay Modes Path Table - Fading*").

Remote-control command:
`SOUR:FSIM:DEL:STAT ON`

Fine Delay 30 MHz

In the **Fine Delay 30 MHz** configuration, each of the groups consists of three paths. This means that 12 or 24 paths can be simulated for a fading channel. The resolution for the path-specific delay is 10 ps. The RF bandwidth is limited to 30 MHz.

Remote-control command:
`SOUR:FSIM:DEL30:STAT ON`

Fine Delay 50 MHz

In the **Fine Delay 50 MHz** configuration, each of the groups consists of two paths. This means that 8 or 16 paths can be simulated for a fading channel. The resolution for the path-specific delay is 10 ps. An RF bandwidth of 50 MHz is available.

Remote-control command:
`SOUR:FSIM:DEL50:STAT ON`

Birth Death Propagation

In the **Birth Death Propagation** configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-320, annex B4. Two paths are simulated which appear (**Birth**) or disappear (**Death**) in alternation at arbitrary points in time (see section "*Birth Death Propagation Path Table - Fading*", page 4.129).

Remote-control command:
`SOUR:FSIM:BIRT:STAT ON`

Moving Propagation

In the **Moving Propagation** configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-320, annex B3.

Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion (see section "*Moving Propagation Path Table* - Fading", page 4.135).

Remote-control command:
`SOUR:FSIM:MDEL:STAT ON`

2 Channel Interferer

In the **2 Channel Interferer** configuration, the fading simulator simulates test case 5 and 6 from MediaFlo.

Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion or appears or disappears in alternation at arbitrary points in time (hopping) (see section "*2 Channel Interferer*", page 4.138).

Remote-control command:
`SOUR:FSIM:TCI:REF|MOV:STAT ON`

User Dynamic

The **User Dynamic** configuration is provided for future use.

Signal dedicated to - Fading

(read-only)

The Doppler shift is computed based on a user-definable virtual RF frequency which is entered under **Virtual RF**.

Virtual RF - Fading

Sets the virtual RF frequency.

The entered value is used as the basis for computing the Doppler shift.

Remote-control command:
`SOUR:FSIM:FREQ 1GHz`

Common Speed for all Paths - Fading

(only available for delay configurations)

Activates/deactivates the same speed in all paths.

The default is the **On** setting.

A change of speed in a path automatically results in a change of speed in all of the other paths.

When switching from Off to On, the speed entry for path 1 of group 1 is used for all of the paths.

Note:
*If **Speed Setting Coupling** is activated (see below), the setting of **Common Speed for all Paths** is also coupled in both faders.*

Remote-control command:
`SOUR:FSIM:CSP ON`

Speed Unit - Fading

Selects the unit for the speed. This setting is valid for all fading configurations.

The speed is entered in the path table.

Remote-control command:
`SOUR:FSIM:SPE:UNIT MPH`

Restart Event - Fading

Selects the event which leads to a restart of fading.

After each restart, the fading process starts at a fixed starting point and from there it passes through identical random processes for a given setting. This helps to achieve repeatable test conditions.

Auto

The modulation signal is continually faded.

Remote-control command:
`SOUR:FSIM:REST:MODE AUTO`

Manual

A restart is triggered by pressing the **Restart** button.

With dual-channel fading, pushing the **Restart** button causes both faders to restart if **Restart Event Manual** is selected for both faders.

Remote-control command:
`SOUR:FSIM:REST:MODE MAN`

Internal Trigger

A restart is triggered by the trigger which is selected for the associated baseband.

In the fader, internal start delays may occur in particular for complex fader configurations. Therefore, the selection of external trigger (or Internal from other baseband) in the baseband is recommended to ensure synchronized data processing. A possible fader start delay can then be taken into account by setting a sufficient trigger delay. The fader starts data processing only after the arrival of valid input data from the baseband.

For dual-channel fading, both faders can be triggered with the same marker signal or with different marker signals, i.e. the triggering can take place simultaneously or at different points in time.

Remote-control command:
`SOUR:FSIM:REST:MODE INT`

External Trigger 1 / 2

A restart is triggered by an external trigger on trigger jack TRIGGER 1 or TRIGGER 2.

It is recommended to also select external trigger in the baseband and to set a sufficient trigger delay to compensate for a possible internal start delay in the fader (see above, **Internal Trigger**).

For dual-channel fading, both faders can be triggered with the same trigger signal or with different trigger signals, i.e. the triggering can take place simultaneously or at different points in time.

Remote-control command:
`SOUR:FSIM:REST:MODE EXT1`

Restart - Fading

Triggers a restart of the fading simulation.

A restart is triggered with this button only if **Restart Event Manual** is selected.

With dual-channel fading, both faders are restarted if **Restart Event Manual** is selected for both faders.

Remote-control command:
`SOUR:FSIM:REST`

Path Settings - Fading

The **Path Settings** sections offers different submenus for the configuration of the fading paths depending on the selected fading configuration. The fading settings are displayed graphically.

Path Table... - Fading

Calls up the menu for setting the fading paths.

See sections "*Delay Modes Path Table - Fading*", page 4.113, "*Birth Death Propagation Path Table - Fading*", page 4.129, "*Moving Propagation Path Table - Fading*", page 4.135, and "*2 Channel Interferer Path Table - Fading*", page 4.138.

Path Delay Wizard- Fading

Calls up the menu for modifying, inserting and deleting paths in the delay modes, see section "*Path Delay Wizard- Fading*", page 4.126.

Coupled Parameters... - Fading

(only for
- Delay configurations
- Configuration with two faders (options B14 and B15) and
- Signal routing A to A /B to B (split))

Calls up the menu for setting the coupled parameters of the two faders A and B, see section "*Coupled Parameters ... - Fading*", page 4.128.

Insertion Loss Configuration ... - Fading

Calls up the menu for setting the insertion loss, see section "*Insertion Loss Configuration ... - Fading*", page 4.143.

Delay Modes Path Table - Fading

Button **Path Table...** calls the path table for configuration of the fading paths.

The paths are grouped in the **Standard Delay**, **Fine Delay 30 MHz,** and **Fine Delay 50 MHz** delay configurations. Each group is characterized by a common group delay (**Basic Delay**). The paths are assigned a path-specific delay (**Additional Delay**). The **Resulting Delay** of a path is calculated by adding the two values. The delay configurations differ in terms of the number of paths, the resolution of the path-specific delay, and the available RF bandwidth. The remaining parameters are the same for the three configurations.

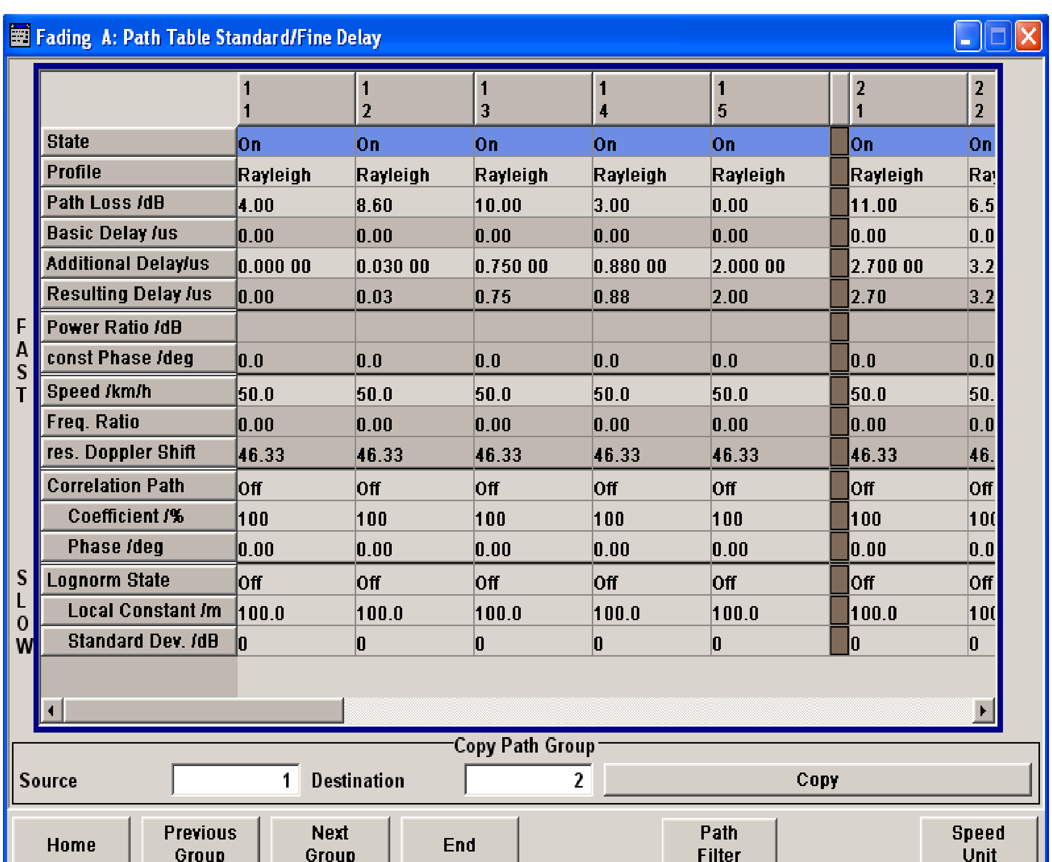
The maximum number of paths is doubled from 20 to 40 when the instrument is fitted with the Path Extension option (B15).

The individual path and group parameters can be set in the path table. The group number is displayed in the first row of the table header and the path number is displayed in the second row. The parameters are displayed row-by-row at the left edge of the table. The sections for fast and slow fading are indicated to the left next to the table.

A light background means that the parameter is adjustable. A dark background means that the parameter is not adjustable. Whether a parameter is configurable or not depends, for example, on the group (e.g. the Basic Delay is always 0 for group 1) and on the selected fading profile (e.g. the power ratio can be entered only for Rice fading). The pure display parameters such as the resulting Doppler shift are also shown with a dark background.

In the **Copy Path Group** section, the settings for a fading group can be copied to a second fading group.

The **buttons** facilitate navigation in the path table by moving the indicated area of the table and suppression of the indication of disabled paths. It is also possible to quickly change the speed unit with a softkey.



State Path - Fading

Activates a fading path.

After power-on, the fading process is initiated for this path with the selected fading profile. However, the fading simulator must be switched on.

Remote-control commands:
```
SOUR:FSIM:DEL:GRO1:PATH2:STAT ON
SOUR:FSIM:DEL30:GRO1:PATH2:STAT ON
SOUR:FSIM:DEL50:GRO1:PATH2:STAT ON
```

Profile - Fading

Determines the fading profile for the selected path. The fading profile determines which transmission path or which radio hop is simulated.

Depending on which profile is selected, certain parameters will be available in the path table and others will not be available.

With correlated paths, the profile setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Static Path

A static transmission path is simulated which can undergo attenuation (loss) or delay.

Remote-control commands:
```
SOUR:FSIM:DEL:GRO1:PATH2:PROF SPAT
SOUR:FSIM:DEL30:GRO1:PATH2:PROF SPAT
SOUR:FSIM:DEL50:GRO1:PATH2:PROF SPAT
```

Pure Doppler

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by the **Speed** and **Frequency Ratio** parameters (see the description of the **Speed** parameter).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO1:PATH2:PROF PDOP
SOUR:FSIM:DEL30:GRO1:PATH2:PROF PDOP
SOUR:FSIM:DEL50:GRO1:PATH2:PROF PDOP
```

Rayleigh

A radio hop is simulated in which many highly scattered subwaves arrive at a moving receiver. The resulting received amplitude varies over time. The probability density function for the magnitude of the received amplitude is characterized by a Rayleigh distribution. This fading spectrum is "Classical".

Remote-control commands:
```
SOUR:FSIM:DEL:GRO1:PATH2:PROF RAYL
SOUR:FSIM:DEL30:GRO1:PATH2:PROF RAYL
SOUR:FSIM:DEL50:GRO1:PATH2:PROF RAYL
```

Rice

A radio hop is simulated in which a strong direct wave (discrete component) arrives at a moving receiver in addition to many highly scattered subwaves. The probability density of the magnitude of the received amplitude is characterized by a Rice distribution. The fading spectrum of an unmodulated signal involves the superimposition of the classic Doppler spectrum (Rayleigh) with a discrete spectral line (pure Doppler).

The ratio of the power of the two components (Rayleigh and pure Doppler) is set with the **Power Ratio** parameter.

Remote-control commands:
`SOUR:FSIM:DEL:GRO1:PATH2:PROF RICE`
`SOUR:FSIM:DEL30:GRO1:PATH2:PROF RICE`
`SOUR:FSIM:DEL50:GRO1:PATH2:PROF RICE`

Const. Phase

A transmission path with the set constant phase rotation is simulated which can undergo attenuation (loss) or delay.

Remote-control commands:
`SOUR:FSIM:DEL:GRO1:PATH2:PROF CPH`
`SOUR:FSIM:DEL30:GRO1:PATH2:PROF CPH`
`SOUR:FSIM:DEL50:GRO1:PATH2:PROF CPH`

Start Phase

(for Pure Doppler and Rice only)

A transmission path with the set start phase rotation is simulated which can undergo attenuation (loss) or delay.

Remote-control commands:
`SOUR:FSIM:DEL:GRO1:PATH2:PROF CPH`
`SOUR:FSIM:DEL30:GRO1:PATH2:PROF CPH`
`SOUR:FSIM:DEL50:GRO1:PATH2:PROF CPH`

Gauss1

GAUS1 is the sum of two Gaussian functions and is used for excess delay times in the range of 0,5 µs to 2 µs (0,5 µs ≤ τ_i ≤ 2 µs).

(GAUS1) $S(\tau_i, f) = G\,(A, -0{,}8f_d, 0{,}05f_d) + G\,(A_1, +0{,}4f_d, 0{,}1f_d)$

where A_1 is 10 dB below A.

Remote-control commands:
`SOUR:FSIM:DEL:GRO1:PATH2:PROF OGAU`
`SOUR:FSIM:DEL30:GRO1:PATH2:PROF OGAU`
`SOUR:FSIM:DEL50:GRO1:PATH2:PROF OGAU`

Gauss2

GAUS2 is also the sum of two Gaussian functions and is used for paths with delays in excess of 2 µs ($\tau_i \geq 2$ µs).

(GAUS2) $S(\tau_i,f) = G(B, +0{,}7f_d, 0{,}1f_d) + G(B_1, -0{,}4f_d, 0{,}15f_d)$

where B_1 is 15 dB below B.

Remote-control commands:
SOUR:FSIM:DEL:GRO1:PATH2:PROF TGAU
SOUR:FSIM:DEL30:GRO1:PATH2:PROF TGAU
SOUR:FSIM:DEL50:GRO1:PATH2:PROF TGAU

GaussDAB

GAUSDAB is composed of a Gaussian function and is used for special DAB profiles.

(GAUSDAB) $S(\tau_i,f) = G(A, \pm 0{,}7f_d, 0{,}1f_d)$

Remote-control commands:
SOUR:FSIM:DEL:GRO1:PATH2:PROF DGAU
SOUR:FSIM:DEL30:GRO1:PATH2:PROF DGAU
SOUR:FSIM:DEL50:GRO1:PATH2:PROF DGAU

WM Doppler

Selects the WM Doppler fading profile.

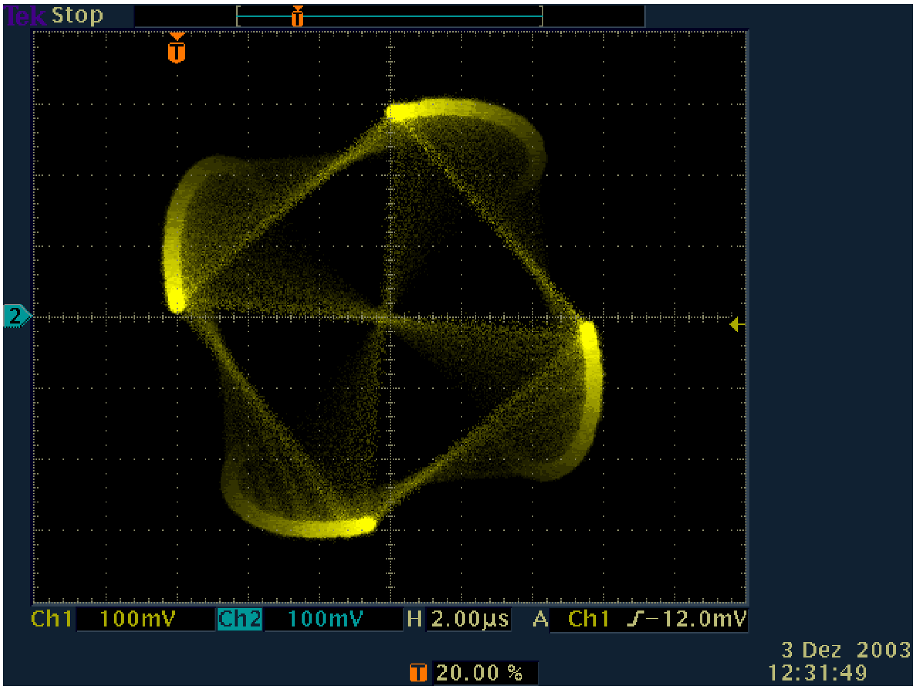
Remote-control commands:
SOUR:FSIM:DEL:GRO1:PATH2:PROF WDOP
SOUR:FSIM:DEL30:GRO1:PATH2:PROF WDOP
SOUR:FSIM:DEL50:GRO1:PATH2:PROF WDOP

WM Rice

Selects the WM Rice fading profile.

Remote-control commands:
SOUR:FSIM:DEL:GRO1:PATH2:PROF WRIC
SOUR:FSIM:DEL30:GRO1:PATH2:PROF WRIC
SOUR:FSIM:DEL50:GRO1:PATH2:PROF WRIC

The following figure shows a baseband signal with QPSK modulation and a rectangular filter which was subjected to Rician fading (one path). As a result of the luminescence setting on the oscilloscope, the variation in phase and amplitude of the constellation points caused by the fader is clearly visible.



Path Loss - Fading

Enters the loss for the selected path.

Remote-control commands:
```
SOUR:FSIM:DEL:GRO1:PATH2:LOSS 2 dB
SOUR:FSIM:DEL30:GRO1:PATH2:LOSS 2 dB
SOUR:FSIM:DEL50:GRO1:PATH2:LOSS 2 dB
```

Basic Delay - Fading

Determines the Basic Delay.

Within a path group, all of the paths are jointly delayed by this value. The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay. The Basic Delay for group 1 is always 0. Thus, for the paths in group 1, we always have a setting range for the Resulting Delay from 0 to 40 ns (= setting range for **Additional Delay**).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH:BDEL 2E-4
SOUR:FSIM:DEL30:GRO2:PATH:BDEL 2E-4
SOUR:FSIM:DEL50:GRO2:PATH:BDEL 2E-4
```

Additional Delay - Fading

Determines the Additional Delay.

The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay. No Additional Delay can be entered for path 1 of group 1.

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:ADEL 1E-6
SOUR:FSIM:DEL30:GRO2:PATH2:ADEL 1E-6
SOUR:FSIM:DEL50:GRO2:PATH2:ADEL 1E-6
```

Resulting Delay - Fading

Displays the Resulting Delay for the path.

The Resulting Delay is obtained by adding the **Basic Delay** (see section "*Basic Delay - Fading*", page 4.117) and the **Additional Delay**, see section "*Additional Delay - Fading*", page 4.117.

The **Path Delay Wizard** (see section "*Path Delay Wizard- Fading*", page 4.112) is very helpful when the user needs to position the paths at defined Resulting Delays.

Remote-control commands:
`SOUR:FSIM:DEL:GRO2:PATH2:RDEL?`
`SOUR:FSIM:DEL30:GRO2:PATH2:RDEL?`
`SOUR:FSIM:DEL50:GRO2:PATH2:RDEL?`

Power Ratio - Fading (Rice Fading)

Enters the power ratio of the discrete component and distributed component for Rice fading.

The total power consisting of the two components is always constant. At a high power ratio, the discrete (Doppler) component prevails. At a low power ratio, the distributed (Rayleigh) component prevails.

Remote-control commands:
`SOUR:FSIM:DEL:GRO2:PATH2:PRAT –15`
`SOUR:FSIM:DEL30:GRO2:PATH2:PRAT -15`
`SOUR:FSIM:DEL50:GRO2:PATH2:PRAT -15`

Const. Phase - Fading

(Pure Doppler and Constant Phase Fading)

Enters the phase by which the path is multiplied for pure Doppler and constant phase fading.

Remote-control commands:
`SOUR:FSIM:DEL:GRO2:PATH2:CPH 5DEG`
`SOUR:FSIM:DEL30:GRO2:PATH2:CPH 5DEG`
`SOUR:FSIM:DEL50:GRO2:PATH2:CPH 5DEG`

Speed - Fading

(Pure Doppler, Rayleigh, and Rice Fading)

Enters the speed v of the moving receiver. Choose the desired Speed Unit in the upper section of the menu.

Based on the speed v and the virtual RF frequency f_{RF}, the Doppler shift f_D is computed.

$$c = 2.998 \cdot 10^8 \, m/s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

Example:

v = 100 km/h; $\mathbf{f_{RF}}$ = 1 GHz : $\mathbf{f_D}$ = 92.66 Hz

The resulting Doppler shift is displayed in the **res. Doppler Shift** line. It may not exceed the maximum Doppler shift of 1600 Hz.

If the speed is changed, the resulting Doppler shift is automatically modified.

In the **Pure Doppler** and **Rice Fading** profiles, the resulting Doppler shift is dependent on the entered speed and also on the ratio of the actual Doppler shift to the (set) Doppler shift $\mathbf{f_D}$.

This ratio is determined in the **Frequency Ratio** line.

The **Speed** parameter is not available for static path and constant phase fading.

A change of speed in one path automatically results in a change of speed in all of the other paths of the fader if **Common Speed in All Paths** is activated.

When fitted with the Path Extension option (B15), the speed for the paths of both faders A and B can be coupled.

With correlated paths, the speed setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made). The same applies to all paths of the two faders when coupling is activated.

Remote-control commands:
```
SOUR:FSIM:SPE:UNIT MPS
SOUR:FSIM:DEL:GRO2:PATH2:SPE 100
SOUR:FSIM:DEL30:GRO2:PATH2:SPE 100
SOUR:FSIM:DEL50:GRO2:PATH2:SPE 100
```

Frequency Ratio - Fading

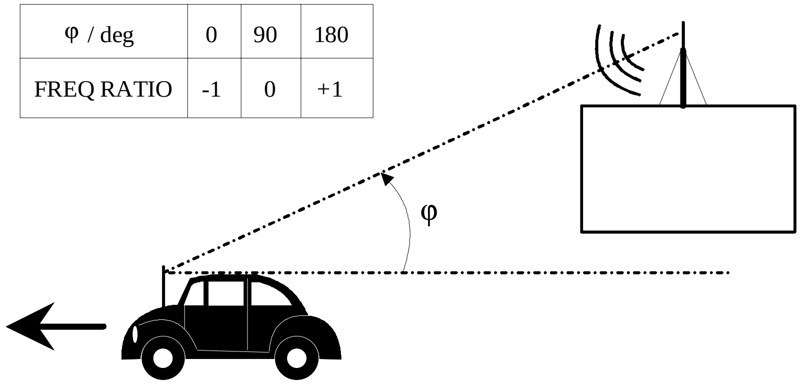
(Pure Doppler and Rice Fading)

Enters the ratio of the actual Doppler frequency to the Doppler frequency set with the Speed parameter for pure Doppler or Rice fading.

The actual Doppler shift is a function of the simulated angle of incidence of the discrete component (see following figure).

Negative values indicate a receiver that is going away from the transmitter, and positive values a receiver that is approaching the transmitter.

φ / deg	0	90	180
FREQ RATIO	-1	0	+1



With correlated paths, the speed setting of the Frequency Ratio must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
`SOUR:FSIM:DEL:GRO2:PATH2:FRAT 0.15`
`SOUR:FSIM:DEL30:GRO2:PATH2:FRAT 0.15`
`SOUR:FSIM:DEL50:GRO2:PATH2:FRAT 0.15`

Resulting Doppler Shift - Fading

(Pure Doppler, Rayleigh, and Rice Fading only)

Displays the Doppler shift.

The Doppler shift is determined by entering the **Speed**.

For the **Pure Doppler** and **Rice Fading** profiles, the actual Doppler shift is a function of the entered ratio of the actual Doppler shift to the Doppler shift set with the Speed parameter (**Frequency Ratio**).

Remote-control commands:
`SOUR:FSIM:DEL:GRO2:PATH2:FDOP?`
`SOUR:FSIM:DEL30:GRO2:PATH2:FDOP?`
`SOUR:FSIM:DEL50:GRO2:PATH2:FDOP?`

Correlation Path - Fading

(only for
– Configuration with two faders (options B14 and B15) and
- Signal routing A to A /B to B (split))

Switches on correlation to the corresponding path of the second fader for dual-channel fading.

Setting correlation necessitates synchronous signal processing on both channels. This means the settings of the following parameters for the correlated fading paths must agree:

- **Profile**
- **Speed**
- **Frequency Ratio**
- **Lognormal Parameters**

When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Correlated paths in dual-channel fading with the same input signal simulate the receiving conditions experienced by a receiver having two antennas in which the received signals exhibit a certain degree of correlation due to a similar environment.

This parameter is available only for the delay configurations with two faders (options B14 and B15) and selection of A to A / B to B signal routing (split) Each fader has a maximum of 20 fading paths.

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:CORR:STAT ON
SOUR:FSIM:DEL30:GRO2:PATH2:CORR:STAT ON
SOUR:FSIM:DEL50:GRO2:PATH2:CORR:STAT ON
```

Correlation Coefficient - Fading

(only for
- Delay configurations
- Configuration with two faders (options B14 and B15) and
- Signal routing A to A /B to B (split))

Enters the magnitude of the complex correlation coefficient as a percentage.

The higher the entered percentage, the greater the correlation of the statistical fading processes for the two correlated paths. Highly correlated ambient conditions for the signal are simulated in this manner.

Each fader has a maximum of 20 path.

ith correlated paths, the coefficient setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:CORR:COEF 95
SOUR:FSIM:DEL30:GRO2:PATH2:CORR:COEF 95
SOUR:FSIM:DEL50:GRO2:PATH2:CORR:COEF 95
```

Correlation Coefficient Phase - Fading

(only for
- Delay configurations
- Configuration with two faders (options B14 and B15) and
- Signal routing A to A /B to B (split))

Enters the phase of the complex correlation coefficient in degrees.

Each fader has a maximum of 20 fading paths.

With correlated paths, the coefficient phase setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:CORR:PHAS 5
SOUR:FSIM:DEL30:GRO2:PATH2:CORR:PHAS 5
SOUR:FSIM:DEL50:GRO2:PATH2:CORR:PHAS 5
```

Lognormal State - Fading

Switches lognormal fading on/off (slow fading).

With lognormal fading, an additional slow fluctuation of the received amplitude of a moving receiver is simulated. This can occur due to peculiarities in the landscape or topography (e.g. when driving through a depression). Lognormal fading has a multiplicative effect on the path loss. The multiplication factor is time-variable and logarithmically normally distributed. If a Rayleigh profile is set simultaneously, what we obtain is Suzuki fading.

Note:
Since the slow level fluctuation is not taken into account statistically in the computation of the insertion loss, the output power can deviate from the displayed power.

When fitted with the Path Extension option (B15), the status of lognormal fading for the paths of both faders A and B can be coupled. With correlated paths, the status setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:LOGN:STAT ON
SOUR:FSIM:DEL30:GRO2:PATH2:LOGN:STAT ON
SOUR:FSIM:DEL50:GRO2:PATH2:LOGN:STAT ON
```

Local Constant - Fading

Enters the Local Constant for lognormal fading.

The Local Constant **L** and the speed **v** of the moving receiver determine the limit frequency $\mathbf{f_L}$ for lognormal fading:
$\mathbf{f_L = v/L}$.

The power density spectrum of an unmodulated carrier consists of a discrete spectral line at $\mathbf{f_{RF}}$ and a frequency-dependent continuous component for which the following holds:

$$S(f) = const \cdot e^{-0.5 \cdot \left(\frac{f - f_{RF}}{f_L} \right)^2}$$

The lower setting limit is a function of the virtual RF frequency $\mathbf{f_{RF}}$.

The following holds: $L_{min} = \frac{12 \cdot 10^9 m/s}{f_{RF}}$

When fitted with the Path Extension option (B15), the Local Constant for the paths of both faders A and B can be coupled.
With correlated paths, the Local Constant setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:LOGN:LCON 100
SOUR:FSIM:DEL30:GRO2:PATH2:LOGN:LCON 100
SOUR:FSIM:DEL50:GRO2:PATH2:LOGN:LCON 100
```

Standard Deviation - Fading

Enters the standard deviation in dB for lognormal fading.

When fitted with the Path Extension option (B15), the standard deviation for the paths of both faders A and B can be coupled.
With correlated paths, the standard deviation setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote-control commands:
```
SOUR:FSIM:DEL:GRO2:PATH2:LOGN:CSTD 1
SOUR:FSIM:DEL30:GRO2:PATH2:LOGN:CSTD 1
SOUR:FSIM:DEL50:GRO2:PATH2:LOGN:CSTD 1
```

In the Copy Path Group section, the settings for a fading group can be copied to a second fading group.

Copy Source - Fading

Selects a group whose setting is to be copied.

Remote-control command:
```
SOUR:FSIM:COPY:SOUR 1
```

Copy Destination - Fading

Selects a group whose setting is to be overwritten.

Remote-control command:
`SOUR:FSIM:COPY:DEST 2`

Copy - Fading

Triggers a copy procedure.

Remote-control command:
`SOUR:FSIM:COPY:EXEC`

The buttons facilitate navigation in the path table by moving the indicated area of the table and suppression of the indication of disabled paths. It is also possible to quickly change the speed unit with a softkey.

Home / End - Fading

Moves the cursor to the first path (**Home**) or to the last path (**End**) of the table.

Remote-control command: n.a.

Previous / Next - Fading

Moves the cursor to the first path of the preceding (**Previous**) or subsequent (**Next**) path group.

Remote-control command: n.a

Path Filter - Fading

Suppresses the indication of the disabled paths.

Remote-control command: n.a.

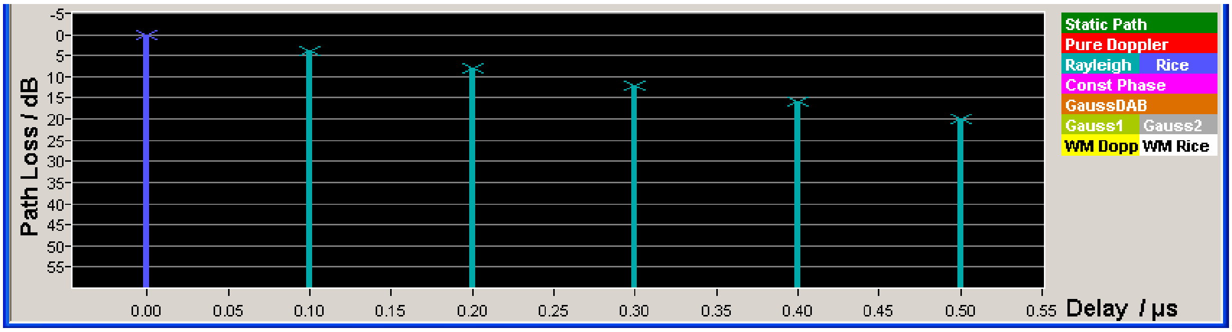
Speed Unit - Fading

Toggles between the available units for speed. The value always remains unchanged but the display is automatically adapted to the selected unit.

Remote-control command: n.a.

Delay Modes Path Graph - Fading

The graphics in the lower menu section provide a fast overview of the paths which are set in the delay modes.



The signal delay is plotted on the X axis. The minimum value is 0 s. The maximum value is equal to the maximum delay which is set (max. Basic Delay + max. Path Delay). The relative path power is plotted on the Y axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB).

Each path is represented by a bar. The color of the bar indicates the fading profile of the path. The color coding for the individual profiles is shown at the top right next to the graphics. The **Path Loss** can be read off from the height of the bar. The minimum value is 0 dB, and the maximum value is – 50 dB.

The groups and the range of signal delay values available for each group are indicated by a broken line. The groups are only indicated if at least one group has a **Basis Delay** other than 0 (i.e. for most Standards / "Test Cases" no groups are indicated as the Basic Delay is mostly 0).

The **Path Delay Wizards** is available to easily modify the settings of existing paths or insert new paths.

Remote-control command: n.a.

Path Delay Wizard- Fading

The menu for modifying, inserting, and deleting paths in the delay modes is called up in the **Fading** menu.

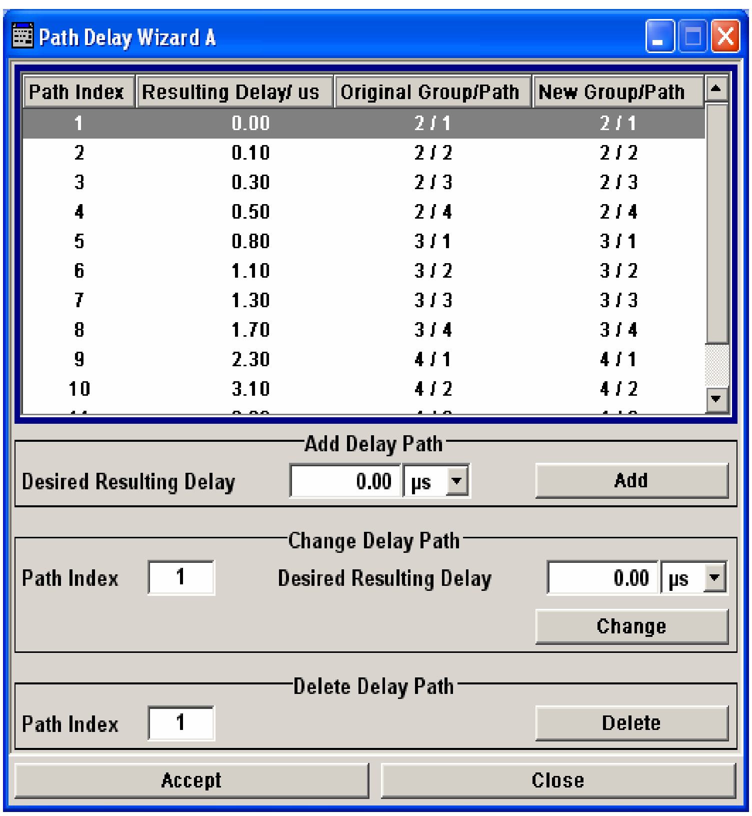
The **Path Delay Wizard** is not available for the **Birth Death** and **Moving Propagation** modes.

The total delay (**Resulting Delay**) of each path is a function of the group-specific delay (**Basic Delay**) and the path-specific delay (**Additional Delay**).

Since the **Additional Delay** has a maximum value of 40 µs, the range of values for the **Resulting Delay** of the individual paths of a group is limited to **Basic Delay + 40 µs**. In order to configure a path with a delay outside of this range of values, it must be activated in another group with a suitable **Basic Delay**.

When inserting new paths and modifying existing paths, the **Path Delay Wizard** provides support through automatic grouping of the paths based on the desired **Resulting Delays** of the paths.

Remote-control commands: n.a.



Wizard Table - Fading

The table shows the active paths sorted by their **Resulting Delays**. The paths are numbered sequentially (**Index**). This index does not correspond to the path number of the path in the respective group. This path number is displayed together with the group to which the path belongs (**Original Group / Path**). Also displayed is the group/path combination in which the path ends up after the modification has been carried out (**New Group Path**).

In the Add Delay Path section, a new path can be defined with a user-definable delay.

Wizard Desired Resulting Delay - Fading

Enters the Resulting Delay for the new path.

Wizard Add Path - Fading

Integrates the new path into the **Path Delay Table**.

If necessary, this will involve regrouping of the paths that were previously active. However, the modification is not made yet. First, the **Accept** button first has to be pressed.

If the new path cannot be integrated (e.g. if no group can be created with a suitable Basic Delay), the **Accept** button is not enabled and the line with the invalid path delay is marked with "ERROR".

In the Change Delay Path section, the delay of an existing path is modified.

Wizard Path Index - Fading

Selects a path for which to modify the delay.

Wizard Desired Delay - Fading

Enters the Resulting Delay for the selected path.

Wizard Change - Fading

Integrates a path with modified delay into the **Path Delay Table**. If necessary, this will involve regrouping of the paths. However, the modification is not made yet. First, the **Accept** button has to be pressed.

The **Accept** button is only enabled when the path delays can be generated in the instrument. Path delays that cannot be assigned are marked with "ERROR" in the list. The restrictions are that a path group can only cover a range of 40 us and that the Basic Delay of the path groups 1 and 5 must be 0.

In the Delete Delay Path section, an existing path can be deleted.

Wizard Index - Fading

Selects a path to be deleted.

Wizard Delete Path - Fading

Removes a path from the **Path Delay Table**. If necessary, the remaining paths will be regrouped. However, the modification is not made yet. First, the **Accept** button first has to be pressed.

Wizard Accept Path - Fading

Accepts the settings for the **Path Delay Table** in the instrument.

The path modifications are not made until the button is pressed. For the modified and shifted paths, all of the parameters for the original paths are accepted (except for the modified delay settings). Newly added paths are assigned the **On State** and the default values for all of the other parameters.

Deleted paths are assigned the **Off State** and the default values for all of the other parameters.

The **Accept** button is only enabled when the path delays can be generated in the instrument. Path delays that cannot be assigned are marked with "ERROR" in the list. The restrictions are that a path group can only cover a range of 40 us and that the Basic Delay of the path groups 1 and 5 must be 0.

Wizard Close - Fading

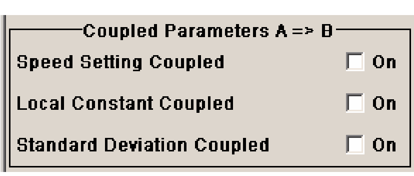
Closes the **Path Delay Wizard** without making any modifications.

Coupled Parameters ... - Fading

The menu for setting the coupled parameters of the two faders A and B is called up in the **Fading** menu. This menu is available only for the delay configurations with two faders (options B14 and B15) and selection of signal routing A to A / B to B (split) Each fader has a maximum of 20 fading paths.

The option of coupling certain parameters is offered in order to simplify operation during dual-channel fading. When coupling is activated, the setting of the fader for which coupling is activated is transferred to both faders. Afterwards, any change in one of the two faders is transferred to the other fader regardless of the changed fader.

The settings are summarized in the section **Coupled Parameters A => B** (Fader A) or **Coupled Parameters B => A**.



Speed Setting Coupled - Fading

Sets the **Speed** of the paths for both faders. The **Common Speed for all Paths** setting is also coupled.

Remote-control command:
`SOUR:FSIM:COUP:SPE ON`

Local Constant Coupled - Fading

With lognormal fading, the setting for the **Local Constant** is coupled for the paths of both faders.

Remote-control command:
`SOUR:FSIM:COUP:LOGN:LCON ON`

Standard Deviation Coupled - Fading

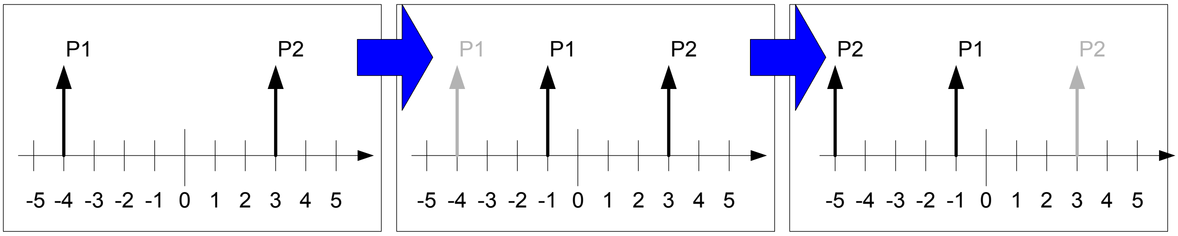
With lognormal fading, the setting for the **Standard Deviation** is coupled for the paths of both faders.

Remote-control command:
`SOUR:FSIM:COUP:LOGN:CSTD ON`

Birth Death Propagation Path Table - Fading

In the **Birth Death Propagation** configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-xxx, annex B4. Here, the behavior of a receiver is tested when it is confronted with the sudden disappearance and reappearance of a signal. This can occur, for example, when a pedestrian making a call walks around the corner of a building.

Two paths are simulated which appear (**Birth**) or disappear (**Death**) in alternation at arbitrary points in time. The points in time fall within a grid of integer delays [-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5] µs. After a certain time (**Hopping Dwell**), a path disappears from a given grid position and appears simultaneously at another randomly chosen grid position. During this hop, the second path remains stable at its grid position. After a further **Hopping Dwell** elapses, the second path changes its position. Now, the first path remains at its position and so on. The two paths never appear at the same time position at the same time (see the following figure).



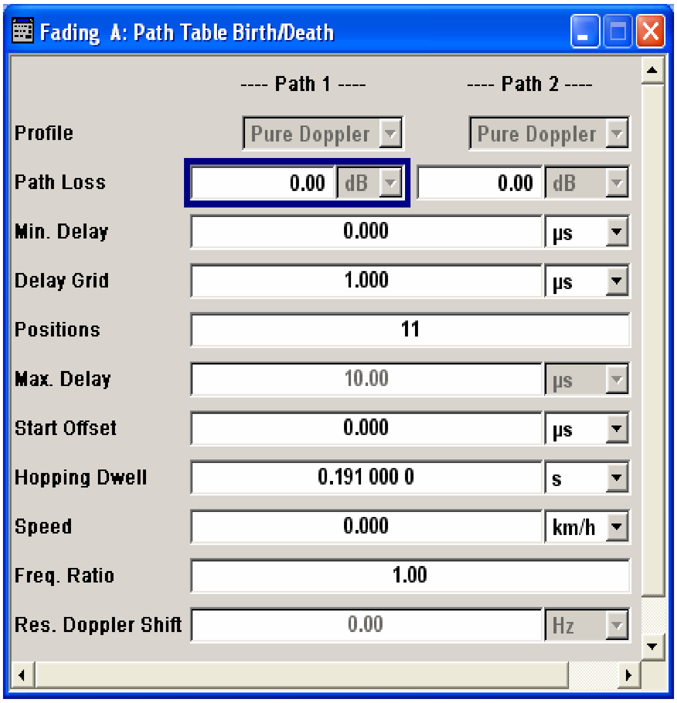
Example of a sequence of hops in **Birth Death Propagation**

Note:
Since it is not possible to generate negative time values (delays), the actual hop range is from 0 to 10 µs.

According to annex B4, each path has the same loss and phase and no Doppler shift. The time until the position of a path is changed is also specified (see table).

Profile	Pure Doppler
Path Loss	0 dB
Min. Delay	0 µs
Delay Grid	1 µs
Positions	11
Max .Delay	10 µs
Hopping Dwell	191 ms
Speed	0 m/s
Frequency Ratio	1.0

These values are the default values for Birth Death Propagation. However, these parameters can also be set for further tests in the fading path table.



Profile Birth Death - Fading

Displays the fading profile for birth death propagation. The fading profile has a fixed setting to **Pure Doppler**.

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by the **Speed** and **Frequency Ratio** parameters.

Remote-control command:
`SOUR:FSIM:BIRT:PATH2:PROF?`
Response: `'PDOP'`

Path Loss Birth Death - Fading

Enters the loss for the selected path.

Remote-control command:
`SOUR:FSIM:BIRT:PATH2:LOSS 2dB`

Min Delay Birth Death - Fading

Enters the minimum delay for the two fading paths.

The minimum delay corresponds to the start value of the delay range.

The delay range is defined by the minimum delay, the delay grid and the number of possible hop positions. It can be in the range between 0 and 40 µs.

0 µs < (Positions – 1) x Delay Grid + Min. Delay < 40 µs

The scaling of the X-axis is adapted according to the entry (see following section "*Birth Death Propagation Path Graph - Fading*").

Invalid entries are rejected, the next possible value is entered.

Remote-control command:
`SOUR:FSIM:BIRT:DEL:MIN 6E-6`

Delay Grid Birth Death - Fading

Enters the delay grid. The value defines the resolution for the possible hop positions of the two fading paths in the delay range.

The scaling of the X-axis is adapted according to the entry (see following section "*Birth Death Propagation Path Graph - Fading*").

Invalid entries are rejected, the next possible value is entered.

Remote-control command:
`SOUR:FSIM:BIRT:DEL:GRID 2E-6`

Positions Birth Death - Fading

Enters the number of possible hop positions in the delay range.

The scaling of the X-axis is adapted according to the entry (see following section "*Birth Death Propagation Path Graph - Fading*").

Invalid entries are rejected, the next possible value is entered.

Remote-control command:
`SOUR:FSIM:BIRT:POS 9`

Maximum Delay Birth Death - Fading

Indication of the maximum delay. The maximum delay corresponds to the stop value of the delay range (see following section *"Birth Death Propagation Path Graph - Fading"*).

The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

Max Delay = (Positions – 1) x Delay Grid + Min. Delay

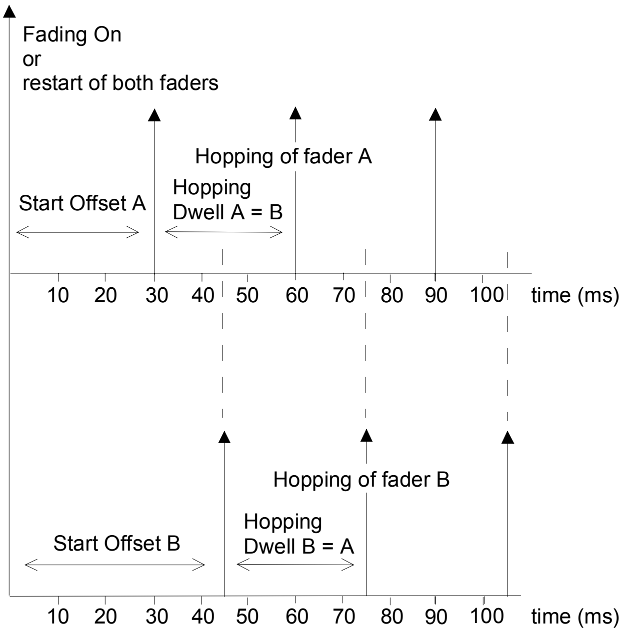
Remote-control command:
`SOUR:FSIM:BIRT:DEL:MAX`
Response: `0.000022`

Start Offset Birth Death - Fading

Enters the timing offset by which the start of **Birth Death Propagation** is offset with respect to when fading is switched on or a restart as a result of a restart trigger.

This allows the user to precisely displace birth death events with respect to one another during two-channel fading. This is required in some 3GPP base station tests.

If the same hopping dwell time is entered in both faders, the offset will take place by a constant value (see figure).

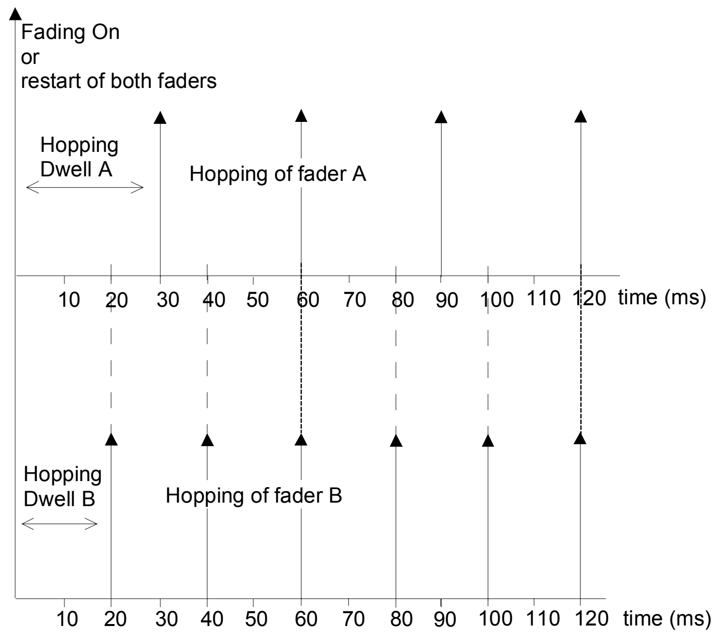


Remote-control command:
`SOUR:FSIM:BIRT:SOFF 30E-3`
`SOUR2:FSIM:BIRT:SOFF 45E-3`

Hopping Dwell Birth Death - Fading

Enters the time until the next change in the delay of a path (birth death event).

During two-channel fading, the dwell times of the two channels can be set independently. This causes the hop time points of the two channels to coincide repeatedly. This is a way of simulating tough receiving conditions as arise when two receiving channels simultaneously change frequency (see figure).



Remote-control command:
`SOUR:FSIM:BIRT:HOPP:DWEL 30 ms`
`SOUR2:FSIM:BIRT:HOPP:DWEL 45 ms`

Speed Birth Death - Fading

Enters the speed **v** of the moving receiver. The unit for entering the speed under **Speed Unit** can be chosen in the upper section of the menu.

Based on the speed v and the virtual RF frequency f_{RF}, the Doppler shift f_D is computed.

$$c = 2.998 \cdot 10^8 \, m/s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

Example:

v = 100 km/h; $\mathbf{f_{RF}}$ = 1 GHz : $\mathbf{f_D}$ = 92.66 Hz

Remote-control command:
`SOUR:FSIM:BIRT:SPE 100`

Frequency Ratio Birth Death - Fading

Enters the ratio of the actual Doppler shift to the Doppler shift set with the **Speed** parameter.

Remote-control command:
`SOUR:FSIM:BIRT:FRAT 0.15`

Resulting Doppler Shift Birth Death - Fading

Displays the actual Doppler shift.

The actual Doppler frequency is determined by the entered **Speed** and the entered ratio of the actual Doppler frequency to the set Doppler frequency (**Frequency Ratio**).

Remote-control command:
`SOUR:FSIM:BIRT:FDOP?`

Birth Death Propagation Path Graph - Fading

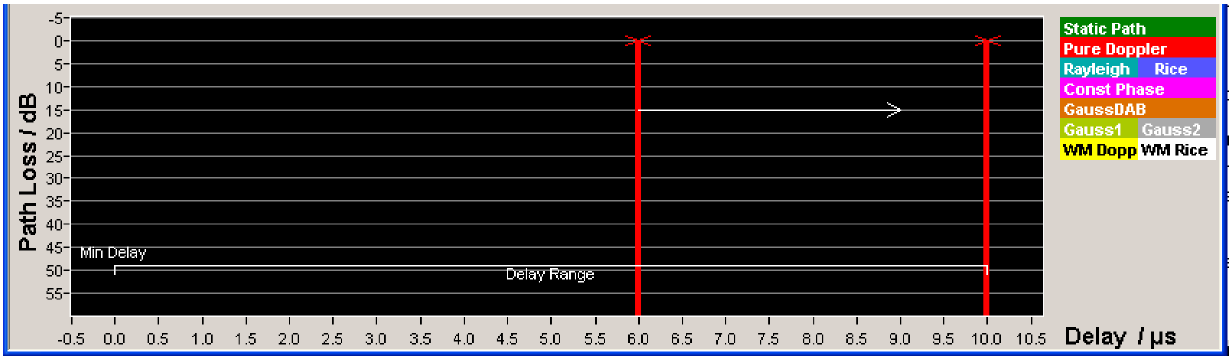
The graphical display of the fading paths in Birth Death Propagation mode shows as an example the changing positions of the two paths within the delay grid. The displayed position change does not correspond to the actual delay hops of the real signal. An arrow indicates the direction of the delay hop of the path that will next change its position, with the head of the arrow marking the new position.

The delay grid is plotted on the X axis. The permissible delay range is shown in the graphics. The path power is plotted on the Y axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.

The scaling of the x-axis depends on the set delay range. It always starts at 0 µs and rages up to 40 µs at the most (= maximum for delay range). The minimum delay corresponds to the start value of the delay range. The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

Max Delay = (Positions – 1) x Delay Grid + Min. Delay

The (mean) delay offset is calculated from the minimum and maximum delay ((max. delay - min. delay)/2).

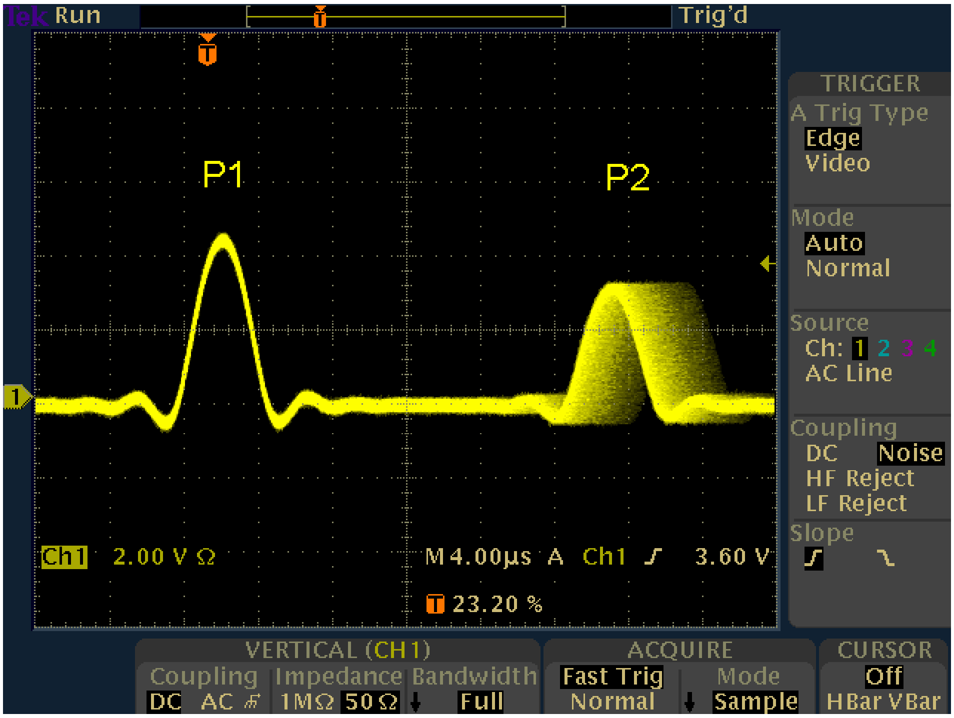


Remote-control command: n.a.

Moving Propagation Path Table - Fading

In the **Moving Propagation** configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-xxx, annex B3. Here, the behavior of a receiver is tested in response to slow delay variations in a signal. Two paths are simulated: Path 1 has fixed delay (Reference Path, P1), while the delay of path 2 varies slowly in a sinusoidal fashion (Moving Path, P2). The two paths have no fading profile. They have the same level, the same phase and no Doppler shift.

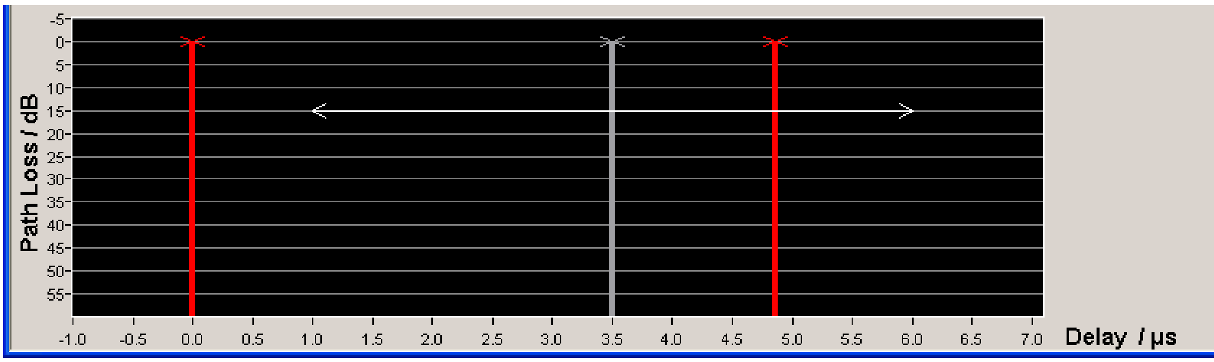
The following figure illustrates a baseband signal with ASK modulation (only one 1 bit, then many 0 bits) which was subjected to moving propagation. Path P1 remains still while path P2 moves in time relative to it. As a result of the luminescence setting on the oscilloscope, the way in which P2 wanders over time is clearly visible.



The **Path Graph** is shown below the path table.

The graphical display of the fading paths in Moving Propagation mode shows as an example the changing positions of the moving path with respect to the stationary reference path. The displayed position change does not correspond to the actual delay changes of the real signal.

The delay grid is plotted on the X axis. The permissible delay range for the moving path is shown in the graphics by the horizontal arrow. The grey path indicates the set start delay for the Moving Path. The path power is plotted on the Y axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.



The delay Δt of the moving path obeys the following equation:

$$\Delta\tau = \left(DELAY + \frac{VARIATION(Pk\ Pk)}{2} \left(\sin\left(\frac{2\pi \cdot t}{VARIATION\_PERIOD}\right) \right) \right)$$

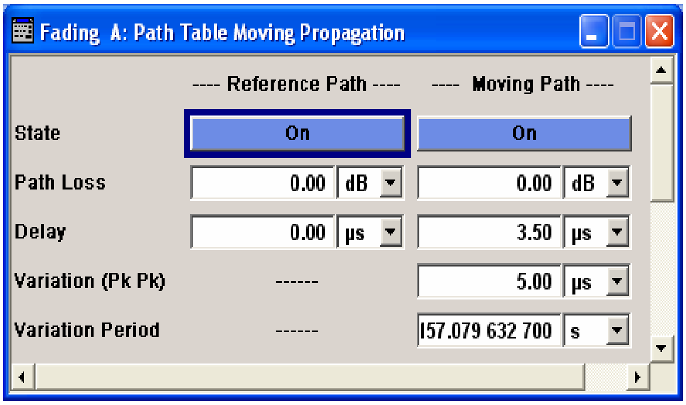
Note:

The values relate to the values proposed in the test case 3GPP, 25.104xxx, annex B3 as follows:
VARIATION(Pk Pk) = A
DELAY = B + A/2
VARIATION_PERIOD = 2 x π /Δ ω'

The settings required to attain the values proposed in the test case 3GPP, 25.104xxx, annex B3 are given in the following table.

Reference Path:	**Delay:**	0 µs
	Path Loss:	0 dB
	State:	On
Moving Path:	**Variation (Pk Pk)**	5 µs
	Variation Period:	157 s
	Delay	3.5 µs
	Path Loss	0 dB
	State:	On

These values are the default values for Moving Propagation. However, these parameters can also be set for further tests in the fading path table.



State Moving Propagation - Reference Path - Fading

Activates reference path P1 for moving propagation.

Remote-control command:
`SOUR:FSIM:MDEL:REF:STAT ON`

Path Loss Moving Propagation - Reference Path - Fading

Enters the loss for the reference path.

Remote-control command:
`SOUR:FSIM:MDEL:REF:LOSS  12 dB`

Delay Moving Propagation - Reference Path - Fading

Enters the delay for the reference path.

Remote-control command:
`SOUR:FSIM:MDEL:REF:DEL 1E-6`

State Moving Propagation - Moving Path - Fading

Activates moving fading path P2 for moving propagation.

Remote-control command:
`SOUR:FSIM:MDEL:MOV:STAT ON`

Path Loss Moving Propagation - Moving Path - Fading

Enters the loss for the moving fading path.

Remote-control command:
`SOUR:FSIM:MDEL:MOV:LOSS  12 dB`

Delay Moving Propagation - Moving Path - Fading

Enters the average delay for the moving fading path.

The delay of the moving path slowly varies sinusoidally within the set variation range around this delay.

Remote-control command:
`SOUR:FSIM:MDEL:MOV:DEL:MEAN?`

Variation Moving Propagation - Moving Path - Fading

Enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidally within this range around the set mean delay.

Remote-control command:
`SOUR:FSIM:MDEL:MOV:DEL:VAR 5E-6`

Variation Period Moving Propagation - Moving Path - Fading

Period duration for delay variation. A complete variation cycle is passed through in this time.

Remote-control command:
`SOUR:FSIM:MDEL:MOV:VPER 157 s`

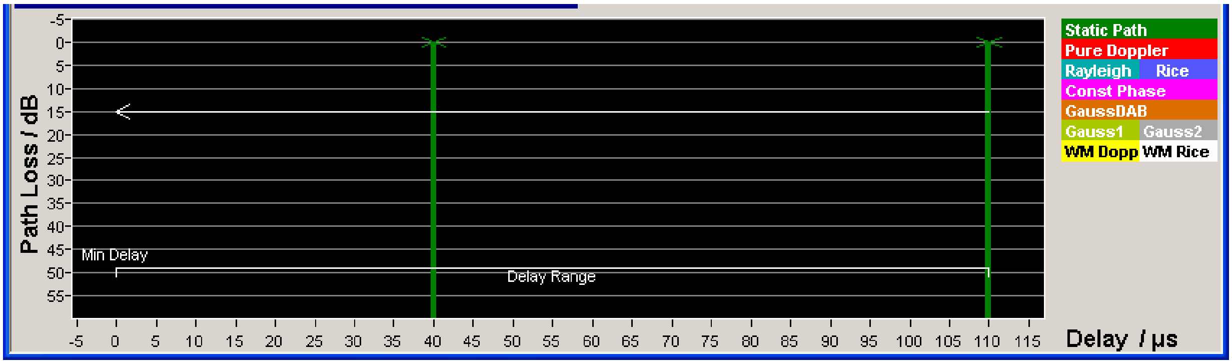
2 Channel Interferer Path Table - Fading

In the **2 Channel Interferer** configuration, the fading simulates dynamic propagation in conformity with the test cases 5 and 6 from MediaFlo. Here, path 1 has a fixed delay while the delay of path two either varies slowly in a sinusoidal way or appears in alternation at arbitrary points in time. Thus 2 channel interferer fading can be considered as a combination of birth death propagation fading and moving propagation fading. The main difference is the broader range of propagation obtainable with 2 channel interferer fading.

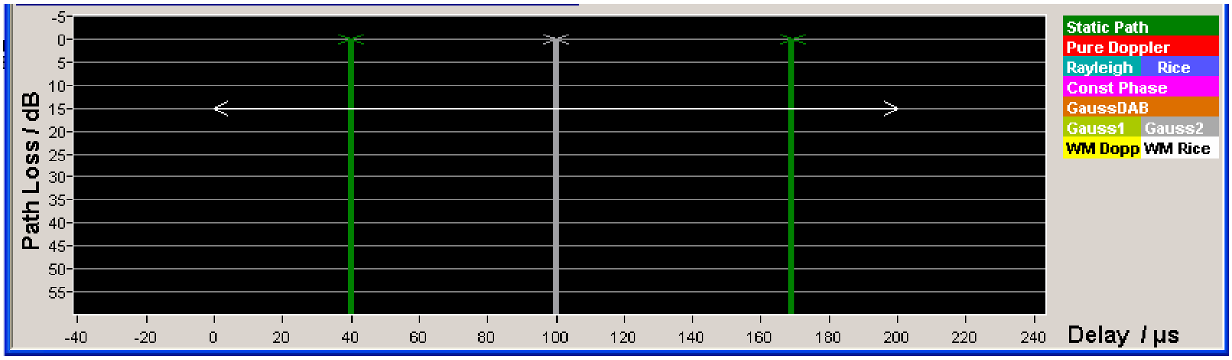
Different fading profiles (**Static Path**, **Pure Doppler**, and **Rayleigh**) can be allocated to the two path.

The following path graph shows an example with the following settings for moving mode **Hopping**:

Reference Path:	**Delay Min:**	30 µs
	Profile:	Static Path
	Path Loss	0 dB
Moving Path:	**Delay Min**	30 µs
	Profile:	Static Path
	Path Loss	0 dB
	Delay max:	100 µs
	Moving Mode:	Hopping



The following graph shows the same setting with moving mode **Sliding**:



The moving path slides from the minimum delay (30 µs) to the maximum delay (100 µs) and back. The mean delay of the moving path (65 µs) is indicated as a gray bar. The permissible delay range for the moving path is shown in the graphics by the horizontal arrow.

The displayed position change does not correspond to the actual delay changes of the real signal.

The settings required to attain the values proposed in the MediaFlo test case 5 and 6 are given in the following table:

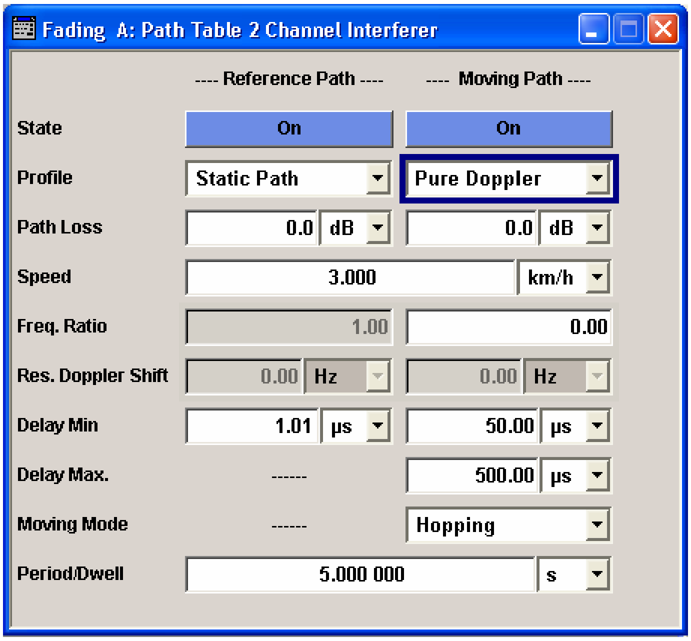
Test Case 5

Reference Path:	**Profile:**	Static Path
	Relativ Delay	10 µs
	Average Power	-3 dB
	Fading Type	Rayleigh, 60 km/h
	Doppler Spectrum	Classic 6 dB
	Static Delay	40 µs
Moving Path:	**Profile:**	Hopping
	Relativ Delay	0/110 µs
	Average Power	-3 dB
	Fading Type	Static
	Doppler Spectrum	N/A
	Dwell Time	2.9 s

Test Case 6

Reference Path:	**Profile:**	Static Path
	Relativ Delay	100 µs
	Average Power	-3 dB
	Fading Type	Static
	Doppler Spectrum	N/A
Moving Path:	**Profile:**	Sliding
	Relativ Delay	0/200 µs
	Average Power	-3 dB
	Fading Type	Rayleigh, 3 km/h
	Doppler Spectrum	Classic 6 dB
	Period	160 s

These values are the default values for 2 Channel Interferer. However, these parameters can also be set for further tests in the fading path table.



State 2 Channel Interferer - Fading

Activates/deactivates either the reference path or the moving path for 2 channel interferer fading.

Remote-control command:
`SOUR:FSIM:TCI:REF:STAT ON`

Profile 2 Channel Interferer - Fading

Selects the fading profile either for the reference path or the moving path to be used for 2 channel interferer fading.

Remote-control command:
`SOUR:FSIM:TCI:REF:PROF SPAT`

Path Loss 2 Channel Interferer - Fading

Sets the attenuation of either the reference path or moving path to be used for 2 channel interferer fading.

Remote-control command:
`SOUR:FSIM:TCI:REF:LOSS 0`

Speed 2 Channel Interferer - Fading

(Rayleigh only)

Enters the speed **v** of the moving receiver. The unit for entering the speed under **Speed Unit** can be chosen in the upper section of the menu.

Based on the speed v and the virtual RF frequency f_{RF}, the Doppler shift f_D is computed.

$$c = 2.998 \cdot 10^8 \, m / s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

Example:

v = 100 km/h; $\mathbf{f_{RF}}$ = 1 GHz : $\mathbf{f_D}$ = 92.66 Hz

The resulting Doppler shift is dependent on the speed **v** and the entered ratio of the actual Doppler shift to the set Doppler shift $\mathbf{f_D}$. This ratio is determined in the **Frequency Ratio** line. The resulting Doppler frequency can be read off from the **Res. Doppler Shift** line. It may not exceed the maximum Doppler frequency of 1600 Hz.

If the speed is changed, the resulting Doppler shift is automatically modified.

Remote-control command:
`SOUR:FSIM:TCI:SPE 300`

Freq. Ratio 2 Channel Interferer Path - Fading

Enters the ratio of the actual Doppler shift to the Doppler shift set with the **Speed** parameter.

Remote-control command:
`SOUR:FSIM:TCI:FRAT 1`

Res. Doppler Shift 2 Channel Interferer - Fading

Displays the actual Doppler shift.

The actual Doppler frequency is determined by the entered **Speed** and the entered ratio of the actual Doppler frequency to the set Doppler frequency (**Frequency Ratio**).

Remote-control command:
`SOUR:FSIM:TCI:REF:FDOP?`

Delay Min 2 Channel Interferer - Fading

Enters the minimum delay for either the reference path or the moving path.

The minimum delay of the moving path corresponds to the start value of the delay range.

The delay range is defined by the minimum delay and the maximum delay. It can be in the range between 0 and 1000 µs.

The scaling of the X-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote-control command:
`SOUR:FSIM:TCI:REF:DEL:MIN 200`

Delay Max 2 Channel Interferer - Moving Path - Fading

Enters the maximum delay for the moving path.

The maximum delay of the moving path corresponds to the end value of the delay range.

The delay range is defined by the minimum delay and the maximum delay. It can be in the range between 0 and 1000 µs.

The scaling of the X-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote-control command:
`SOUR:FSIM:DEL:MAX 500`

Moving Mode 2 Channel Interferer - Moving Path - Fading

Selects the Type of moving applied to the moving path.

Sliding

The reference path has a fix delay while the delay of the moving path varies slowly in a sinusoidal way.

Remote-control command:
`SOUR:FSIM:TCI:MMOD:SLID`

Hopping

The reference path has a fix delay while the delay of the moving path appears or disappears in alternation at arbitrary points in time.

Remote-control command:
`SOUR:FSIM:TCI:MMOD:HOPP`

Period Dwell 2 Channel Interferer - Fading

Enters either the dwell time or the period of a complete cycle for the moving path depending on the setting in the **Moving Mode** field: If the moving mode is set to **Sliding**, the period for a complete cycle of the moving path can be set here. If the moving mode is set to **Hopping**, the dwell time of the moving path can be set here.

The gradient of the delay/period ratio may not fall und 6 us/s, that is, the minimum value of the period depends on the value of the delay.

If the value for the delay is increased in a way that the value for the gradient falls below 6us/s, the value for the period is recalculated automatically.

Example:

Delay min = 20 us, Delay max 120 us

6 ≥ ((Delay max - Delay min)/2) x 2 x π)/T

6 ≥ 314us/T

T ≥ = 314/6

T is set to 52,33 s. The value of T can not be decreased below this value.

Note:
This recalculation of the period is a very computing power consumptive process. Therefore, no further operations should be performed until the calculation is finished.

Remote-control command:
`SOUR:FSIM:TCI:PER 50`

Insertion Loss Configuration ... - Fading

The menu for setting the insertion loss is called in the **Fading** menu.

The fading process increases the crest factor of the signal, and this increase must be taken into account in the drive at the baseband level.

The crest factor gives the difference in level between the peak envelope power (PEP) and average power value (RMS) in dB. A higher crest factor can be achieved by either increasing the peak value or decreasing the RMS value. As the peak value is always kept as close as possible to the full drive level (multiplier peak ≈ 1), fading reduces the RMS value by the additional crest factor due to fading (multiplier RMS < 1). The insertion loss is determined from the ratio of these two multipliers. The crest factor of the signal at the fader output is derived from the crest factor of the signal at the fader input and the insertion loss. The output power is set using this crest factor.

Signal generation →	**Fading** →	**Resulting signal**
Crest factor a = Peak value a / RMS value a	Insertion loss = Multiplier peak / Multiplier RMS	Crest factor b = Peak value b / RMS value b = Crest factor a x Insertion loss

If one of the available standards/test cases is selected, the optimal range for adapting the insertion loss is set.

In the case of a user-defined fading configuration, the mode with which the insertion loss range is determined can be selected.

In **Normal** mode, the insertion loss is set so that normally full drive does not occur, which avoids any clipping of the signal at the maximum level. The signal quality is very high, but the RMS level is lower than the maximum possible level. If a higher dynamic range is required (e.g. for adjacent channel measurements = ACP), a lower insertion loss can be selected (**Low ACP** mode). In that case, a higher level relative to the maximum drive is output (greater S/N ratio). However, this will decrease the signal quality because of a higher percentage of clipping. **Low ACP** mode is only recommended for fading paths with Raleigh profile as only in this case statistical distribution of level fluctuation is ensured. For other fading profiles, non-statistical level fluctuations occur which lead to an enormous increase of clipping. However, monitoring the percentage of clipped samples is recommended for Raleigh paths also.

Since it is possible to manually enter the insertion loss, the user can find a favorable **Insertion Loss** setting with the desired signal dynamic range and acceptable clipping rate for any application (**User** mode).

This is supported by displaying the current percentage of clipped samples.

The output level is always automatically adapted, regardless of the selected mode and the path loss settings, so that the set level is output as the summed level (RMS) of all paths.

The correct automatic adaptation of the insertion loss is possible only if the processes involved in fading (the paths among themselves as well as the paths relative to the input signal) are statistically independent of each other. If correlations occur, the output level must be measured again and perhaps manually taken into account as a level offset.

Examples:

Correlated processes resulting from the modulation signal used and the configuration of the fader:

A QPSK signal with a symbol rate of 1 Msymb/s is generated, using the PRBS9 sequence as the data source.

Two paths are set with a Rayleigh profile, identical speed and a resulting delay of 0 µs and 1 µs, respectively, on the fader.

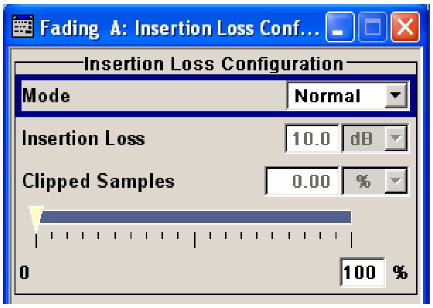
The symbol rates of the modulation signal are in the range of the delay differences of the fading paths; the autocorrelation of the modulation data (PRBS9) to the adjacent symbol is not equal to 0. The fading process is therefore statistically not independent of the process of generating the modulation signal, and an error occurs in the automatic calculation of the insertion loss.

Correlated processes within the fader:

Two paths have a pure doppler profile and a resulting doppler shift of 100 Hz. The start phases of the two paths differ.

This causes superimpositions, which can result in the deletion of the signal, e.g. with a phase setting of 0° and 180°; automatic calculation of the insertion loss is not possible.

The settings are summarized in the **Insertion Loss Configuration** section.



Insertion Loss Mode - Fading

Sets the mode for determining the insertion loss.

Mode Normal

The insertion loss for a path of the fading simulator is automatically chosen so that even when lognormal fading is switched on, overdrive will occur only very rarely in the fading simulator. This setting is recommended for bit error rate tests (BERTs).
The current insertion loss is displayed under **Insertion Loss**.

Remote-control command:
`SOUR:FSIM:ILOS:MODE NORM`

Mode Low ACP

The insertion loss is automatically chosen so that an overdrive will occur with an acceptable probability. **Low ACP** mode is only recommended for fading paths with Raleigh profile as only in this case statistical distribution of level fluctuation is ensured. For other fading profiles, non-statistical level fluctuations occur which lead to an enormous increase of clipping. However, monitoring the percentage of clipped samples is recommended for Raleigh paths also.
The current insertion loss is displayed under **Insertion Loss**.

Remote-control command:
`SOUR:FSIM:ILOS:MODE LACP`

Mode User

Any value for the minimum insertion loss in the range from 0 dB to 18 dB can be selected. Desired value is entered under **Insertion Loss**.

This mode is provided to ensure optimization of the dynamic range and signal quality for any application. Display of the clipping rate for any value which is entered enables estimation of the signal quality for the specified signal dynamic range.

Remote-control command:
`SOUR:FSIM:ILOS:MODE USER`

Insertion Loss - Fading

Displays the current insertion loss in the **Normal** and **Low ACP** modes.

Entry of the insertion loss in **User** mode.

Remote-control command:
`SOUR:FSIM:ILOS 4 dB`

Clipped Samples - Fading

Displays the samples whose level is clipped as a %.

If the full drive level is reached for an insertion loss which is too low, the I/Q signals are limited to the maximum available level (clipping).

Remote-control command:
`SOUR:FSIM:ILOS:CSAM?`
Response: `'0'`

0 ... 100 %

Graphically displays the samples whose level is clipped as a %. The scale resolution is determined by entering the maximum value as a %.

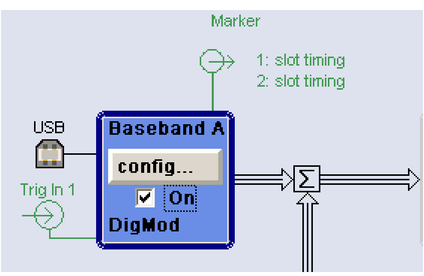
Baseband Signal - Baseband

Introduction - Baseband Signal

The R&S AMU 200A Baseband Signal Generator and Fading Simulator provides you with the ability to generate digital modulation signals in accordance with the definitions in the digital standards or with user-definable characteristics. Signals are generated in realtime or from a data store with the aid of external and internal data. You can also load externally computed modulation signals into the R&S AMU in the form of waveform files.

Several digital standards are provided, plus digital modulation with user-definable signal characteristics, generation of waveforms with the aid of the Arbitrary Waveform Generator and generation of multicarrier CW signals with the aid of Multicarrier CW.

The settings for digital modulation can be accessed in the block diagram via the "**Baseband**" function block or with the aid of the MENU key.



The equipment layout for generating the internal, digital modulation signals includes the options Baseband Main Module (B13)) and one of the options Baseband Generator (B9/B10/B11)).The three Baseband Generator options feature different ARB memory sizes (see data sheet). Apart from the memory size, however, the options offer the same functionality, either one can be installed.

In addition, the appropriate option is required for the digital standards. These options are specified in the description of the respective standard.

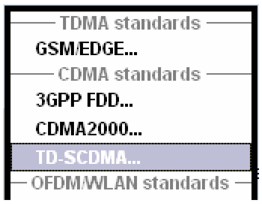
The minimum equipment for a two-path instrument is a second R&S AMU-B9/B10/B11 option. This can be used simultaneously on the second path to generate a modulation signal which can either be routed via path A or added to the signal on path A with a frequency offset that can be set. In the case of a fully two-path layout path B can be operated as a second signal generator independently of path A (see chapter 2, '*Getting Started*', and data sheet).

If the appropriate options are fitted, externally supplied real-time baseband signals can be added to the internally generated signals.

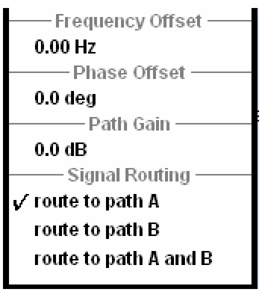
In the subsequent signal route the baseband signals can be frequency-shifted, faded, detuned or loaded with noise (see sections *External Baseband Signal - Baseband Input*, "*Fading Simulation - Fader Block*" *Menu Impairment Settings*" and "*Noise generator - AWGN*").

Signal Routing and Frequency Shifting

In the case of two-path instruments, signal routing, frequency offset and path gain definition are defined at the topmost menu level in the **Baseband** block or by using the MENU button under **Baseband**.



The upper part of the **Baseband** menu is used for selecting digital standards, digital modulation and waveform generation. These menus are described in the respective chapters relating to the modulation systems.



The lower part of the **Baseband** menu can be used to define a frequency offset a path gain, a phase offset, and the signal routing for two-path instruments.

The **Frequency Offset** section is used to enter the frequency offset.

Frequency Offset - Baseband

Enters the frequency offset for the baseband signal.

The offset affects the signal on the **Baseband block** output**.** It shifts the useful baseband signal in the center frequency.

Note:

For sample rates of exactly 100 MHz it is not possible to enter a frequency offset. The digital signal is fed into the signal path directly and not routed to the resampler where the frequency offset takes place. This type of entry is also prohibited if the noise generator (AWGN block) is on.

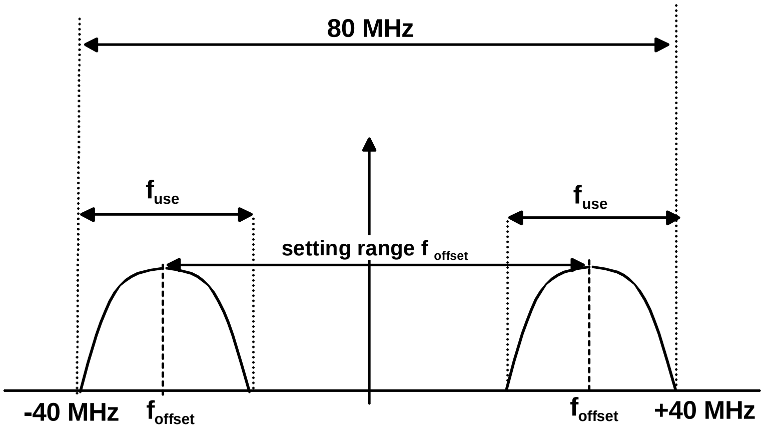
The complex I/Q bandwidth of the shifted useful signal must not exceed 80 MHz in total. The following applies:

$$f_{offset} - {}^{f_{use}}\!/_{2} \geq -{}^{80}\!/_{2}\,MHz \quad \text{and} \quad f_{offset} + {}^{f_{use}}\!/_{2} \leq +{}^{80}\!/_{2}\,MHz$$

f_{use} = the complex useful bandwidth of the I/Q signal before the offset.

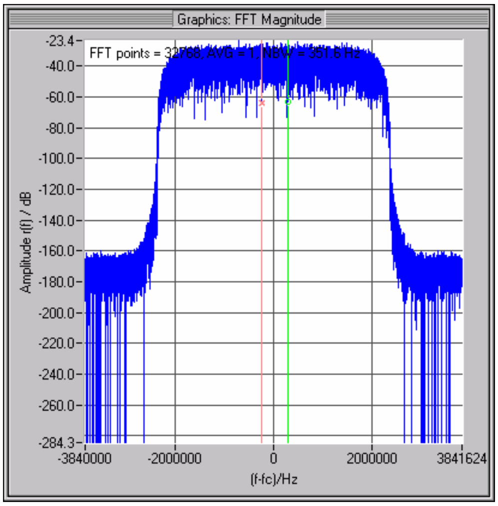
f_{offset} = frequency offset.

The following graph illustrates the setting range for the frequency offset.



Example:

3GPP FDD signal (chip rate 3.84 Mcps, root-cosine filter 0.22).



The complex useful bandwidth of a signal which has been filtered using a root-cosine filter with roll off α is calculated as follows:

$$f_{use} = (1+\alpha) * f_{symbol}$$

f_{symbol} = the symbol rate or chip rate of the signal.

In the example the complex useful bandwidth is calculated as follows:

F_{use} = (1+ 0.22) * 3.84 MHz = 4.6848 MHz.

So as to comply with the condition requiring a maximum I/Q bandwidth of 40 MHz, the valid range of values for the frequency offset is then:

$$-40\text{MHz} + \frac{4.6848\text{ MHz}}{2} \le f_{offset} \le 40\text{MHz} - \frac{4.6848\text{ MHz}}{2} =$$

$$-35.3152\text{MHz} \le f_{offset} \le 35.3152\text{MHz}$$

In the case of ARB signals, the output clock rate can be used for estimating the maximum I/Q bandwidth of the waveform.

Remote-control command:
`SOUR:BB:FOFF 2MHZ`

The **Phase Offset** section is used to enter the relative path gain.

Phase Offset - Baseband

Enters the phase offset for the baseband signal of the selected path compared to the baseband signal of the other path and/or of the external baseband input.

The gain affects the signal on the **Baseband block** output.

Remote-control command:
`SOUR:BB:POFF 0.4DEG`

The **Path Gain** section is used to enter the relative path gain.

Path Gain - Baseband

Enters the path gain for the baseband signal of the selected path compared to the baseband signal of the other path and/or of the external baseband input.

The gain affects the signal on the **Baseband block** output.

The **Path Gain**s of the different baseband sources (Baseband Input, Baseband A and Baseband B) define the relative gain of the associated signals. The real gain depends on the following parameters along with the set path gain:

- Signal characteristics, in particular the crest factor
- Number of baseband sources
- Overall output level.

The sum baseband signal can be verified in the spectrum display in the **Graphics** block.

Remote-control command:
`SOUR:BB:PGA 2 dB`

The **Signal Routing** section is used to define the signal route for two-path instruments.

Signal Routing - Baseband

Selects the signal route for the baseband signal of a two-path instrument. The following table shows the combination of signal routes allowed for two-path instruments.

Route to path A
The baseband signal is introduced into path A. The signals from both paths are summed if necessary.

Remote-control command:
`SOUR:BB:ROUT A`

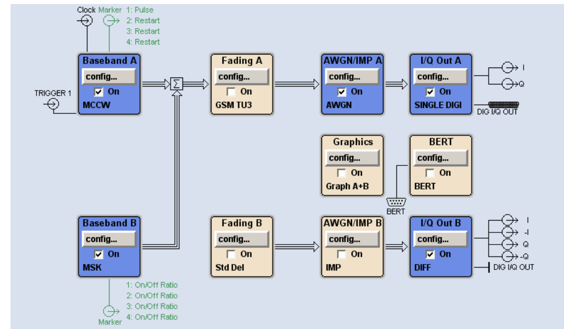
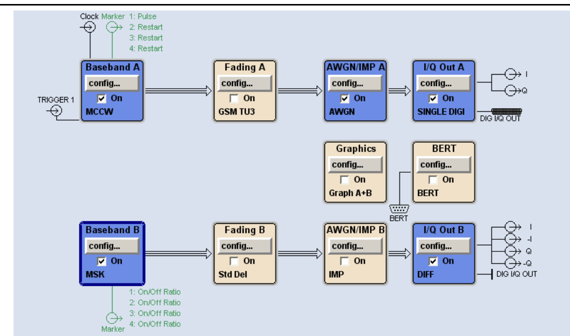
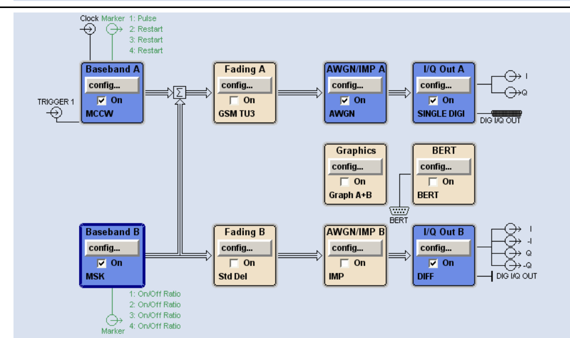
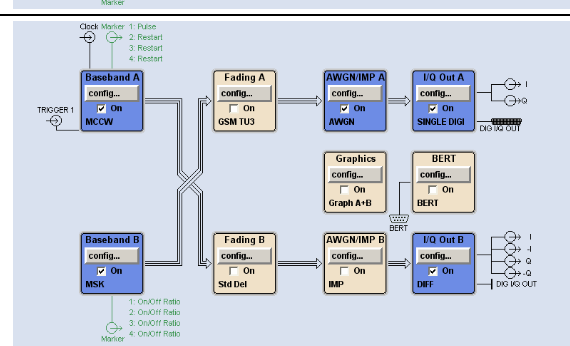
Route to path B
The baseband signal is introduced into path B. The signals from both paths are summed if necessary.

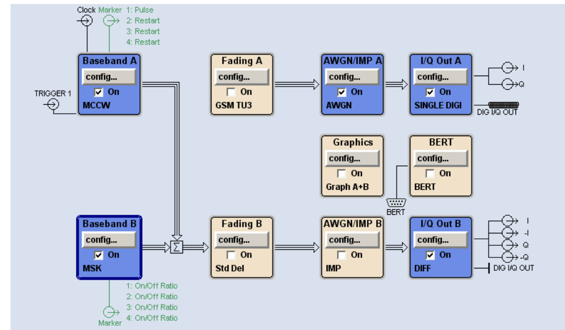
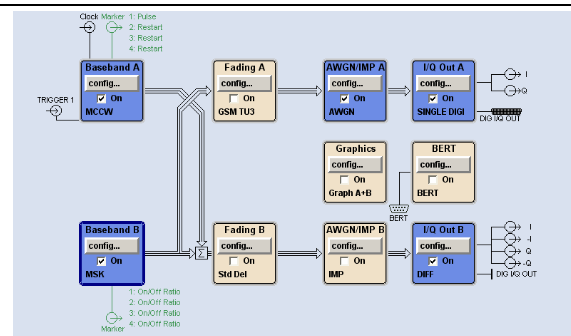
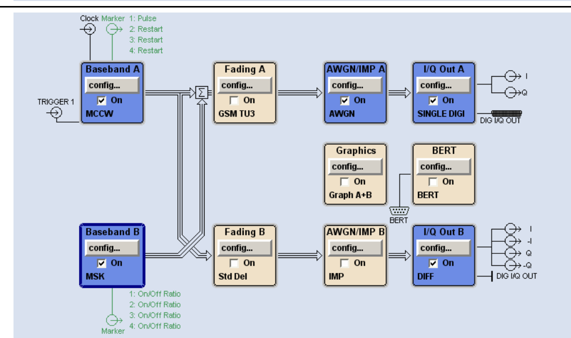
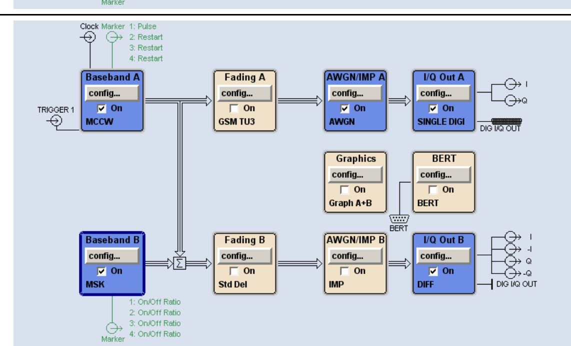
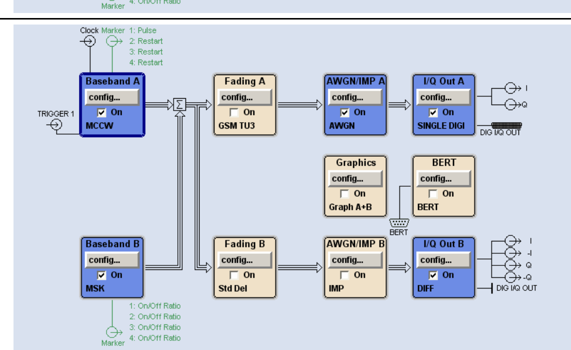
Remote-control commands:
`SOUR:BB:ROUT B`

Route to path A and B
The baseband signal is introduced into path A and path B. The signals from both paths are summed if necessary.

Remote-control command:
`SOUR:BB:ROUT AB`

Combinations of signal routings for two-path instruments

Routing baseband A	Routing baseband B	Block diagram
Route to path A	Route to path A	
Route to path A	Route to path B	
Route to path A	Route to path A and B	
Route to path B	Route to path A	

Routing baseband A	**Routing baseband B**	**Block diagram**
Route to path B	Route to path B	
Route to path B	Route to path A and B	
Route to path A and B	Route to path A	
Route to path A and B	Route to path B	
Route to path A and B	Route to path A and B	

Data and Signal Sources in Baseband

This section describes the common characteristics of the signals used for generating the baseband signal for all standards, including for example all listed data sources. The selection in the digital menus at any given time depends on the parameter and standard concerned and is clear from the selection list offered in the menu. The external data sources may therefore not be available in certain cases.

Characteristics which are uniquely specific to particular standards are described in relation to the menu concerned.

***Note**:*
Externally generated analog baseband signals can be fed into the digital signal path via the analog I/Q input I IN and Q IN (option Baseband Input, R&S AMU-B17)

The following input signals are used when digital modulation signals are being generated:

- Modulation data
- Clock signals
- Control signals

The input signals can be both internally generated and supplied from an external source. The internally generated data and clock signals are output not only on the DATA and Clock connectors but also on the corresponding pins of the AUX I/O interface.

In the case of two-path instruments, the external data and clock sources are permanently allocated to path A, and data output is always for path A.

Clock signals for both paths can be internally generated or supplied from an external source. When the external clock source is selected, the externally supplied clock signal always applies to both paths simultaneously.

Likewise control signals and also trigger signals for triggering signal generation in the R&S AMU can be internally generated or supplied from an external source.

Up to four marker output signals for synchronizing external instruments can be user-defined for each path.

Externally computed waveform files can be loaded via one of the computer interfaces (USB - memory stick, or Ethernet interface - network drive) or via the IEC bus in the instrument and generated with the aid of the Arbitrary Waveform Generator (ARB, see section "*Arbitrary Waveform Generator ARB*", page 4.213). Internally the **Multicarrier CW** menu for defining multicarrier waveforms is available (see section "*Multicarrier Continuous Wave*", page 4.250).

Internal PRBS Data and Data Patterns

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.

By way of example, the diagram below shows a 9-bit generator with feedback to registers 4 and 0 (output).

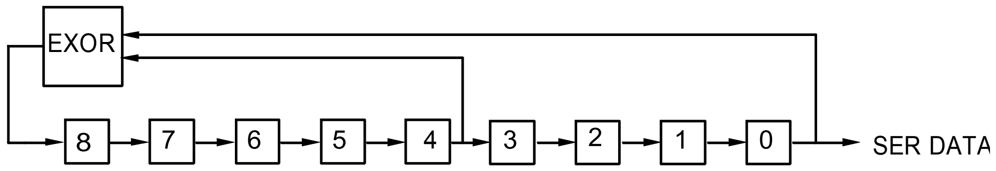
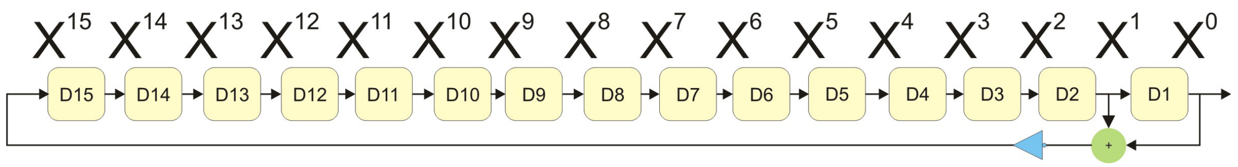


Fig. 4-1 9-bit PRBS generator

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



The pseudo-random sequence from a PRBS generator is uniquely defined by the register number and the feedback. The following table describes all the available PRBS generators:

Table 4-1 PRBS generators

PRBS generator	Length in bits	Feedback to	Menu selection
9-bit	2^9 -1 = 511	Registers 4, 0	PRBS 9
11-bit	2^{11} -1 = 2047	Registers 2, 0	PRBS 11
16-bit	2^{16} -1 = 65535	Registers 5, 3, 2, 0	PRBS 16
20-bit	2^{20} -1 = 1048575	Registers 3, 0	PRBS 20
21-bit	2^{21} -1 = 2097151	Registers 2, 0	PRBS 21

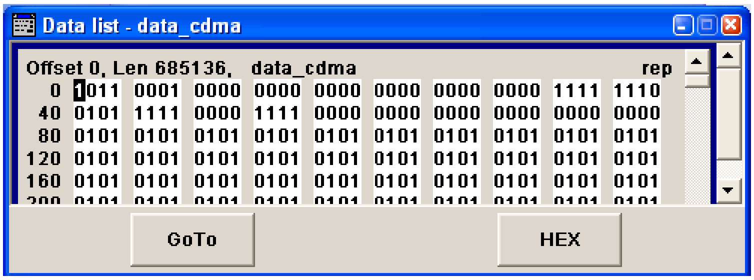
The **Data Source** selection for PRBS data from the menus is **PN09, ...**

Simple data patterns such as binary 0 strings or 1 strings can also be used as internal modulation data. The **Data Source** selection from the menus is **ALL 0**, **ALL1**. A variable bit string with a maximum length of 64 bits can be entered in an input field by selecting **Pattern**.

Internal Modulation Data from Lists

Internal modulation data can be generated and stored in the form of binary lists. A separate file is created for each list and held on the R&S AMU hard disk. The file name can be defined by the user.

The **Data Source** selection from the menus is **Data List**. When this menu item is chosen the **Select Data List** button appears; this opens the file-selection window for data lists. A list can be created and edited in the **Data List Editor**, which is accessed from the menu via the **List Management** or **Data List Management** button.



The maximum length of a data list is determined by the size of the data list memory (see data sheet). There is no restriction on the number of lists that can be stored.

External Synchronous Modulation Data

External Serial Modulation Data via the DATA Connector

For **Custom Digital Modulation**, serial modulation data can be supplied bit-by-bit via the DATA connector. The **Data Source** selection from the menu is **Extern Serial**. In the case of two-path instruments the DATA input is permanently allocated to path A.

In the case of modulation modes with more than 1 bit/symbol, the most significant bit (MSB) must be fed in first (MSB first).

The clock reference (symbol clock) used to read in the data can be either internal or external.

External serial data is output on the PARDATA pins of the AUX I/O interface as parallel data LSB-justified.

The maximum data rate for serial data processing can be found in the data sheet.

External Parallel Modulation Data via the AUX I/O Interface

For **Custom Digital Modulation**, parallel data can be supplied symbol-by-symbol via the AUX I/O interface (D0 – D9). The **Data Source** selection from the menu is **Extern Parallel**. In the case of two-path instruments the data lines from the AUX I/O interface are allocated to path A permanently.

In the case of modulation modes with fewer than 10 bits/symbol, the data must be applied LSB-justified. In the case of 8-PSK modulation for example (3 bits/symbol) only data lines D0, D1 and D2 are used.

The clock reference (symbol clock) used to read in the data can be either internal or external.

External parallel data is output on the DATA connector serially. However, there is a maximum data rate above which serial data processing becomes impossible and the DATA connector becomes high-impedance. The maximum data rate for parallel data processing is shown in the data sheet.

Clock Signals

The clock reference used for generating the timing pulse can be either internal or external (**Clock Source** selection from the menu: **Internal** / **External**).

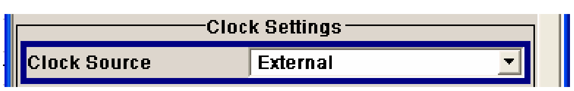
Internal clock reference

When the internal clock reference is selected, the clock signals generated by the R&S AMU are output on the following connectors:

CLOCK (front panel)	Bit clock
CLOCK OUT (rear panel)	Choice of bit clock or symbol clock
BITCLK (AUX I/O interface, rear panel)	Bit clock
SYMBCLK (AUX I/O interface, rear panel)	Symbol clock

If required, in the case of two-path instruments the internal bit clock or symbol clock from path B can be output on one of the USER interfaces. The clock output signals are assigned in the menu sequence Setup-**Environment - Global Trigger/Clock/External Inputs - USER Marker /AUX I/O Settings**.

External clock reference



When the external clock reference is selected, it is always supplied via the CLOCK connector on the front panel. The internal clocks synchronized to it are output on the following connectors:

CLOCK OUT (rear panel)	Choice of bit clock or symbol clock
BITCLK (AUX I/O interface, rear panel)	Bit clock
SYMBCLK (AUX I/O interface, rear panel)	Symbol clock

The active edge of the external clock signal on the CLOCK input is selectable (menu Setup-**System-Global Trigger/Clock/External Inputs**). Internally the rising edge is always taken as the active edge. The active rising edge of the internal clocks is therefore synchronized with either the rising or the falling edge of the external clock reference. A symbol clock can be supplied externally or, if internally generated or externally asynchronous data is being fed in, a multiple of a symbol clock can be supplied.

In the case of two-path instruments the external clock signal is applied to path A.

In order for the clock synthesizer on the R&S AMU to be synchronized correctly, the external clock reference must first be applied and the correct symbol rate must then be set. Until this has been done the external clock source must not be selected (**Clock Source External**).

Note:
The symbol rate set must not deviate from the symbol rate of the external signal by more than 2% (see also data sheet).

The synchronization of data signals and clock signals for the various data sources and clock sources is described in the following section.

Synchronizing Data Signals and Clock Signals

When selecting data signals and clock signals, the following operating modes are possible:

- Internal clock and internal data
- Internal clock and external synchronous data
- External clock and external synchronous data

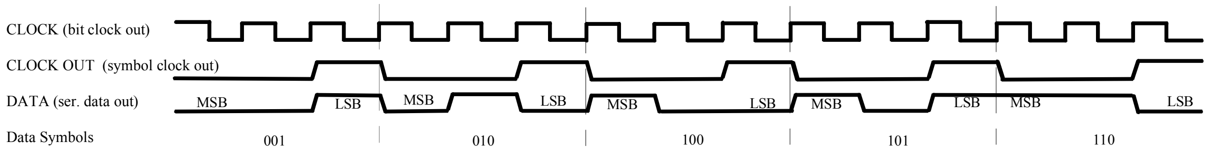
Internal Clock and Internal Data

When internal data is selected for path A, this data is output in serial mode on the DATA connector or in parallel mode on the PARADATA pins of the AUX I/O interface (**Custom Digital Modulation**).

In modulation modes with fewer than 10 bits/symbol, the parallel data is output LSB-justified. In the case of 8-PSK modulation for example (3 bits/symbol) only data lines D0, D1 and D2 are used.

The internal data of path B is not output in two-path instruments. For synchronization purposes, however, it is possible to output the bit clock or symbol clock from this path to one of the USER connectors.

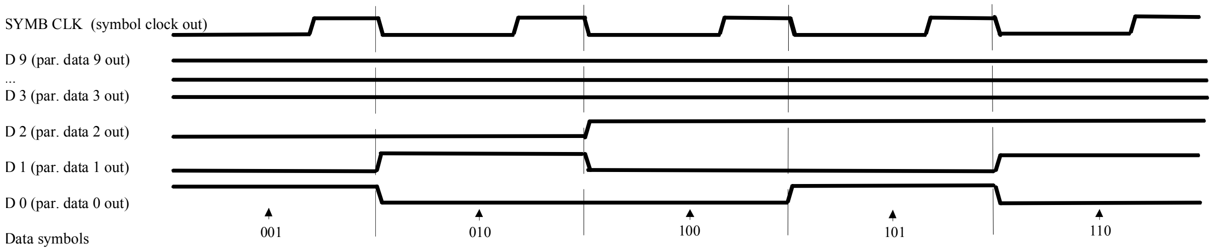
In the following example, the diagram shows the output signals of an 8-PSK modulation (3 bits per symbol) on the serial DATA interface. The positive edge of the clock is always used when outputting data. The data source is a data list with 15 bits = 001 010 100 101 110 (5 symbols).



Output signal on the serial data interface and clock output signals on the AUX I/O interface

There is a maximum data rate above which serial data processing becomes impossible. This data rate can be found in the data sheet. If the rate is exceeded the DATA connector becomes high-impedance, and the output on the CLOCK connector is the symbol clock instead of the bit clock.

In the following example, the diagram shows the output signals of an 8-PSK modulation (3 bits per symbol) on the parallel interface. The data source is a data list with 15 bits = 001 010 100 101 110 (5 symbols).



Data and clock output signals on the parallel AUX I/O interface

In order for parallel external data to be retrieved correctly the rising edge of the symbol clock must be used, since the timing between the falling edge of the symbol clock and the data switch on the parallel interface is undefined.

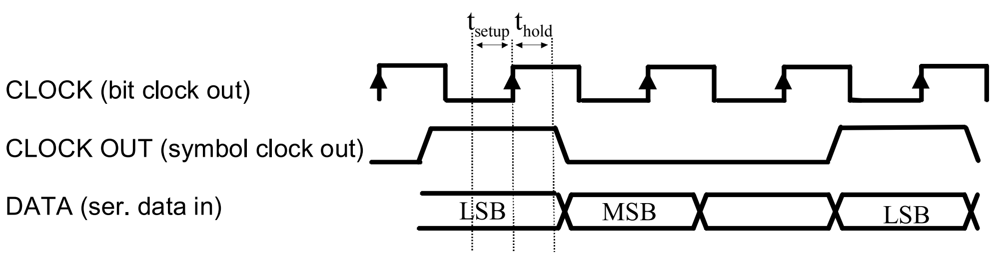
Internal Clock and External Synchronous Data

External serial data

When serial data for **Custom Digital Modulation** is being fed in via the DATA connector on the front panel, the symbol clock acts as a scanning pulse (strobe) so as to mark the least significant bit in a symbol.

The clock signals are output on the CLOCK and CLOCK OUT connectors (front panel and rear panel respectively, choice of bit clock or symbol clock on the latter) and on the BITCLK or SYMBCLK pins on the AUX I/O interface. Optimum timing is achieved from using the output signal on the CLOCK connector on the front panel. The setup and hold times (see following diagram, t_{setup} and t_{hold}) that must be maintained in the R&S AMU to ensure that the serial data is accepted correctly can be found in the data sheet.

The following diagram illustrates the timing ratios between data and clock when serial data is being supplied from an external source and the internal clock source is being used.



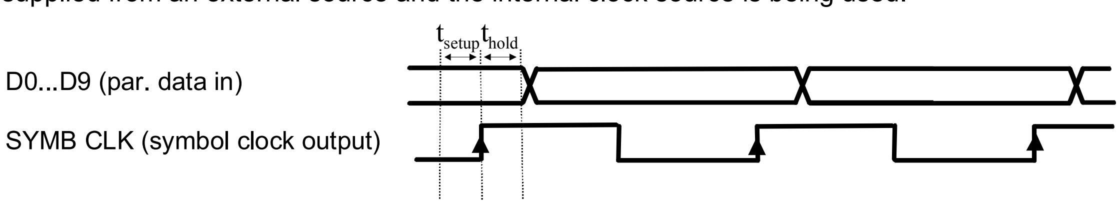
External serial data and the clock signals which are output (bit clock and symbol clock). The setup time (t_{setup}) and hold time (t_{hold}) can be found in the data sheet.

External parallel data

When parallel data for **Custom Digital Modulation** is being fed in via the AUX I/O interface (D0 – D9), the internal symbol clock is used.

The symbol clock is output on the CLOCK OUT connector (rear panel, choice of bit clock or symbol clock) and on the SYMBCLK pin on the AUX I/O interface. Optimum timing is achieved by using the symbol clock on the SYMBCLK pin on the AUX I/O interface. The setup and hold times (see following diagram, t_{setup} and t_{hold}) that must be maintained in the R&S AMU to ensure that the serial data is accepted correctly can be found in the data sheet.

The following diagram illustrates the timing ratios between data and clock when parallel data is being supplied from an external source and the internal clock source is being used.



External parallel data, internal clock signal and the clock signal that is output on the AUX I/O interface The setup time (t_{setup}) and hold time (t_{hold}) can be found in the data sheet.

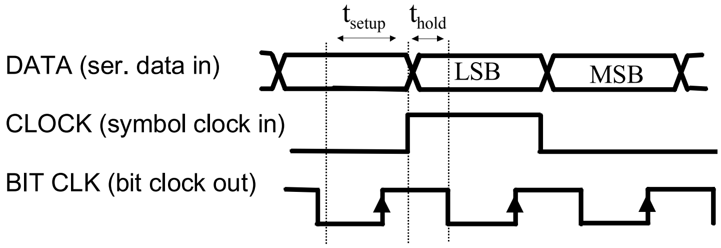
External Clock and External Synchronous Data

When synchronous modulation data is being fed in from an external source for **Custom Digital Modulation**, clock generation in the R&S AMU can be synchronized on the rising or falling edge of an external symbol clock. The clock reference is supplied on the CLOCK connector (front panel).

The clock signals generated as a result are output on the CLOCK OUT connector (rear panel, choice of bit clock or symbol clock) and on the BITCLK or SYMBCLK pins on the AUX I/O interface.

External serial data

The following diagram illustrates the timing ratios between data and clock when serial data is being supplied from an external source and an external reference clock is being used.

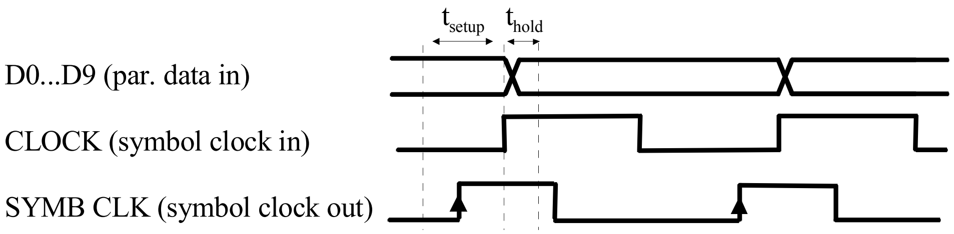


External serial data and external symbol clock - 3 bits/symbol with high and low active symbol clock **for marking the LSB. The data and the symbol clock must change state simultaneously. The setup time (t_{setup}) and hold time (t_{hold}) can be found in the data sheet.**

A bit clock is generated from the externally supplied symbol clock and is used for reading the serial data into the R&S AMU. The active edge of this bit clock is located ahead of the symbol clock.

External parallel data

The following diagram illustrates the timing ratios between data and clock when parallel data is being supplied from an external source and an external reference clock is being used.



External parallel data with high and low active external symbol clock. The setup time (t_{setup}) and hold time (t_{hold}) can be found in the data sheet.

The R&S AMU uses the externally supplied symbol clock to generate an internal symbol clock that defines the sampling points at which the parallel data is read into the R&S AMU. These sampling points are also located a little ahead of the external symbol clock.

Control Signals

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

- **Burst Gate** and **Level Attenuation** for power ramping
- **CW** for controlling the CW (continuous wave) mode
  The **CW** signal turns off digital modulation. The signal is output in unmodulated form.
  In case of standards in which it is possible to switch between different modulation modes, the signal is output only and cannot be supplied from an external source. In such cases it indicates the modulation mode internally (standard GSM: signal high (1) = modulation mode GMSK and signal low (0) = modulation mode 8PSK EDGE).

The CW control signal is generated internally and fed to the AUX I/O interface. The control signals for power ramping can be provided externally for **Custom Digital Modulation** only. When generated internally the signals are output on the AUX I/O interface.

A dedicated internal **Control Data Editor** is provided for defining the control signals. This editor with its intuitive graphical interface can be used to define and save control signals. Definition by generating or editing a binary list is no longer necessary (though it is still possible via the IEC bus).

A separate file with the file extension ***.dm_iqc** is created for each defined control signal and held on the R&S AMU hard disk.

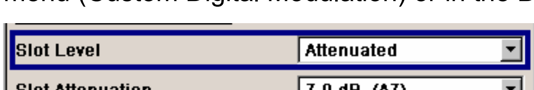
If the **Component Data Editor** is used, the **Control Data Editor** is integrated with it. The defined control data is not held separately, but stored with the data structure. This applies both to signals of the Data Editor Realtime and the Data Editor Offline.

Power Ramping and Level Attenuation

In TDMA radio networks it is necessary to control the RF output signal envelope synchronously for the purpose of digital modulation. The signals **Burst** Gate and **Lev Att** are used for this. These signals are internally generated. In case of **Custom Digital Modulation** they can also be supplied from an external source via the AUX I/O interface.

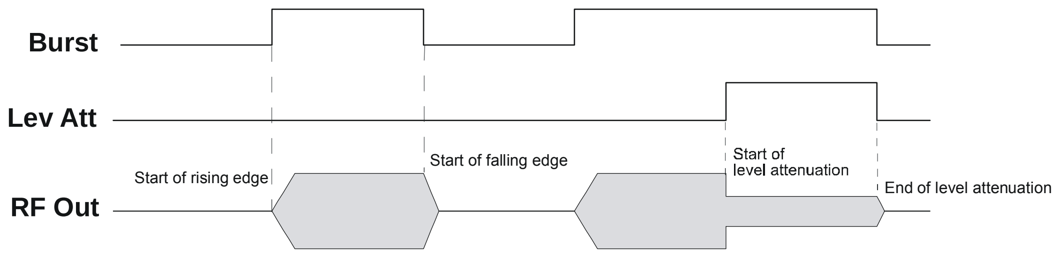
When power ramping is enabled, a ramp is generated whenever there is a data switch on the **Burst** signal (from high to low or low to high). The steepness of this ramp can be adjusted. Power ramping is enabled and configured in the **Power Ramp Control** submenu.

The **Lev_Att** signal is used to control a defined level attenuation. If level attenuation is enabled, the modulation signal level is attenuated by a defined value if the **Lev Att** signal is high. The level attenuation value is defined in the **Power Ramp Control** menu. For the **GSM/EDGE** standard a maximum of 7 different level attenuation values can be defined and allocated separately to the 8 slots quite independently of one another. Level attenuation is enabled either in the **Power Ramp Control** menu (Custom Digital Modulation) or in the Burst Editor (GSM/EDGE).



Level attenuation enables to simulate radio stations located at various distances.

The diagram below shows an example of how the power ramping signals work.



Signal behavior when power ramping is enabled. The Burst **Gate signal defines the start of the rising and falling edges of the envelope, and the** Lev Att **signal defines the start and end of level attenuation. The level attenuation value is defined in the** Power Ramp Control **menu.**

Trigger Signals

In the R&S AMU, trigger signals are internally generated or externally supplied signals which start signal generation at a particular point in time.

Signal generation can also take place without triggering, in which case the signal is then generated in full after modulation is powered up. A trigger event either has no effect on signal generation (menu setting **Trigger Mode Auto**) or triggers a signal restart (menu setting **Trigger Mode Retrigger**).

If signal generation is triggered, the signal is continuously generated after the first trigger. In the **Armed_Auto** mode, a further trigger event has no effect. In the **Armed_Retrig** mode, every additional trigger event triggers a restart of the signal. In both cases, triggering can be reset to the initial state (**armed**), i.e. signal generation is stopped and the instrument waits for the next trigger to start signal generation anew.

The status of signal generation (**Running** or **Stopped**) is displayed for all trigger modes in the corresponding trigger menu of the digital standard currently switched on. The signal generation status particularly with an external trigger can thus be checked.

Internal and external trigger sources are available for triggering.

- Internally, triggering is carried out manually by pressing the **Execute Trigger** button (menu selection **Internal**).
- In the case of two-path instruments, internal triggering can be caused by the trigger signal on the second path (menu selection **Internal (Baseband A/B)**). This makes it possible to synchronize the signal on one of the two paths with the signal on the second path. Using an external trigger source, it is possible to set the trigger signal to be delayed or suppressed.
- External trigger signals can be fed in via the TRIGGER 1 and 2 connectors on the front and rear panels (menu selection **External**).

  In the case of external triggering and internal triggering by the trigger signal on the second path, the start can be delayed by a definable number of symbols (menu setting (**External) Trigger Delay**). This makes it possible to purposely simulate the time delay between a base station signal and a user equipment signal, for example in the course of base station tests.

  The effect of a restarted trigger signal in the **Retrigger** trigger mode can be suppressed for a definable number of symbols (menu setting (**External) Trigger Inhibit**). By this means the trigger can be suppressed for a definable number of frames, for example in the course of base station tests, and yet the signal can still be generated synchronously. In each frame the base station generates a trigger which would cause a signal generation restart every time but for the suppression.

  Example: Entering 1000 samples means that after a trigger event, any subsequent trigger signal is ignored for the space of 1000 samples.

A signal which marks the trigger event set off by the current internal or external trigger of path A or B can be output at the USER connectors (AUX IO interface or USER BNC connector).

Note:
The trigger mode setting, the selection of the trigger source and the setting of a delay and trigger suppression in the case of external triggering are carried out independently for each of the two paths. On the other hand configuration of the trigger connectors (polarity and impedance) is carried out jointly for both paths.

Marker Output Signals

The R&S AMU generates user-definable marker output signals which can be used to synchronize external instruments. By this means a slot clock or frame clock can be set, for instance, or the start of a particular modulation symbol can be marked.

Four marker outputs are available for each path. The outputs for markers 1 to 3 are defined, but marker 4 can be mapped to one of the USER outputs according to choice.

path A

Markers 1/2	MARKER 1A / 2A BNC connectors on the front panel
Marker 3	MARKER 3A pin of the AUX I/O connector on the rear panel
Marker 4	USER1 BNC connector or USER2/3/4 pins of the AUX I/O connector on the rear panel according to choice

path B

Marker 1	MARKER 1B / 2B BNC connector on the rear panel
Markers 2/3	MARKER 3B pin of the AUX I/O connector on the rear panel
Marker 4	USER1 BNC connector or USER2/3/4 pins of the AUX I/O connector on the rear panel according to choice

External Baseband Signal - Baseband Input

Introduction - Baseband Input

The R&S AMU 200A Baseband Signal Generator and Fading Simulator makes it possible to feed external analog or digital baseband signals into the signal paths. The complex baseband input bandwidth is 60 MHz, i.e. the I and Q components of the signal are each filtered with a 30 MHz lowpass.User-specific wanted signals or interference signals can thus be added to internally generated signals and subsequently - provided the instrument is fitted with the required options - be faded, detuned or loaded with noise (see the sections "*Fading Menu*", "*Impairment Settings Menu*" and "*AWGN Settings Menu*").

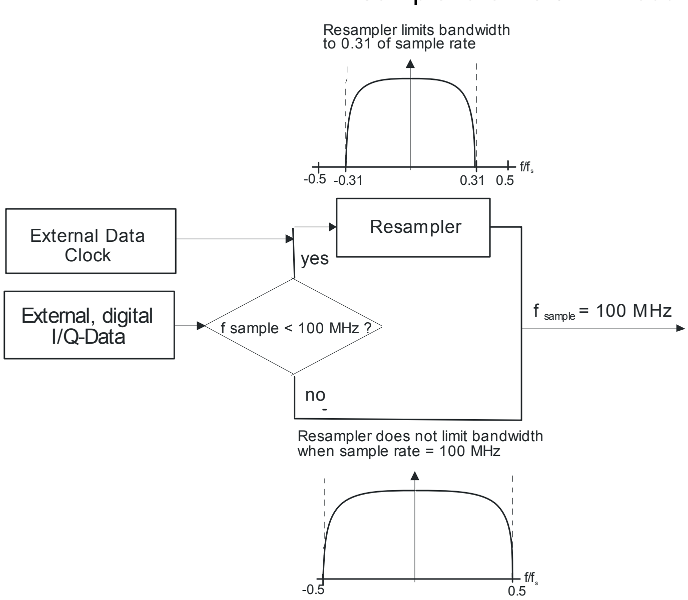
An analog signal is fed in via the **I/Q** connectors and then A/D-converted. Digital signals are input via the LVDS interface **Digital Input**. A signal can be added to the internally generated signals and be frequency-shifted as well as loaded with a relative gain.

The equipment options for the basic unit includes the option R&S AMU-B17 (Baseband I/Q Input digital/analog) and the option R&S AMU-B13 (Baseband Main Module). If the R&S AMU is equipped with a baseband generator module (option R&S AMU-B9/B10/B11, Baseband Generator), internally generated signals can be added to the baseband input. If the R&S AMU is equipped with a fading simulator (option R&S AMU-B14, Fading Simulator and option R&S AMU-B15, the Fading Simulator Extension), the signals can be faded. The fading module can also process external I/Q signals.

For two-path instruments, the external signal can be connected to baseband path A or path B. Up to two baseband input modules can be applied. The signal of the first baseband module can be routed to path A, path B or to both paths. The signal of the second baseband input module is firmly connected to path B.

The range for the sample rate of the external digital signals is 400 Hz to 100 MHz. The resampler operates in such a way that a baseband signal with a sample rate of less than 100 MHz is interpolated on the 100-MHz sample rate and then used as output. The sample rate must fulfill the following condition:

$$\text{Sample rate} \times 0.31 \geq \text{modulation bandwidth}$$



External Baseband Signals

For sample rates in the range of 400 Hz ... < 100 MHz, the external clock must be provided, it is required to reconstruct the signal (Baseband In Mode **Digital Input** (Sample Rate Source **Digital I/Q In**)).

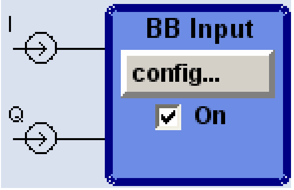
For sample rates of exactly 100 MHz the digital signal is directly fed into the digital signal path (Baseband In Mode **Digital Input** (Sample Rate Source **User Defined**)).

Note:
The signal source (typically a second R&S AMU) and the receiving R&S AMU have to be synchronized.

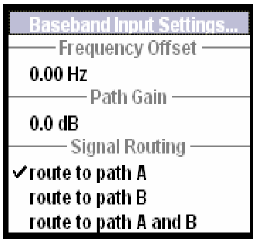
The modulation bandwidth of the external digital signals (Baseband In Mode = **analog**) is limited to 30 MHz.

BB Input Block

The settings for signal routing, frequency offset and path gain are available in the "**BB Input**" function block of each path or in the "**BB Input**" menus which are opened using the MENU key.



The external baseband signal is activated by switching on in the Baseband Input settings menu as well as by ticking the checkbox of the BB Input function block.



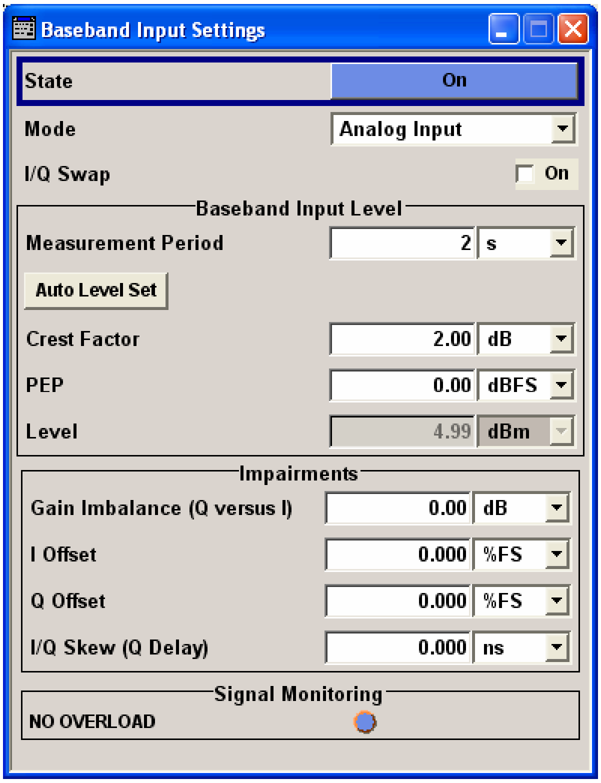
The **Baseband Input Settings** menu containing the external baseband signal settings is opened under the first item of the **BB Input** block menu (see "*Baseband Input Settings Menu*", on page *4.165*)

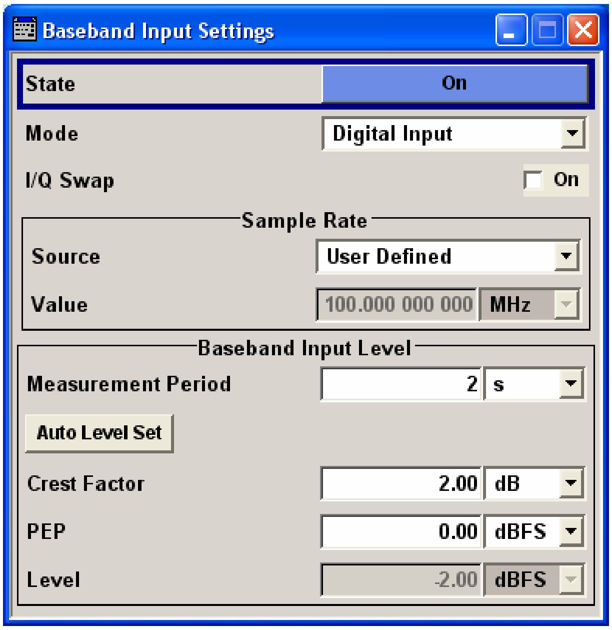
A frequency offset and a path gain can be set in the two following menu items of the **BB Input** block menu – provided the instrument is equipped with at least two baseband sources.

For two-path instruments the routing of the signals can be defined in the **Signal Routing** section of the **BB Input** block.

Baseband Input Settings Menu

The settings for the external baseband signal are available in the "**BB Input**" function block of each path or in the "**BB Input**" menus which are opened using the MENU key.





State - Baseband Input

Switches On/Off the feeding of an external analog or digital signal into the signal path.

An external analog signal is A/D-converted and fed into path A or path B or into both paths simultaneously.

If no signal is applied at the input selected with parameter **Mode** an error message is displayed.

On

Switches On the external I/Q input signal of the corresponding BB Input block. The input symbols display the active signal mode (digital DIG I/Q IN or analog I and Q).

Remote-control command:
`SOUR:BBIN:STAT ON`

Off

Switches Off the external I/Q input signal of the corresponding BB Input block.

Remote-control command:
`SOUR:BBIN:STAT OFF`

Mode - Baseband Input

Selects the signal mode (analog or digital) of the external input signal of the **BB Input** block.

Analog Input

An external analog baseband signal (**BB Input**) is fed in via the **I** and **Q** analog inputs.

The block diagram shows the BNC connectors at the **BB Input** block. The signals are A/D-converted using the 100 MHz system clock and fed into the digital signal path.

Remote-control command:
`SOUR:BBIN:MODE ANAL`

Digital Input

(User defined)

The external digital baseband signal is fed into the digital signal path via the **Digital Input** connector.

The internal signal processing is based on a sample rate of 100 MHz. External input signals with sample rates less than 100 MHz are upsampled. The external sample rate can be estimated or defined by the user in the appropriate entry fields.

Remote-control command:
`SOUR:BBIN:MODE DIG`

Digital EX I/Q Box

This mode is reserved for future extensions.

Remote-control command:
`SOUR:BBIN:MODE EBOX`

I/Q-Swap - Baseband Input

Activates swapping of the I and Q signal components, which mirrors the spectrum at the f=0 line and inverts the sign of the frequency.

The I/Q swap may be needed if an external CDMA signal is to be added to an internally generated baseband signal (see section "*Digital Standard CDMA2000*").

Remote-control command:
`SOUR:BBIN:IQSW:STAT ON | OFF`

For **digital input signals** the section **Sample Rate** is available in the **Baseband Input Settings** dialog. This section indicates the permitted sample rate of the external digital baseband input signal.

Sample Rate Source - Baseband Input

(Digital Input only)

Selects the source for estimating the sample rate or defining it by the user.

Note:
The Sample Rate section shows the permitted sample rate of the external digital baseband input signal. Currently the entry fields Source and Value are firmly set to User defined and 100 MHz and in read-only mode. For future upgrades the sample rate is intended to be automatically estimated or defined by the user.

User Defined

Enables the user to define the sample rate in the entry field value.

Note:
Only the source User defined is currently available. Digital I/Q In is intended for future upgrades.

Remote-control command:
`SOUR:BBIN:SRAT:SOUR USER`

Digital I/Q In

Estimates the sample rate on the digital I/Q input and displays the value in the value field. This mode is intended for future upgrades.

Remote-control command: n.a.

Sample Rate Value - Baseband Input

(Digital Input only)

Indicates the sample rate of the external digital baseband input signal.

Note:
The Sample Rate section shows the permitted sample rate of the external digital baseband input signal. Currently, the entry fields Source and Value are firmly set to User defined and 100 MHz and in read-only mode. For future upgrades the sample rate is intended to be automatically estimated or defined by the user.

Remote-control command:
`SOUR:BBIN:SRAT:ACT  100MHz`

The crest factor and the peak power of the external baseband signal are entered in the section **Baseband Input Level**. These values are necessary for a correct internal signal processing in the R&S AMU. They can also be automatically estimated by a measurement using the **Auto Level Set** button.

Measurement Period - Baseband Input

Sets the recording duration for measuring the baseband input signal by **Auto Level Set**. For accurate level measurements, the measurement period should be set to a time value that is long enough to capture several periods of the input signal.

Remote-control command:
`SOUR:BBIN:MPER 4s`

Auto Level Set - Baseband Input

Starts measuring the input signal. The measurement estimates the crest factor, the peak power and rms power. The estimated values are automatically entered into the input fields **Crest Factor**, **PEP** and **Level**. Using these estimated values the internal gain control adjusts the input signal gain to achieve an optimal dynamic range.

Remote-control command:
`SOUR:BBIN:ALEV:EXEC`

Crest Factor - Baseband Input

Sets the crest factor of the external analog or digital baseband signal. Indicates the crest factor acquired with **Auto Level Set**.

Remote-control command:
`SOUR:BBIN:CFAC 33`

PEP - Baseband Input

Enters the peak level of the external analog or digital baseband signal relative to full scale of 0.5 V (in terms of dB full scale).
Indicates the peak level acquired with **Auto Level Set**.

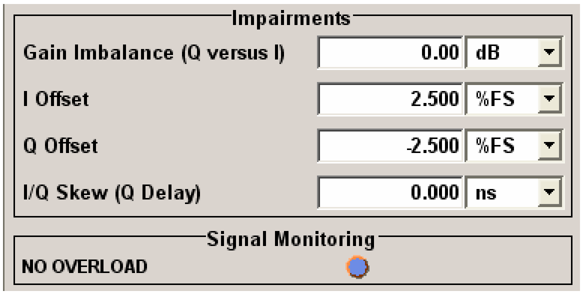
Remote-control command:
`SOUR:BBIN:POW:PEAK -4.56`

Level - Baseband Input

Indicates the estimated rms level acquired with **Auto Level Set**.

Remote-control command:
`SOUR:BBIN:POW:RMS?`

For **analog input signals** the section **Impairments** is available in the **Baseband Input Settings** dialog. Additionally to the internal calibration of the instrument a DC offset, gain imbalance and time delay can be set to I and Q signal components. The section **Signal Monitoring** indicates the overload of the A/D - Converter.



Gain Imbalance (Q versus I) - Baseband Input

(Analog Input only)

Enables to amplify the Q component of the input signal additionally to the internal calibration. This setting is needed e.g. to balance the I and Q signal channel by exactly the same degree.

Remote-control command:
`SOUR:BBIN:GIMB -1.0dB`

I Offset - Baseband Input

(Analog Input only)

Sets a DC offset to the I component of the input signal additionally to the internal calibration. This setting is needed to compensate an offset that has been fed in from the external signal.

Remote-control command:
`SOUR:BBIN:OFFS:I +2.5PCT`

Q Offset - Baseband Input

(Analog Input only)

Sets a DC offset to the Q component of the input signal additionally to the internal calibration. This setting is needed to compensate an offset that has been fed in from the external signal.

Remote-control command:
`SOUR:BBIN:OFFS:Q -0.1PCT`

I/Q-Skew (Q Delay) - Baseband Input

(Analog Input only)

Determines the delay between Q and I channel. Positive values represent a delay for Q versus I.

Remote-control command:
`SOUR:BBIN:SKEW -23PS`

Overload - Baseband Input

(Analog Input only)

Indicates that the I/Q input is overloaded. This indication also appears in the block diagram close to the Baseband Input block.

If overload is indicated either the amplitude of the external signal is too high (full scale of 0.5 V) and must be reduced or the entered **Peak Level** (in dB full scale) value does not correspond with the real value and must be corrected. It also can be evaluated automatically with button **Auto Level Set**.

Remote-control command:
`SOUR:BBIN:OLOad:STAT?`

The section **Frequency Offset** is used to enter the frequency offset.

Frequency Offset - Baseband Input

Enters the frequency offset for the external baseband signal.

The offset affects the signal on the output of the **Baseband** block.

It shifts the useful baseband signal in the center frequency.

Note:

For sample rates of exactly 100 MHz (Baseband In Mode Digital Input (Sample Rate Source User Defined)) it is not possible to enter a frequency offset. The digital signal is fed into the signal path directly and not routed to the resampler where the frequency offset takes place.

The complex I/Q bandwidth of the shifted useful signal must not exceed 80 MHz in total (see section "*Signal Routing and Frequency Shifting*", on page 4.148).

The following applies:

$$f_{offset} - {}^{f_{use}}\!/_{2} \geq -{}^{80}\!/_{2}\,MHz \quad \text{and} \quad f_{offset} + {}^{f_{use}}\!/_{2} \leq +{}^{80}\!/_{2}\,MHz$$

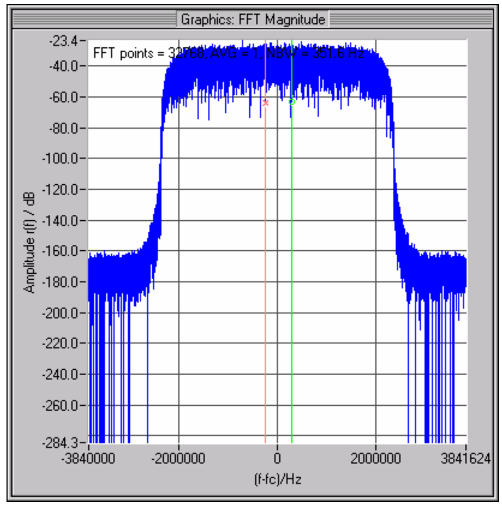
f_{use} = the complex useful bandwidth of the I/Q signal before the offset.

f_{offset} = frequency offset.

The following graph shows the setting range for the frequency offset.

Example:

3GPP FDD signal (chip rate 3.84 Mcps, root-cosine filter 0.22).



The complex useful bandwidth of a signal which has been filtered using a root-cosine filter with roll off α is calculated as follows:

$$f_{use} = (1+\alpha) * f_{symbol}$$

f_{symbol} = the symbol rate or chip rate of the signal.

In the example the complex useful bandwidth is calculated as follows:

F_{use} = (1+ 0.22) * 3.84 MHz = 4.6848 MHz.

So as to comply with the condition requiring a maximum I/Q bandwidth of 40 MHz, the valid range of values for the frequency offset is then:

$$-40\text{MHz} + \frac{4.6848\ \text{MHz}}{2} \leq f_{offset} \leq 40\text{MHz} - \frac{4.6848\ \text{MHz}}{2} =$$

$$-35.3152\text{MHz} \leq f_{offset} \leq 35.3152\text{MHz}$$

In the case of ARB signals, the output clock rate can be used for estimating the maximum I/Q bandwidth of the waveform.

Remote-control command:
`SOUR:BBIN:FOFF 2MHZ`

The section **Path Gain** is used to enter the relative gain of the external signal compared with the signals of the other baseband sources.

Path Gain - Baseband Input

Enters the relative gain for the external baseband signal compared with the signals of the other baseband sources. The gain affects the signal on the output of the **BB Input** block.

The **Path Gains** of the different baseband sources (Baseband In A. Baseband In B, Baseband A and Baseband B) determine the gain of the associated signals relative to each other. The actual gain of the different baseband signals depends not only on the path gain setting but also on the signal characteristics like the crest factor, on the number of used sources and on the total output level.

The cumulative baseband signal can be verified in the **Graphics** block in the spectrum view.

Remote-control command:
`SOUR:BBIN:PGA 2 dB`

The section **Signal Routing** is used to define the signal routes of a external baseband signals in two-path instruments.

Signal Routing - Baseband Input

Selects the signal routes of external baseband signals in a two-path instrument. Up to two baseband input modules can be applied. The signal of the first baseband module can be routed to path A, path B or to both paths.

Note:
The second baseband input module Baseband Input B is firmly connected to signal path B. Therefore no routing is provided for this block.

The following table shows some of the possible combinations of signal routes for two-path instruments.

Route to path A The external baseband signal is fed into path A. If an internal signal from path A is generated at the same time, the two signals are summed.

Remote-control command:
`SOUR:BBIN:ROUT A`

Route to path B The external baseband signal is fed into path B. If an internal signal from path B is generated at the same time, the two signals are summed.

Remote-control command:
`SOUR:BBIN:ROUT B`

Route to path A and B The external baseband signal is fed into path A and path B. If internal signals from one or two paths are generated at the same time, all signals in each path are summed.

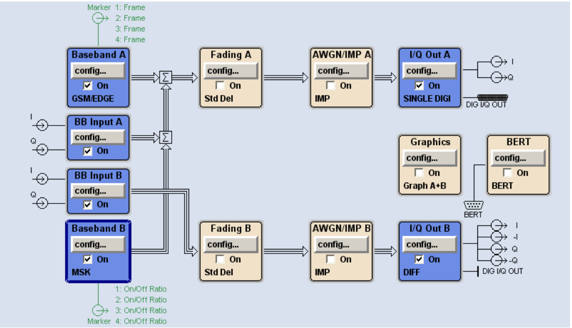
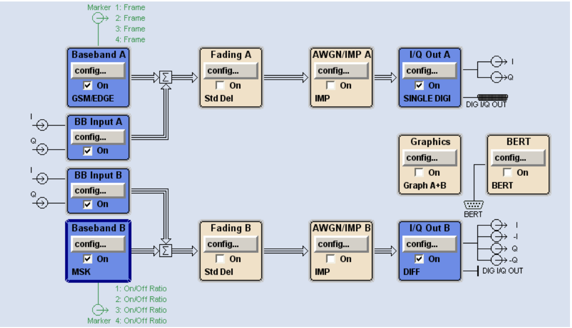
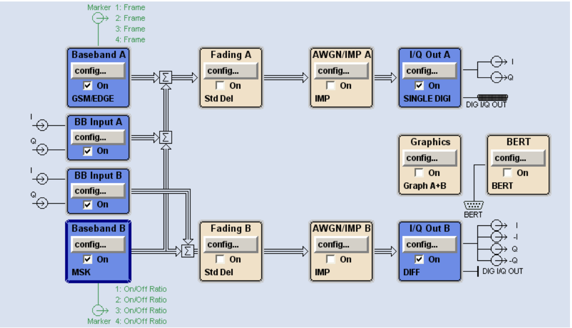
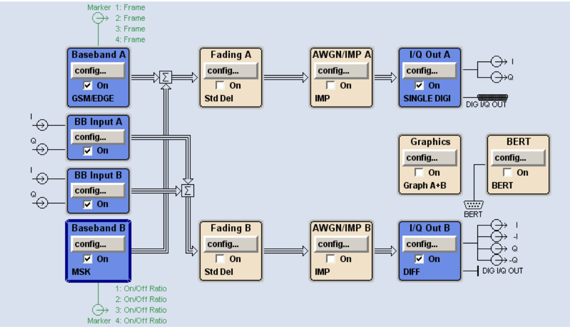
Remote-control command:
`SOUR:BBIN:ROUT AB`

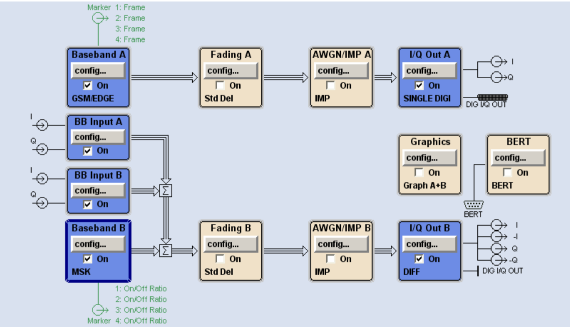
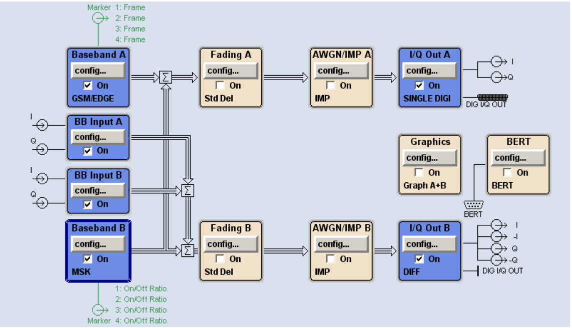
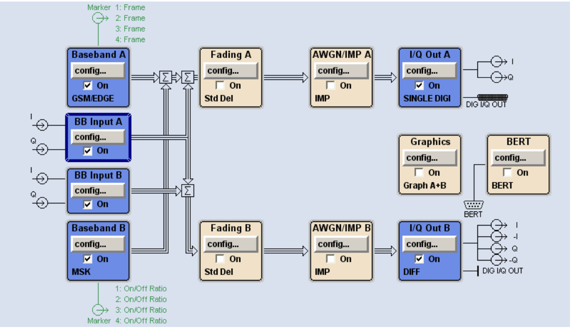
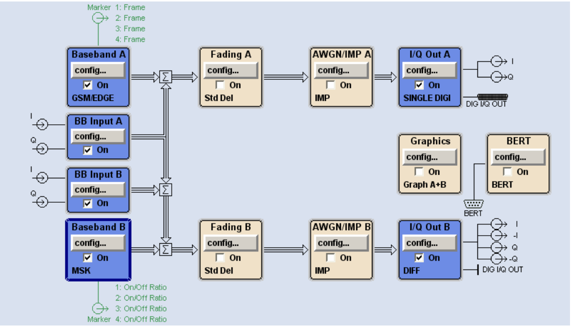
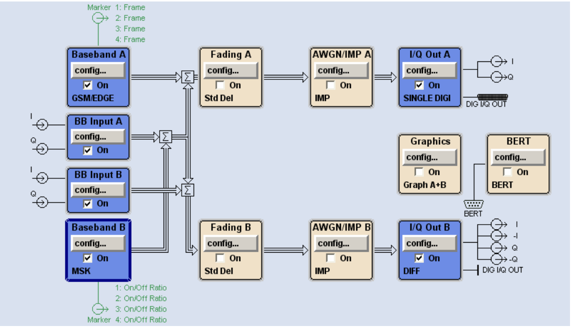
Combinations of signal routes for two-path instruments

Note:

The table shows some possible combinations of signal routes in a two-path instrument, containing four signal sources. On the basis of Routing baseband block A to path A the signal routings are shown.

Routing baseband block A to path B or Routing baseband block A to path A + B similar routing combinations are possible for the remaining signal sources (Baseband In A, Baseband B and Baseband In B). These possibilities are unlisted to limit the number of figures in the table.

Routing baseband A	**Routing baseband In A**	**Routing baseband In B**	**Routing baseband B**	**Block diagram**
Route to path A	Route to path A	Route to path B	Route to path A	
Route to path A	Route to path A	Route to path B	Route to path B	
Route to path A	Route to path A	Route to path B	Route to path A + B	
Route to path A	Route to path B	Route to path B	Route to path A	

Routing baseband A	Routing baseband In A	Routing baseband In B	Routing baseband B	Block diagram
Route to path A	Route to path B	Route to path B	Route to path B	
Route to path A	Route to path B	Route to path B	Route to path A + B	
Route to path A	Route to path A + B	Route to path B	Route to path A	
Route to path A	Route to path A + B	Route to path B	Route to path B	
Route to path A	Route to path A + B	Route to path B	Route to path A + B	

Digital Modulation - Custom Digital Modulation

Introduction - Custom Digital Modulation

The R&S AMU 200A Baseband Signal Generator and Fading Simulator can generate digital modulation signals with user-definable characteristics. Baseband filtering and the symbol rate can be set within wide limits.

The equipment layout for generating the digital modulation signals includes the options Baseband Main Module (B13) and Baseband Generator (B9/B10/B11).

In the case of two-path instruments, at least one further Baseband Generator (B9/B10/B11) option is needed for signal generation in the second path. Using this option a signal can be defined in path B and then either routed via path A or added to the signal on path A with a frequency offset that can be set. When path B is fully expanded with a second option Baseband Main Module (B13) the analog modulation signal can be output on **I/Q Out B**.

Note:
The differential output of the baseband signal in two-path instruments requires a second option R&S AMU-B16, Differential I/Q Out and, for digital output a second option R&S AMU-B18, Digital I/Q Out respectively.

A two-part level indication is shown in the header section of the display. This displays both the rms voltage (Level) and the peak envelope voltage (PEP) of the output signal.

The difference between PEP and LEVEL depends on the modulation type and the filtering: Both values are pre-measured internally so that the displayed values match the true values in the signal. When external signals are used, they are replaced by PRBS data during pre-measurement.

Modulation Types - Custom Digital Mod

The available modulation types are ASK (amplitude shift keying), FSK (frequency shift keying), PSK (phase shift keying) and QAM (quadrature amplitude modulation).

The actual modulation procedure is described by mapping, which assigns I and Q values (PSK and QAM) or frequency shifts (FSK) to every modulation symbol that occurs. This is represented graphically in the constellation diagrams.

The mapping for the selected modulation type is displayed in the **More..**. submenu in the **Modulation** menu section (see "*More - Modulation Type - Digital Modulation*", page *4.191*)

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

In the case of all FSK procedures, the user can set the symbol rate f_{SYMB} up to a maximum value (see data sheet). If MSK is selected, the frequency deviation (**FSK deviation**) cannot be set since it is permanently set to ¼ of the symbol rate.

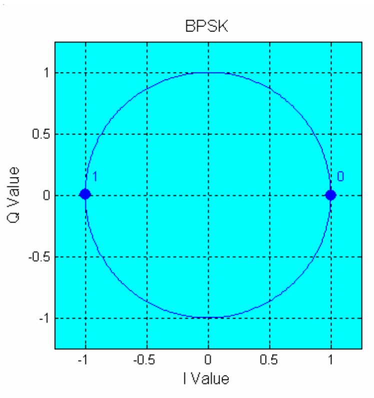
Modulation type and associated mapping

PSK

BPSK

1 bit per symbol

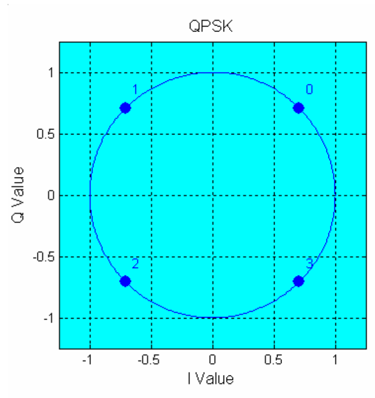
`SOUR:BB:DM:FORM BPSK`



QPSK

2 bits per symbol

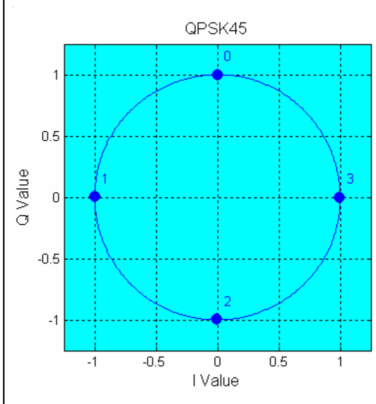
`SOUR:BB:DM:FORM QPSK`



QPSK 45° Offset

2 bits per symbol
45° rotation

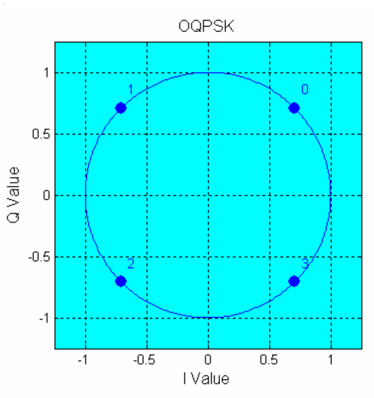
`SOUR:BB:DM:FORM QPSK45`



OQPSK

2 bits per symbol
Q offset

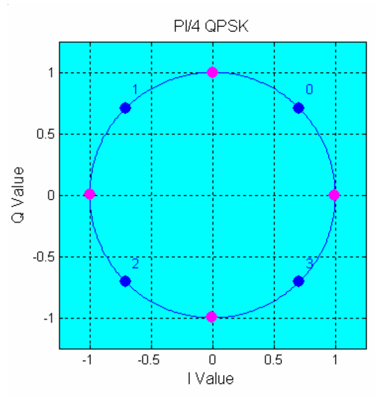
`SOUR:BB:DM:FORM OQPSK`



π/4-QPSK

2 bits per symbol
π/4 rotation

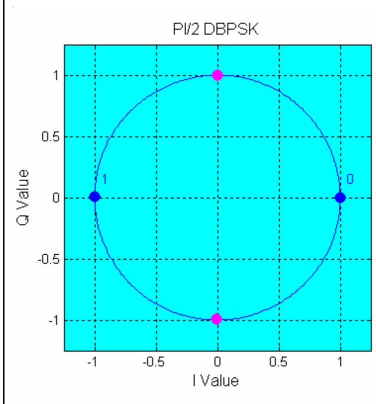
`SOUR:BB:DM:FORM P4QP`



π/2-DBPSK

1 bit per symbol
Differential coding, π/2 rotation

`SOUR:BB:DM:FORM P2DB`



π/4-DQPSK

2 bits per symbol
Differential coding, π/4 rotation

`SOUR:BB:DM:FORM P4DQ`

π/8-D8PSK

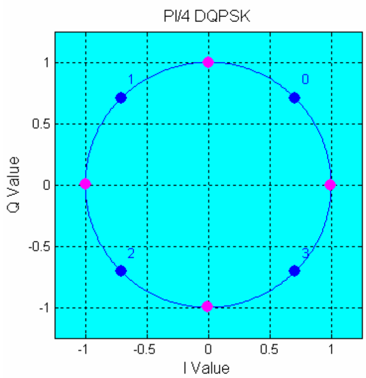
3 bits per symbol
Differential coding, π/8 rotation

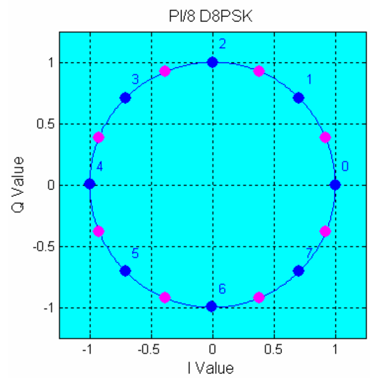
`SOUR:BB:DM:FORM P8D8`

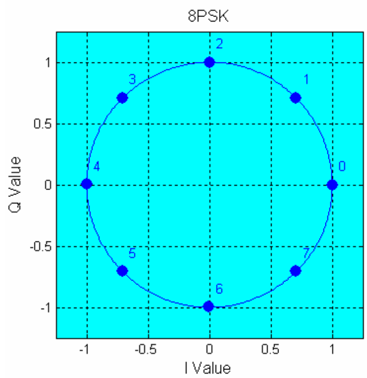
8PSK

3 bits per symbol

`SOUR:BB:DM:FORM PSK8`



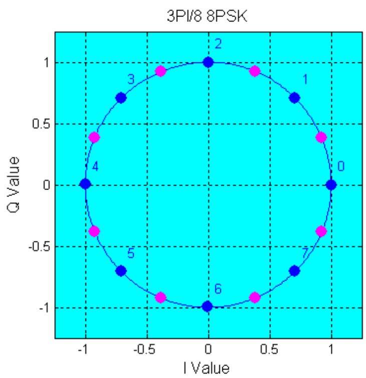




8PSK EDGE (3π/8 8PSK)

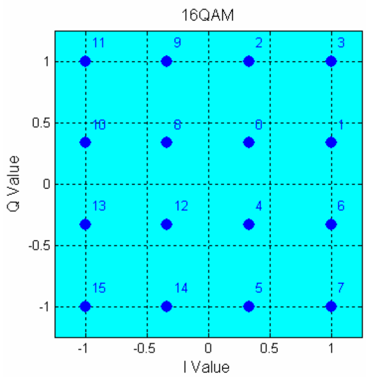
3 bits per symbol
Edge coding, 3π/8 rotation

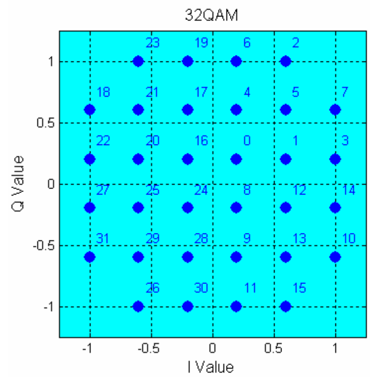
`SOUR:BB:DM:FORM P8ED`

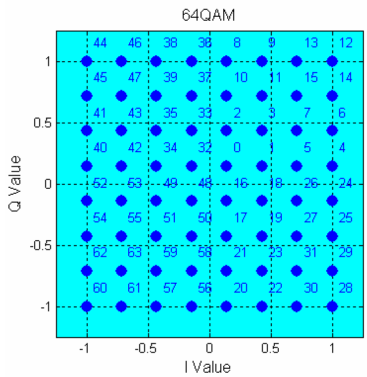


QAM

16QAM	32QAM	64QAM
4 bits per symbol	5 bits per symbol	6 bits per symbol
`SOUR:BB:DM:FORM QAM16`	`SOUR:BB:DM:FORM QAM32`	`SOUR:BB:DM:FORM QAM64`



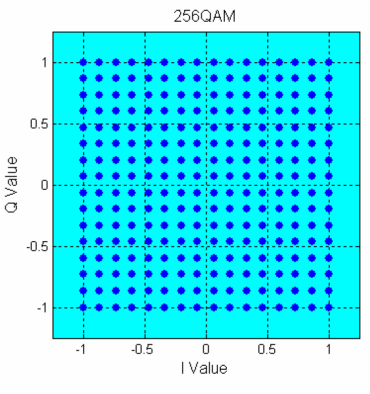




256QAM

8 bits per symbol

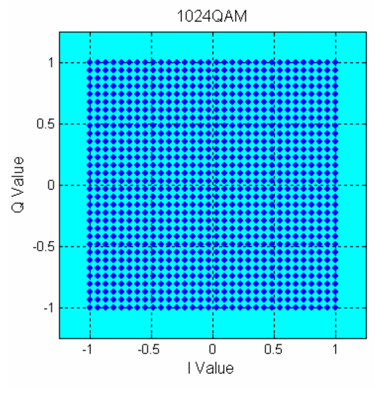
`SOUR:BB:DM:FORM QAM256`



1024QAM

10 bits per symbol

`SOUR:BB:DM:FORM QAM1024`



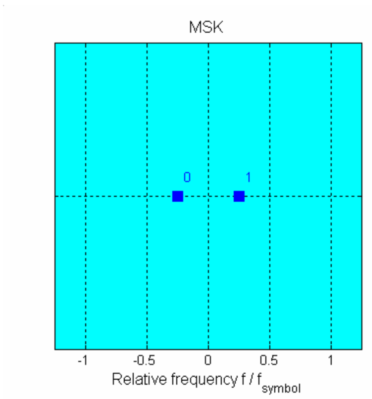
FSK

Note:
In addition to the following FSK modulations, a variable FSK modulation with definable deviation per symbol is available.

MSK

1 bit per symbol
FSK deviation

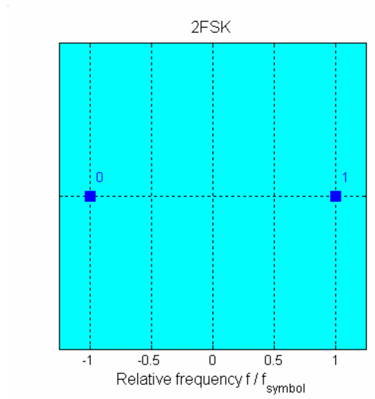
```
SOUR:BB:DM:FORM MSK
SOUR:BB:DM:FSK:DEV 0.1 MHz
```



2FSK

1 bit per symbol

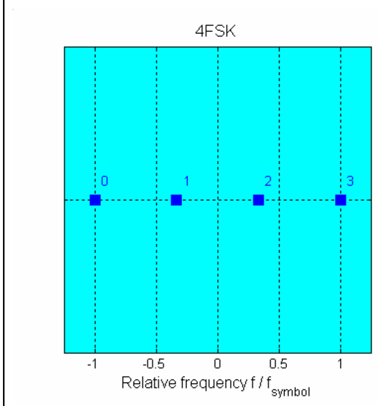
`SOUR:BB:DM:FORM FSK2`



4FSK

2 bits per symbol

`SOUR:BB:DM:FORM FSK4`



Coding - Custom Digital Mod

Modulation symbols are coded directly before I and Q values or frequency shifts are assigned. Coding is thus directly related to modulation methods, which is the reason why codings are not freely combinable with modulation methods. The following table shows which of the coding combinations are available and defines the modulation types for which the various coding procedures can be used.

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} and so on. The same applies to the output symbols.

Permissible coding combinations for modulation symbols and modulation type

	OFF	**Differ-ence**	**Phase differ-ence**	**Differ-ence + Gray**	**Gray**	**GSM**	**NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT**	**TFTS/ TETRA**	**INMARSAT, ICO, WCDMA 3GPP, cdma2000**	**VDL**	**APCO25 (FSK)**
ASK	X	X		X	X						
BPSK	X	X		X	X						
π/2 DBPSK	X				X						
QPSK	X	X		X	X				X		
QPSK 45° Offset	X	X		X	X				X		
π/4 QPSK	X	X			X						
π/4 DQPSK	X				X		X	X			
8PSK	X	X		X	X					X	
8PSK_EDGE	X										
π/8 D8PSK	X				X						
MSK	X	X		X	X	X					
2FSK	X	X		X	X	X					
4FSK	X	X		X	X						X
16QAM	X	X	X	X	X						
32QAM	X	X	X	X	X						
64QAM	X	X	X	X	X						
256QAM	X	X	X	X	X						
1024QAM	X	X	X	X	X						

Modulation type π/4DQPSK

With differential coding switched on at the same time, a constellation diagram is obtained for π/4DQPSK which is similar to that obtained for 8PSK. Phase shifts are however assigned to the individual modulation symbols. The following tables show the assignment of modulation symbols to phase shifts of the I/Q vector in relation to the selected coding.

Phase shifts for π/4DQPSK

Modulation symbol a_n (binary indication: MSB, LSB)	00	01	10	11
Phase shifts without coding	+ 45°	+135°	- 135°	-45°
Phase shifts with coding NADC, PDC, PHS, TETRA or APCO25 (PSK)	+ 45°	+135°	-45°	- 135°
Phase shifts with coding TFTS	- 135°	+135°	-45°	+ 45°

Coding algorithms

Common coding types are listed in the following table.

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	dc_n = not (d_n exor d_{n-1})	k = 1

Example 1: Differential coding for QPSK modulation with K = 2 bit/symbol

Decimal display; value range for modulation symbols

$$a_n \in \{0; 1; 2; 3\}$$

Recursive coding is defined as follows: $b_n = (a_n + b_{n-1})$ modulo 4.

Depending on the state of a preceding modulation symbol b_{n-1} the coded modulation symbol b_n is obtained for example from modulation symbol $a_n = 2$ as follows:

$a_n = 2$	b_{n-1}	b_n
	0	2
	1	3
	2	0
	3	1

By means of differential coding, the assignment between modulation symbols and phase differences shown in the following table is generated:

Modulation symbol a_n (binary, MSB, LSB)	00	01	10	11
Phase difference	0°	90°	180°	270°

Example 2: Gray and differential coding for 8PSK modulation

First, a gray coding is performed according to the gray code. Afterwards, a differential coding is performed according to the recursive coding algorithm quoted above. The assignment between modulation symbols and phase differences shown in the following table is generated:

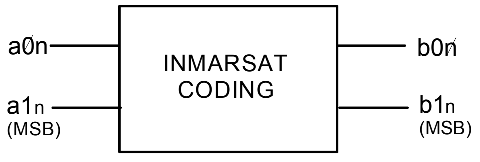
Modulation symbol a_n (binary, MSB, LSB)	000	001	010	011	100	101	110	111
Phase difference	0°	45°	135°	90°	270°	315°	225°	180°

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

Differential coding according to VDL

Modulation symbol d_n (binary, MSB, LSB)	000	001	010	011	100	101	110	111
Phase difference	0°	45°	135°	90°	315°	270°	180°	225°

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. It uses the following algorithm.



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 $b_{1(n-1)}$)]

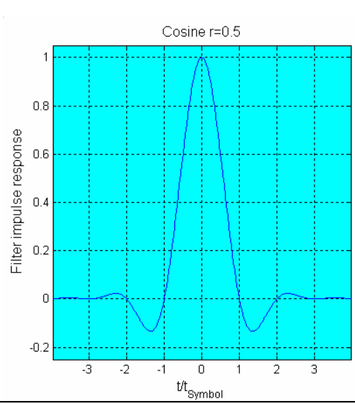
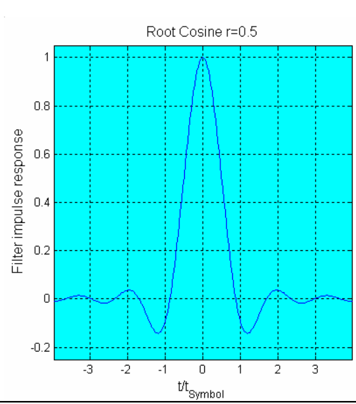
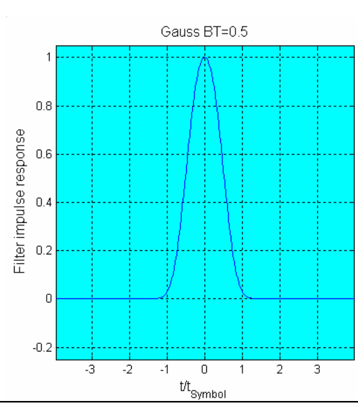
Baseband Filter - Custom Digital Mod

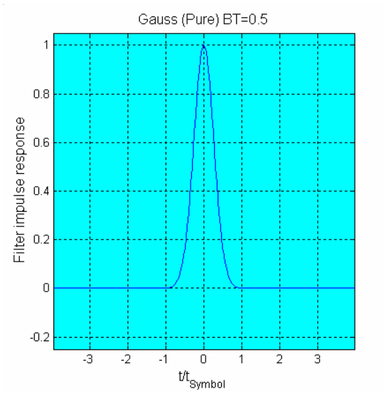
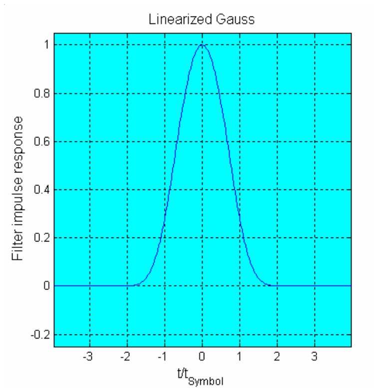
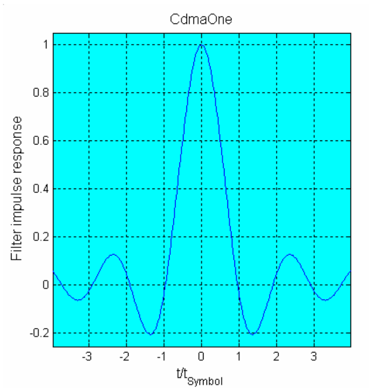
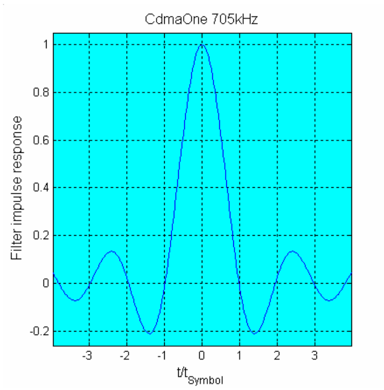
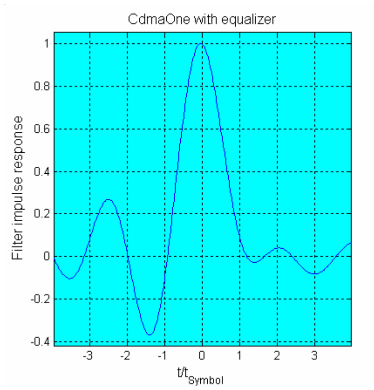
The R&S AMU offers a wide selection of predefined baseband filters. The filter characteristic for the selected filter is displayed in the **More..**. submenu in the **Filter** menu section (see "*More - Filter - Digital Modulation*", page 4.193).

The following table shows the filters that are available, together with the associated parameters and IEC bus commands. The filter characteristic is displayed in graphical form.

Baseband filter

Cosine
Roll Off Factor
`SOUR:BB:DM:FILT:TYPE COS`
`SOUR:BB:DM:FILT:PAR:COS 0.99`
	Root Cosine ($\sqrt{\cos}$)
	Roll Off Factor
	`SOUR:BB:DM:FILT:TYPE RCOS`
	`SOUR:BB:DM:FILT:PAR:RCOS 0.99`
		Gauss (FSK)
		B x T
		`SOUR:BB:DM:FILT:TYPE GAUS`
		`SOUR:BB:DM:FILT:PAR:GAUS 2.5`

<table>
<tr>
<td>Pure Gauss
B x T
<code>SOUR:BB:DM:FILT:TYPE PGA</code>
<code>SOUR:BB:DM:FILT:PAR:PGA 2.5</code>

</td>
<td>Gauss Linearized
<code>SOUR:BB:DM:FILT:TYPE LGA</code>

</td>
<td>cdmaOne
<code>SOUR:BB:DM:FILT:TYPE CONE</code>

</td>
</tr>
<tr>
<td>cdmaOne 705 kHz
<code>SOUR:BB:DM:FILT:TYPE COF705</code>

</td>
<td>cdmaOne + Equalizer
<code>SOUR:BB:DM:FILT:TYPE COE</code>

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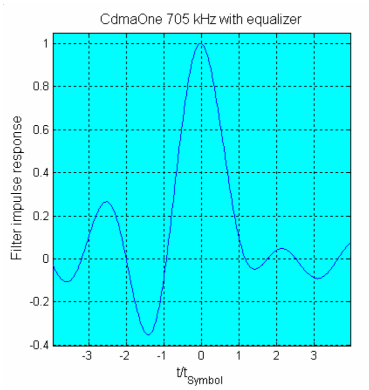
<td>cdmaOne 705 kHz + Equalizer
<code>SOUR:BB:DM:FILT:TYPE COFE</code>

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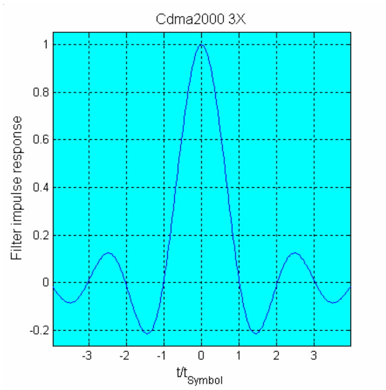
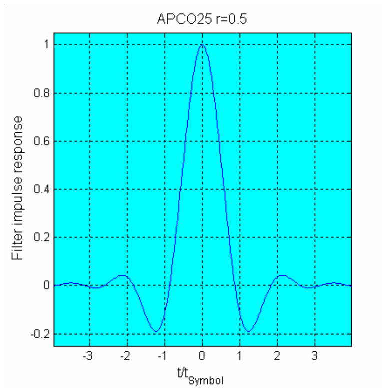
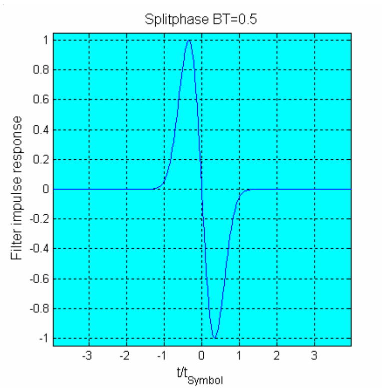
<td>cdma2000 3X

<code>SOUR:BB:DM:FILT:TYPE DM3x</code>
</td>
<td>APCO25
Roll Off Factor
<code>SOUR:BB:DM:FILT:TYPE APCO25</code>
<code>SOUR:BB:DM:FILT:PAR:APC 0.5</code>
</td>
<td>Split Phase
BxT
<code>SOUR:BB:DM:FILT:TYPE SPH</code>
<code>SOUR:BB:DM:FILT:PAR:SPH 0.15</code>
</td>
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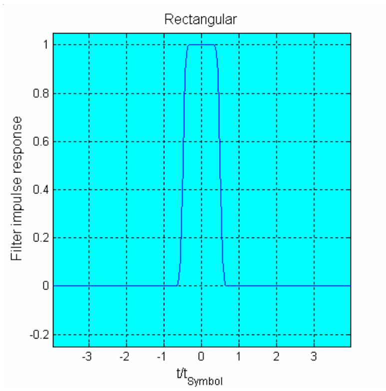
<table>
<tr>
<td>Rectangular

<code>SOUR:BB:DM:FILT:TYPE RECT</code>
</td>
</tr>
</table>

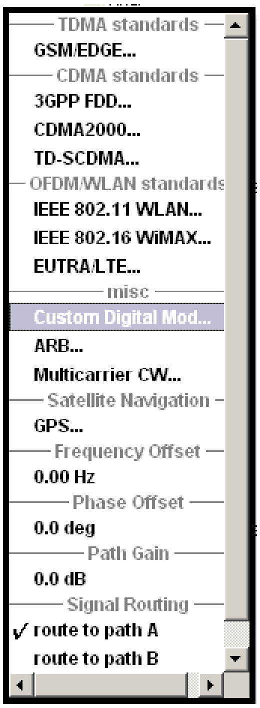
Conflicting Settings - Custom Digital Mod

Having selected a modulation procedure, not every combination is possible when selecting the settings for the modulation parameters **Symbol Rate** and **Coding**. These restrictions inevitably give rise to conflicting settings if a parameter is changed and leads to a prohibited combination.

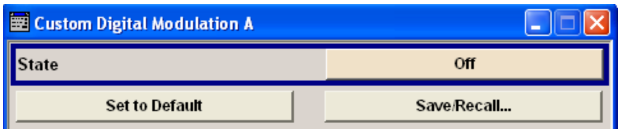
A conflicting setting is indicated by a message on the Info line in the display. The R&S AMU displays the setting entered by the user, but the modulation signal actually generated does not correspond to this display. A conflict of settings can be triggered if the user changes a parameter inappropriately. The message disappears as soon as a conflict-free setting is entered. A list of the possible settings conflicts and messages in digital modulation can be found in chapter 9 "*Error messages*".

Custom Digital Mod Menu

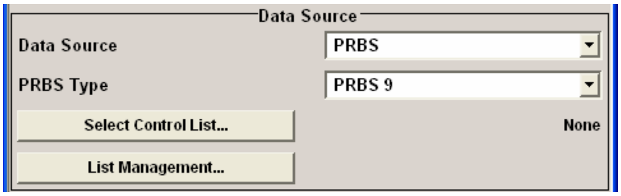
The menu for setting digital modulation can be opened either in the **Baseband** block or in the menu tree under Baseband.



The **Custom Digital Modulation** menu enables direct selection of the data source, standard, symbol rate, coding, modulation type and filter. All other settings are entered in submenus which are called via **More** buttons.

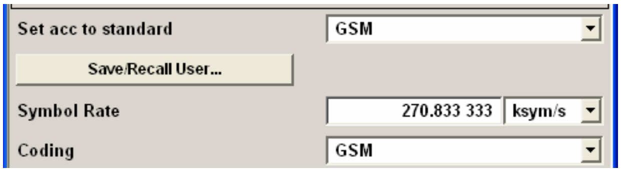


The upper part of the menu is used for powering up digital modulation as well as for calling the default settings and user-defined standards.

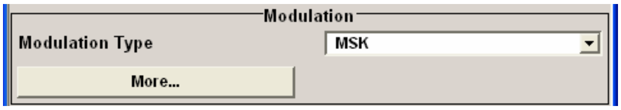


The data source is selected and set in the **Data Source** section.

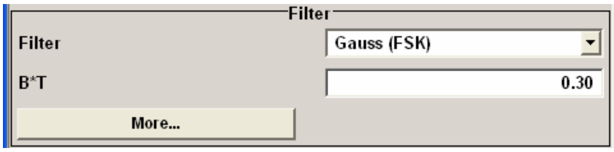
The **More** button opens a submenu for calling the data editor and the file manager.



The middle part of the menu is used for selecting the standard, the symbol rate and the coding.

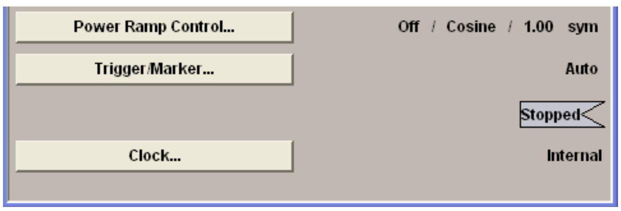


The modulation type is set in the **Modulation** section. The **More** button opens a submenu that displays the mapping for the selected modulation.



The filter is set in the **Filter** section.

The **More** button opens a submenu where the filter characteristic of the selected filter is displayed.



The buttons in the lower part of the menu open submenus for power ramping and for configuring triggers and clocks.

In each case the current setting is displayed next to the button.

Custom Digital Modulation Main Menu

The upper part of the menu is used for powering up digital modulation as well as for calling the default settings and user-defined standards.

State - Digital Modulation

Enables/disables digital modulation.

Switching on digital modulation turns off all the other digital standards on the same path.

The digital modulation is generated in realtime (no precalculated signal), and therefore all parameter changes (in the ON state) directly affect the output signal.

Remote-control command:
`SOUR:BB:DM:STAT ON`

Set To Default - Digital Modulation

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

Remote-control command:
`SOUR:BB:DM:PRES`

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
Time	1 sym
Function	Cos
Fall Offset	0
Rise Offset	0

Parameter	Value
Source	Internal
State	Off
Trigger	
Mode	Auto
Source	Internal
Ext. Delay	0
Ext. Inhibit	0
Clock	
Source	Internal
Mode	Symbol
Delay	0

Save/Recall - Digital Modulation

Calls the **Save/Recall** menu.

From the **Save/Recall** menu the **File Select** windows for saving and recalling the complete settings in the **Custom Digital Modulation** menu can be called.

The Digital Modulation Settings are stored as files with the predefined file extension ***.dm**. The file name and the directory they are stored in are user-definable.

The complete settings in the **Custom Digital Modulation** menu are saved and recalled.

Remote-control commands:
```
MMEM:MDIR 'F:\gen\dig_mod\sett'

SOUR:BB:DM:SETT:CAT?
SOUR:BB:DM:SETT:DEL
SOUR:BB:DM:SETT:LOAD
SOUR:BB:DM:SETT:STOR
```

The data source is selected and set in the **Data Source** section. The parameters offered depend on the data source selected. The **More** button opens a submenu for calling the data editor and the file manager.

Data Source - Digital Modulation

Selects the data source (see also section "*Data and Signal Sources in Baseband*", page 4.153).

You may choose from the following data sources:

All 0
All 1

0 data or 1 data is internally generated.

Remote-control command:
`SOUR:BB:DM:SOUR ONE | ZERO`

PRBS

PRBS Type

PRBS data in accordance with the IUT-T with period lengths between 2^9-1 and 2^{23}-1 are internally generated.

The length is selected in the **PRBS Type** input box.

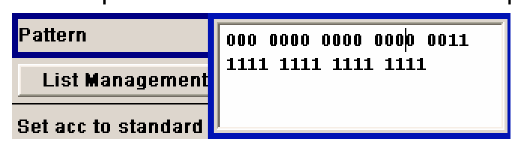
Remote-control commands:
`SOUR:BB:DM:SOUR PRBS`
`SOUR:BB:DM:PRBS 9|11|15|16|20|21|23`

Pattern

Pattern

A user-definable bit pattern with a maximum length of 64 bits is internally generated.

The bit pattern is defined in the **Pattern** input box.



Remote-control command:
`SOUR:BB:DM:SOUR PATT`
`SOUR:BB:DM:PATT #H77550,17`

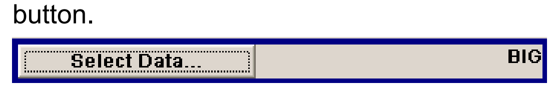
Data List

...Select Data

Data lists will be used.

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

Data lists are selected in the **File Select** window, which is called by means of the **Select Data** button.



The **File Manager** is used to transmit external data lists to the R&S AMU, and can be called within every File Select window by means of the **File Manager** button.

Remote-control command:
`SOUR:BB:DM:SOUR DLIS`
`SOUR:BB:DM:DLIS:SEL "d_list1"`

External Serial

External serial data is supplied via the DATA connector.

Remote-control command:
`SOUR:BB:DM:SOUR SER`

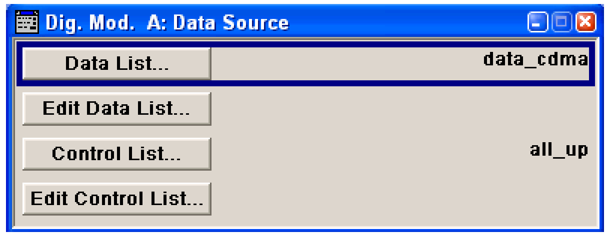
External Parallel (AUX I/O)

External parallel data is supplied externally via the PARDATA pins on the AUX I/O interface.

Remote-control command:
`SOUR:BB:DM:SOUR PAR`

List Management - Digital Modulation

Calls the menu for managing data and control lists (see section "*List Management - Digital Modulation Menu*", page 4.194).



Remote-control command: n.a.

The middle part of the menu is used for selecting the standard, the symbol rate and the coding.

Set acc. to Standard - Digital Modulation

Selects a standard.

After selection, modulation parameters **Modulation Type**, **Symbol Rate**, **Filter** and **Coding** are automatically set in accordance with the standard.

If one of these parameters is subsequently altered, the display changes to User. The User setting can be saved to a file so that it can be recalled at some later time (**Save/Recall User...** button).

The following table shows the standards that are available, together with the associated settings of the modulation parameters.

Remote-control command:
`SOUR:BB:DM:STAN PDC`

Standards - Custom Digital Modulation

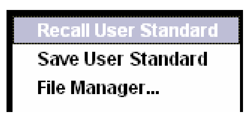
Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for IEC command
Bluetooth	2FSK, Deviation 160.0 kHz	1.0 Msym/s	Gauss, B*T = 0,5	OFF	`BLUetooth`
DECT	2FSK, Deviation 288.0 kHz	1.152 Msym/s	Gauss, B*T = 0,5	OFF	`DECT`
ETC (ARIB STD T55)	ASK, ASK Depth 100%	1.024 Msym/s	Split Phase, B*T = 2.0	OFF	`ETC`
GSM	MSK	270.833333 ksym/s	Gauss, B*T = 0.3	GSM	`GSM`
GSM EDGE	8PSK EDGE ($3\pi/8$ 8PSK)	270.833333 ksym/s	Gauss linear	OFF	`GSMEdge`
NADC	$\pi/4$ DQPSK	24.3 ksym/s	SQR COS, α = 0.35	NADC	`NADC`
PDC	$\pi/4$ DQPSK	21.0 ksym/s	SQR COS, α = 0.50	PDC	`PDC`
PHS	$\pi/4$ DQPSK	192.0 ksym/s	SQR COS, α = 0.50	PHS	`PHS`
TETRA	$\pi/4$ DQPSK	18.0 ksym/s	SQR, α = 0.35	TETRA	`TETRa`
WCDMA 3GPP	QPSK 45° Offset	3.84 Msym/s	SQR, α = 0.22	WCDMA 3GPP	`W3GPp`
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	WCDMA 0.22	OFF	`TCSCdma`

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for IEC command
cdma2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	`CFORward`
cdma2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	`CREVerse`
Worldspace	QPSK	1.84 Msym/s	SQR COS, α = 0.40	Worldspace	`WORLdspace`
TFTS	π/4 DQPSK	22.1 ksym/s	SQR COS, α = 0.40	TFTS	`TFTS`

Save/Recall User - Digital Modulation

Calls the **Save/Recall User** menu.

From the **Save/Recall** menu the **File Select** windows for saving and recalling user-defined standards and the **File Manager** can be called.



User standards are stored as files with the predefined file extension ***.dm_stu**. The file name and the directory they are stored in are user-definable.

Remote-control commands:

```
MMEM:MDIR 'F:\gen\gen_lists\dm'

SOUR:BB:DM:STAN:ULIS:CAT?
SOUR:BB:DM:STAN:ULIS:DEL
SOUR:BB:DM:STAN:ULIS:LOAD
SOUR:BB:DM:STAN:ULIS:STOR
```

Symbol Rate - Digital Modulation

Selects the symbol rate.

The value range is dependent on the selected modulation type.

When the modulation type changes, the range is automatically redefined. If the set symbol rate is outside this range, an error message is generated and the maximum value for the newly chosen modulation type is automatically set.

Remote-control command:

```
SOUR:BB:DM:SRAT 15 MHz
```

Coding - Digital Modulation

Selects the coding (see section "*Coding - Custom Digital Mod*", page 4.179).

The menu offers only the coding settings that are permissible for the chosen modulation type. The other coding methods are grayed out.

If the system is subsequently switched to a modulation type for which the selected coding is not available, coding is automatically set to OFF.

Remote-control command:
`SOUR:BB:DM:COD`

The modulation type is set in the **Modulation** section. The parameters offered depend on what is currently selected. The **More...** button opens a submenu for displaying the user-defined mapping.

Modulation Type - Digital Modulation

Selects a modulation type.

The associated symbol mapping is displayed in the **More...** submenu (see also table *Modulation type and associated mapping, page 4.175*).

If the coding that is set is not possible with the chosen modulation type, **coding** is set to **Off**.

You may choose from the following:

ASK, the PSK modulations BPSK, QPSK, QPSK 45° Offset, OQPSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8-D8PSK, 8PSK, 8PSK EDGE, the QAM modulations 16QAM to 1024QAM and the FSK modulations MSK, 2FSK , 4FSK and Variable FSK.

For selection "Variable FSK", the deviation of each symbol can be set in the **More...** submenu.

Remote-control command:
`SOUR:BB:DM:FORM ASK`

Load User Mapping - Digital Modulation

Selects user defined mapping table. This opens the **Select List File User Mapping** window in which the mapping table can be selected.

Remote-control command:
`SOUR:BB:DM:MLIS:SEL "d_mod_list1"`

ASK Depth - Digital Modulation

Sets the modulation depth for ASK modulation.

Remote-control command:
`SOUR:BB:DM:ASK:DEPT 100 PCT`

FSK Deviation - Digital Modulation

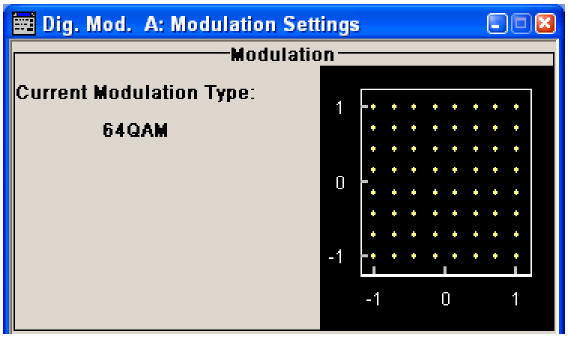
Sets the frequency deviation for FSK modulation. The range of values depends on the chosen symbol rate (see data sheet).

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

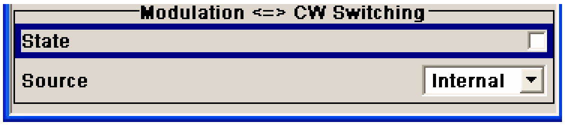
Remote-control command:
`SOUR:BB:DM:FSK:DEV 5 Hz`

More - Modulation Type - Digital Modulation

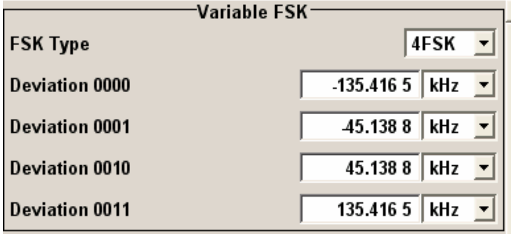
Calls the submenu which displays the mapping of the currently selected modulation type and the digital modulation delay in the case of an external data source.



The **Modulation - CW Switching** section can be used to enable switching a carrier signal between modulated and unmodulated.



In case of selection **Variable FSK**, the FSK type and the deviation for each symbols is set in the **Variable FSK** section.



FSK Type - Digital Modulation

(Variable FSK only)

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

You may choose from 4FSK, 8FSK and 16FSK.

Remote-control command:
`SOUR:BB:DM:FSK:VAR:TYPE FSK8`

Deviation xxxx - Digital Modulation

(Variable FSK only)

Set 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-control command:
`SOUR:BB:DM:FSK:VAR:SYMB2:DEV 13E3`

Modulation Delay - Digital Modulation

(Data Source ext serial and ext parallel only)

Displays the digital modulation delay from the data input to the I/Q output.

The value is displayed only if an external synchronous data source is selected. In this case the value represents the delay between the active clock edge for data and the corresponding peak I/Q value (associated with this data item) on the I/Q connectors.

Remote-control command:
`SOUR:BB:DM:MDEL?`

Current Modulation Type - Digital Modulation

Displays the currently selected modulation type together with its associated mapping.

Remote-control command: n.a.

The **Modulation ⇔ CW Switching** section is used to enable switching a carrier signal between modulated and unmodulated.

State Mod - CW - Digital Modulation

State Enables switching between a modulated and an unmodulated carrier signal.

Switching is carried out by a control signal (CW) that is defined internally in the control list or supplied from an external source via a user-defined input.

Remote-control command:
```
SOUR:BB:DM:SWIT:SOUR INT
SOUR:BB:DM:CLIS:SEL 'CLIST1'
SOUR:BB:DM:SWIT:STAT ON
SOUR:BB:DM:SWIT:SOUR EXT
SOUR:BB:DM:SWIT:STAT ON
```

Source Mod - CW - Digital Modulation

Selects the CW control signal for switching between a modulated and an unmodulated carrier signal.

Internal The CW signal in the control list is used for the control. The internal signal can be output on one of the user interfaces.

Remote-control command:
`SOUR:BB:DM:SWIT:SOUR INT`

External The control signal **CW-Mode In** is used for the control. This signal can be input on one of the user interfaces.

Remote-control command:
`SOUR:BB:DM:SWIT:SOUR EXT`

Filter - Digital Modulation

Selects the baseband filter (see also section "*Baseband Filter - Custom Digital Mod*", page 4.181).

Remote-control command:
`SOUR:BB:DM:FILT:TYPE COS`

The filter is set in the **Filter** section.

Filter Parameter- Digital Modulation

Sets the filter parameter.

The filter parameter offered as the setting depends on the currently selected filter type.

Remote-control commands:
```
SOUR:BB:DM:FILT:PAR:APCO25 0.2
SOUR:BB:DM:FILT:PAR:COS 0.35
SOUR:BB:DM:FILT:PAR:GAUS 0.5
SOUR:BB:DM:FILT:PAR:PGA 0.5
SOUR:BB:DM:FILT:PAR:RCOS 0.35
SOUR:BB:DM:FILT:PAR:SPH 2
```

More - Filter - Digital Modulation

Calls the menu for displaying the filter characteristic of the currently selected filter.

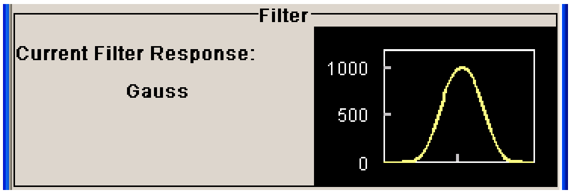
Load User Filter- Filter - Digital Modulation

Calls the menu for selecting a user-defined filter. The button is only available if filter type **USER** is selected.

Remote-control command:
`SOUR:BB:DM:FLIS:SEL user_filter3`

Current Filter Response

Displays the filter characteristic of the currently selected filter.



Remote-control command: n.a.

The lower part of the **Custom Digital Modulation** menu is used for setting triggers and clocks, as well as for power ramp settings.

Power Ramp Control - Digital Modulation

Calls the power ramp control menu (see section "*Power Ramp Control - Digital Modulation Menu*", page 4.203).

Remote-control command: n.a.

Trigger/Marker - Digital Modulation

Calls the **Trigger/Marker/Clock** menu. The **Trigger/Marker/Clock** menu is used to select the trigger source, set the time delay on an external trigger signal and configure the marker output signals (see section "*Trigger/Marker/Clock - Custom Digital Modulation Menu*", page 4.206).

Remote-control command: n.a.

Execute Trigger - Digital Modulation

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than Auto have been selected.

Remote-control commands:
`SOUR:BB:DM:TRIG:SOUR INT`
`SOUR:BB:DM:SEQ RETR`
`SOUR:BB:DM:TRIG:EXEC`

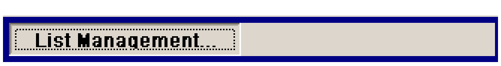
Clock - Digital Modulation

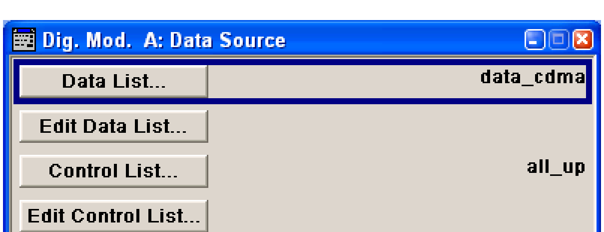
Calls the **Trigger/Marker/Clock** menu. The **Trigger/Marker/Clock** menu is used to select the clock source (see section "*Trigger/Marker/Clock - Custom Digital Modulation Menu*", page 4.206).

Remote-control command: n.a.

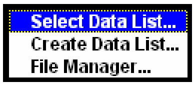
List Management - Digital Modulation Menu

The **List Management** menu is called from the **Digital Modulation** main menu.





The data and control lists are selected and created in the **File Select** menu which is called up by means of the **Data List...** and **Control List...** buttons.



The **File Manager** is used to copy, rename and delete files and to create directories (see also Chapter 3, section "*File Management*")

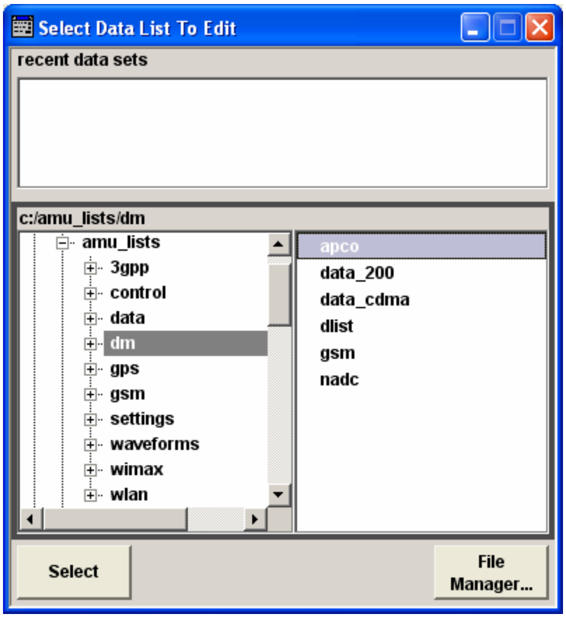
To ensure that the selected data or control list is used for generating the digital signal, the list must be selected as the data source:

Data	Parameter	Selection
Digital data	Source:	DList
Marker	Marker Mode:	CList
Control signals CW, Level Attenuation and Burst Gate	Source	Internal

The data editor is called using the **Edit Data List...** and **Edit Control List...** buttons. The contents of the selected list are displayed. Operating the list editors is described in Chapter 3, section "*List Editors*".

Select Data/Control List - Digital Modulation

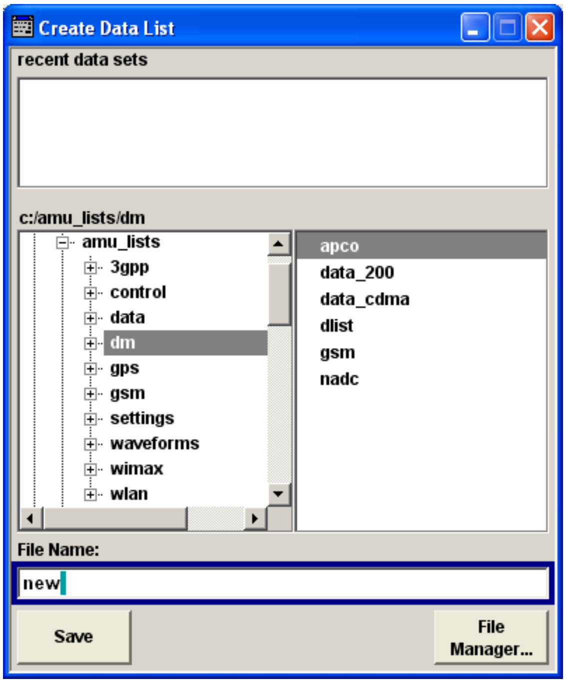
Selects data/control list. This opens the **File Select** window in which the data/control list can be selected.



Remote-control commands:
`SOUR:BB:DM:DLIS:SEL "d_list1"`
`SOUR:BB:DM:CLIS:SEL "c_list3"`

Create Data/Control List - Digital Modulation

Creates new data/control list. This opens the **File Select** window in which the data/control list can be created.



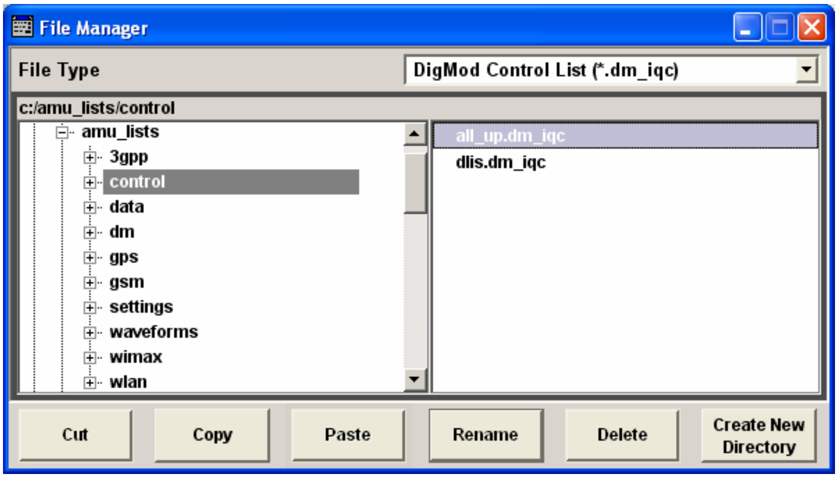
The file name has to be entered in field **File Name:**. The new list contains no data, it can be edited in the list editor.

Remote-control commands:
`SOUR:BB:DM:DLIS:SEL "d_list1"`
`SOUR:BB:DM:CLIS:SEL "c_list3"`

File Manager - Digital Modulation

Calls the **File Manager**.

The File Manager is used to copy, delete and rename files and to create new directories.




```
Remote-control commands:
SOUR:BB:DM:DLIS:SEL "d_list1"
SOUR:BB:DM:DLIS:COPY "D_list2"
SOUR:BB:DM:DLIS:DEL "c_list1"
SOUR:BB:DM:CLIS:SEL "c_list3"
SOUR:BB:DM:CLIS:COPY "c_list2"
SOUR:BB:DM:CLIS:DEL "c_list1"
MMEM:MDIR "D:\user\new"
```

Data List Editor - Digital Modulation

The **Data List Editor** for editing the selected data list is called up in the **Data/Control List Management** submenu of the **Digital Modulation** main menu by means of the **Edit Data List...** button. Chapter 3, Section "*List Editor*" describes how to use the editor.

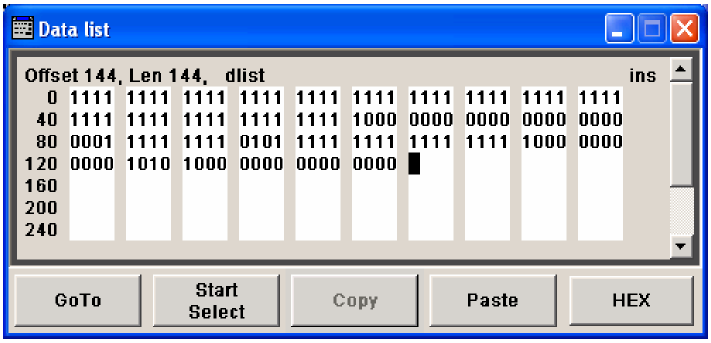
A list of binary values with a maximum length of 2^31 bits can be entered in the **Data Editor**. This value corresponds to a file size of approx. 268 Mbyte. While it is being processed, the file is continuously automatically buffered. When the menu is exited, the file is automatically saved with the new values, i.e. there is no extra **Save** button. Depending on the size of the file, saving may take some time.

To increase readability, the bits are displayed in groups of four. The current cursor position, the length of the list and the list file name are displayed above the list. The offset starts with the value 0 which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.

An existing list can be edited in the insert or overwrite mode.

Remote-control commands:

```
SOUR:BB:DM:DLIS:SEL "d_list1"
SOUR:BB:DM:DLIS:DATA 1,1,0,1,0,1,0,1,1,1,1,0,0,0
SOUR:BB:DM:DLIS:DATA:APP 1,1,0,1,0,1,0,1,1,1,1,0,0,0
```



GoTo - Digital Modulation

Opens the entry window for the bit position. The cursor marks the bit at the selected position.

Remote-control command: n.a.

Start Select - Digital Modulation

Defines the current cursor position as the start position for the range to be marked. The stop position is defined by entering an offset under **GoTo**.

When a start position has been activated, the button will be re-labelled to **Undo Select**. When the button is clicked now, the selected range will be deactivated.

Remote-control command: n.a.

Copy - Digital Modulation

Copies the selected values.

Remote-control command: n.a.

Cut - Digital Modulation

Cuts the selected values.

Remote-control command: n.a.

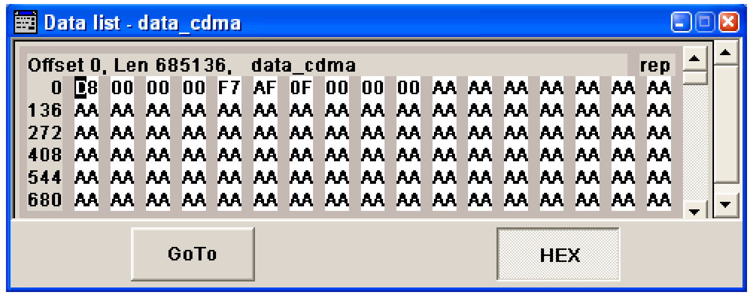
Paste - Digital Modulation

Pastes the values that have been copied or cut before.

Remote-control command: n.a.

Hex - Digital Modulation

Switchover to hexadecimal display.

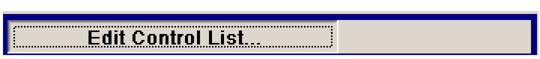


Each four bits are displayed as a hexadecimal value: To increase readability, the hexadecimal values in turn are displayed in pairs of two. The hex functions are automatically assigned to the numeric keys at the front panel.

Remote-control command: n.a.

Control and Marker List Editor - Digital Modulation

The **Control and Marker List Editor** for editing the selected control list is called up in the **Data/Control List Management** submenu of the **Digital Modulation** main menu by means of the **Edit Control List...** button.



The four available marker signals and the CW, Hop, Burst Gate and Level Attenuation control signals can be defined in the **Control and Marker List Editor**.

Note:

The marker signals defined in the Control and Marker List Editor are activated by selecting the Marker mode "CList" in the Trigger/Marker/Clock menu.
The control signals have to be activated by selecting an "Internal" Source in the respective setting menu, e.g. the Power Ramp Control menu for the Burst Gate and Level Attenuation control signals.

While it is being processed, the file is continuously automatically buffered. When the menu is exited, the file is automatically saved with the new values, i.e. there is no extra **Save** button. Depending on the size of the file, saving may take some time.

The configuration of the currently selected control list is displayed. This list is either selected in the **File Select** menu (**Data/Control List Management** submenu by means of the **Control List...** button) or via

Remote-control commands:
`SOUR:BB:DM:CLIS:SEL "c_list3"`
`SOUR:BB:DM:CLIS:DATA 0,8,8,8,8,8,8,0,0,0,...`

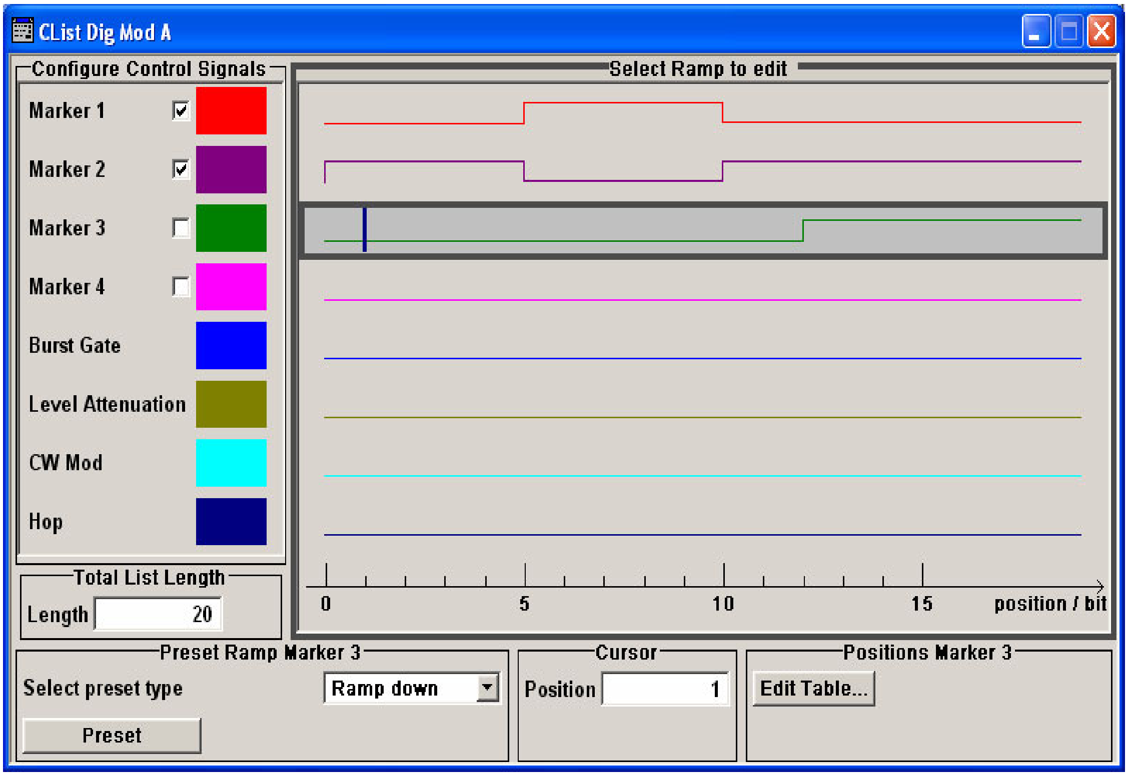
The available marker/control signals are color-coded. In the left **Configure Control Signal** section, each individual signal is assigned a colour; a check in the check box shows the marker for which the "**CList**" marker type has been selected and the control signal for which the "**Internal**" source has been selected.

In the **Select Ramp to Edit** section the signal characteristics are graphically displayed. The scaling of the x-axis is always adapted to the overall length of the control list to provide constant overview of all defined ramps.

The ramps can be assigned the exact bit position in the signal by means of

- The bit scale below the marker/control signal characteristic.
- The display of the current cursor position in the **Cursor** menu section if the cursor marks the ramp.

The ramps can be set either graphically in the **Select Ramp to Edit** section or in the table of the **Positions** <**Signal**> section in the lower right corner. To make the setting easy, a selection of preset ramp characteristics is offered in the **Preset Ramp <Signal>** section.



Configure Control Signal - Digital Modulation

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

Displays whether the "**CList**" marker type has been selected in the Trigger/Marker/Clock menu for this marker.

Displays whether the "**Internal**" source has been selected for this control signal in the individual setting menu. Burst Gate and Level Attenuation are set in the **Power Ramping** submenu, CW in the **Modulation** submenu.

The source "**CList/Internal**" for the individual marker/control signal can be selected here as well and will then be used in the associated menus.

Remote-control command: n.a.

Select Ramp to Edit - Digital Modulation

Graphically edit marker/control signals.

For this purpose, the cursor is set to the position where a ramp is required. The ramp is generated by pressing Enter (e.g. clicking on the rotary knob). Any number of ramps can be defined per marker. Each of the generated ramp positions will be saved even if the definition of another ramp produces a low/low or high/high transition. These ramps are displayed as dashed lines.

Existing ramps can be shifted after the cursor has been placed on the ramp and Enter has been pressed - it then changes colour twice. The ramp is shifted by using the cursor keys or the rotary knob. The new position is determined by pressing Enter again.

Ramps can be deleted by means of the BACK-SPACE key after the cursor has been placed on the ramp.

Chapter 3 describes how to operate the control and marker list editor in detail.

Remote-control command: n.a.

Total List Length - Digital Modulation

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.

With very long control lists, the displayed area can be zoomed to approx. 300 bits around the current cursor position (**Zoom in** button).

The preset functions set the ramp in the center of the currently selected area.

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.

Remote-control command: n.a.

Preset Ramp - Digital Modulation

Activates presetting for the ramp characteristic of the selected control signal. The presetting is selected with **Select Preset Type** and activated by means of the **Preset** button.

Remote-control command: n.a.

You can select from:

All Up The marker/control signal is continuously high.

All Down The marker/control signal is continuously low.

Ramp Up The marker/control signal contains a ramp from low to high. The ramp is shifted to the center of the displayed signal area and can subsequently be shifted as required.

Ramp Down The marker/control signal contains a ramp from high to low. The ramp is shifted to the center of the displayed signal area and can subsequently be shifted as required.

Ramp Up/Down The marker/control signal contains a ramp from low to high and from high to low. The ramps are symmetrically shifted around the center of the displayed signal area and can subsequently be shifted as required.

Ramp Down/Up The marker/control signal contains a ramp from high to low and from low to high. The ramps are symmetrically shifted around the center of the displayed signal area and can subsequently be shifted as required.

Cursor Position - Digital Modulation

Enters the cursor position.

In the graphic display, the cursor is positioned according to the entry.

Vice versa, graphically shifting the cursor will change the displayed value.

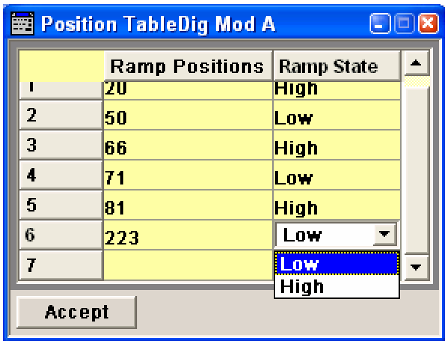
If the entered value exceeds the selected length of the definition range, the length is adjusted automatically.

Remote-control command: n.a.

Ramp Positions - Digital Modulation

Opens table by using the **Edit Table ...** button.

The ramps of the selected signal can be edited in the table. When the table is opened, the current configuration of the selected marker/control signal is displayed.



The bit position is specified in the **Ramp Position** column, the high or low signal status in the **Ramp State** column. At the end of the list, there is always a blank row for entering new values.

The changes are accepted in the graphic display after pressing the **Accept** button.

Remote-control command: n.a.

Zoom - Digital Modulation

Zooms the displayed area of the control list. The designation of the button changes from **Zoom in** to **Zoom out**.

With very long control lists, the displayed area can be zoomed to approx. 300 bits around the current cursor position.

Ramps outside the displayed area are not lost by zooming.

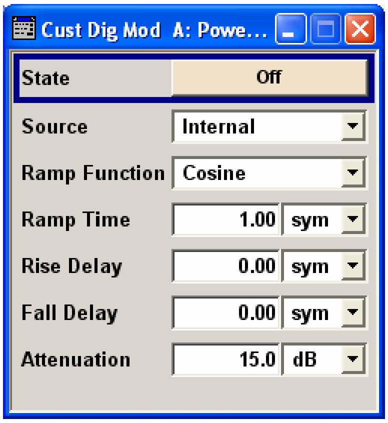
Remote-control command: n.a.

Power Ramp Control - Digital Modulation Menu

The Power Ramp Control menu is accessed via the **Digital Modulation** main menu.

The menu is used to set the power ramping. Control signals **Burst** and **Lev_Att** are used to control power ramping (see also section "*Power Ramping and Level Attenuation*", page 4.160).

Note:
Power ramping is possible up to a symbol rate of 5 MHz. If a higher symbol rate is set, power ramping is automatically switched off and an error message is output.



State - Power Ramp Control - Digital Modulation

Enables/disables power ramping.

Remote-control command:
`SOUR:BB:DM:PRAM:STAT ON`

Source - Power Ramp Control - Digital Modulation

Enters the source for the power ramp control signals.

Internal

The control signals in the internal control list are used for control purposes. The signals are output on the LEV_ATT and BURST pin on the AUX I/O interface (path A). In the case of two-path instruments, the path B signal can be placed on one of the USER interfaces.

Remote-control command:
`SOUR:BB:DM:PRAM:SOUR INT`

External Digital

The control signal is fed in via the AUX I/O interface (path A = LEV-ATT pin, path B = user-definable USER pin or USER connector).

Remote-control command:
`SOUR:BB:DM:PRAM:SOUR EXT`

Ramp Function - Digital Modulation

Enters the form of the transmitted power, i.e. the shape of the rising and falling edges during power ramp control.

Linear

The transmitted power rises and falls linear fashion.

Remote-control command:
`SOUR:BB:DM:PRAM:SHAP LIN`

Cosine

The transmitted power rises and falls with a cosine-shaped edge. This gives rise to a more favorable spectrum than the **Linear** setting.

Remote-control command:
`SOUR:BB:DM:PRAM:SHAP COS`

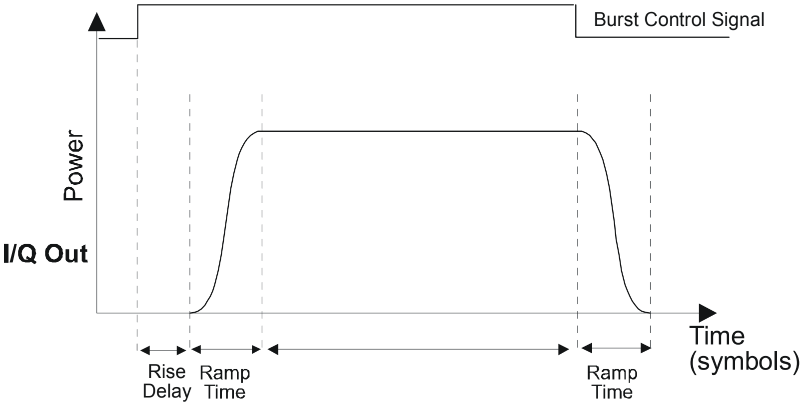
Ramp Time - Digital Modulation

Enters the power ramping rise time and fall time for a burst. The setting is expressed in symbols.

Remote-control command:
`SOUR:BB:DM:PRAM:TIME 2.5`

Rise Delay - Power Ramp Control - Digital Modulation

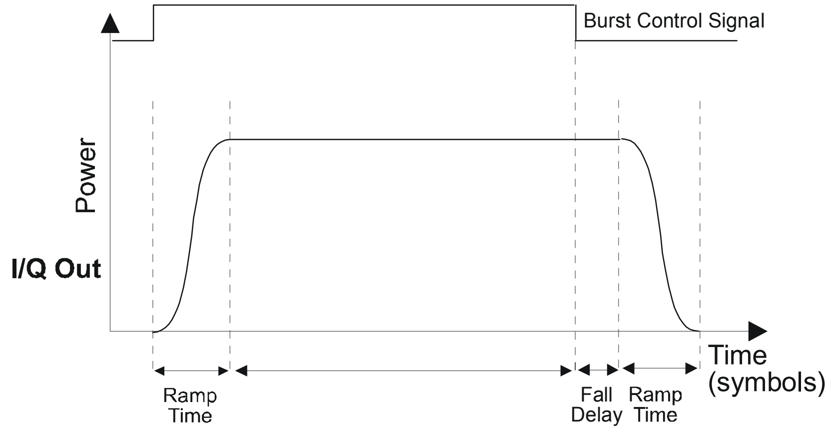
Sets the offset in the rising edge of the envelope at the start of a burst. A positive value gives rise to a delay (see figure, the envelope length decreases) and a negative value causes an advance (the envelope length increases). The setting is expressed in symbols.



Remote-control command:
`SOUR:BB:DM:PRAM:RDEL -1`

Fall Delay - Power Ramp Control - Digital Modulation

Sets the offset in the falling edge of the envelope at the end of a burst. A positive value gives rise to a delay (see figure, the envelope length increases) and a negative value causes an advance (the envelope length decreases). The setting is expressed in symbols.



Remote-control command:
`SOUR:BB:DM:PRAM:FDEL -1`

Attenuation - Power Ramp Control - Digital Modulation

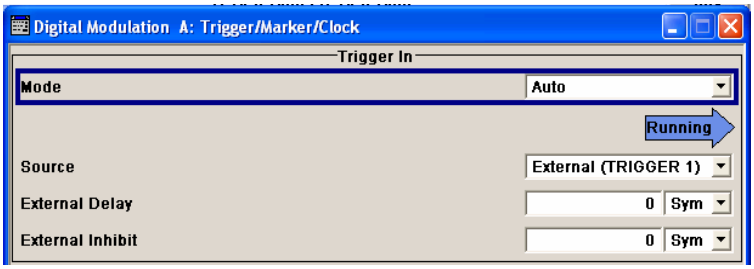
Sets the level attenuation relative to the average level for the signal ranges in which the level is set to **attenuated** (LEV_ATT control signal).

The LEV_ATT control signal is defined in the **Control Data Editor** or supplied via the LEV_ATT pin (path A) or a user-defined USER pin (path B) on the AUX I/O interface.

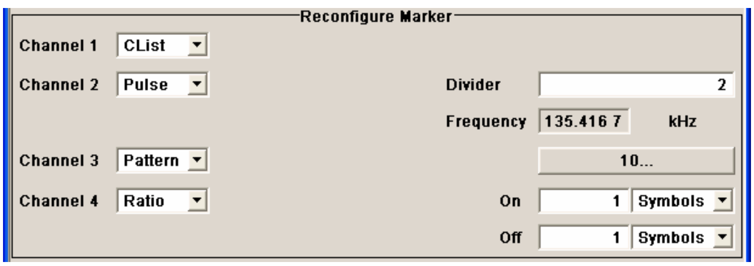
Remote-control command:
`SOUR:BB:DM:PRAM:ATT 15 dB`

Trigger/Marker/Clock - Custom Digital Modulation Menu

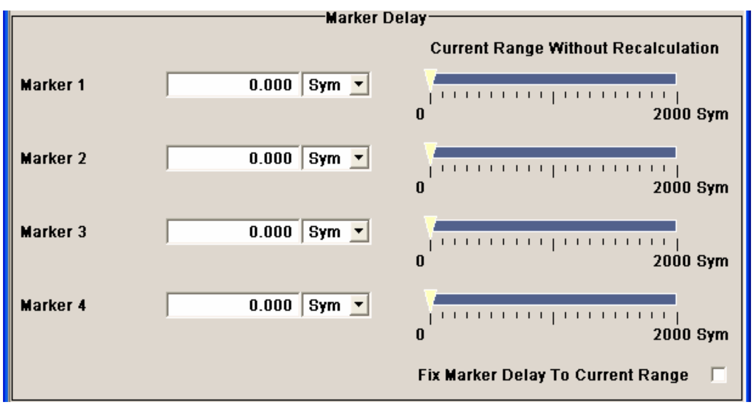
The Trigger menu is accessed via the **Digital Modulation** main menu.



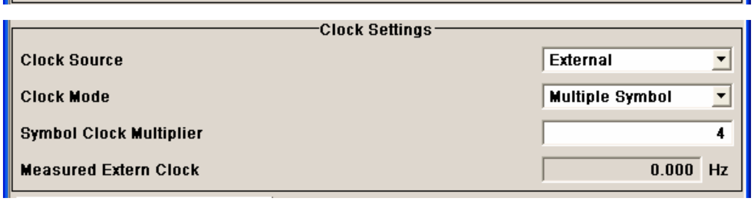
The Trigger In section is where the trigger for the modulation signal is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation (Running or Stopped) is indicated for all trigger modes.



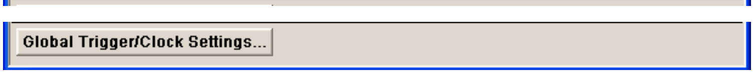
The Reconfigure Marker section is where the marker signals at the MARKER output connectors are configured.



The Marker Delay section is where a marker signal delay can be defined, either without restriction or restricted to the dynamic section, i.e. the section in which it is possible to make settings without restarting signal and marker generation.



The Clock Settings section is where the clock source is selected and - in the case of an external source - the clock type.



The Global Trigger/Clock Settings button leads to a submenu for general trigger, clock and external input settings.

The **Trigger In** section is used to configure the trigger signal for the digital modulation. The current status of signal generation is indicated for all trigger modes.

Trigger Mode - Digital Modulation

Selects trigger mode.

Auto

The digital modulation signal is generated continuously.

Remote-control command:
`SOUR:BB:DM:SEQ AUTO`

Retrigger

The digital modulation signal is generated continuously. A trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:DM:SEQ  RETR`

Armed_Auto

The digital modulation signal is generated only when a trigger event occurs. Then the digital modulation signal is generated continuously.

Button **Arm** stops signal generation. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:DM:SEQ  AAUT`

Armed_Retrigger

The digital modulation signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

The button **Arm** stops signal generation. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:DM:SEQ ARET`

Single

The digital modulation signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at **Signal Duration**. Every subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:DM:SEQ SING`

Trigger Signal Duration - Digital Modulation

Enters the length of the signal sequence to be output in the **Single** trigger mode. The input is to be expressed in symbols.

Remote-control commands:
`SOUR:BB:DM:TRIG:SLEN 200`

Running - Stopped - Digital Modulation

Displays the status of signal generation for all trigger modes. This display appears only when Custom Dig Mod is enabled (**State On**).

Remote-control command:
`SOUR:BB:DM:TRIG:RMOD?`
Response: `RUN` or `STOP`

Running

The digital modulation signal is generated; a trigger was (internally or externally) initiated in triggered mode.

If Armed_Auto and Armed_Retrigger have been selected, generation of signals can be stopped with the **Arm** button. A new trigger (internally with **Execute Trigger** or externally) causes a restart.

Stopped

The signal is not generated, and the instrument waits for a trigger event (internal or external).

Arm - Digital Modulation

Stops signal generation. This button appears only with **Running** signal generation in the **Armed_Auto** and **Armed_Retrigger** trigger modes.

Signal generation can be restarted by a new trigger (internally with **Execute Trigger** or externally).

Remote-control command:
`SOUR:BB:DM:TRIG:ARM:EXEC`

Execute Trigger - Digital Modulation

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than **Auto** have been selected.

Remote-control commands:
`SOUR:BB:DM:TRIG:SOUR INT`
`SOUR:BB:DM:SEQ RETR`
`SOUR:BB:DM:TRIG:EXEC`

Trigger Source - Digital Modulation

Selects trigger source.

Internal

The trigger event is executed by **Execute Trigger**. As a precondition a trigger mode other than **Auto** must be selected.

Remote-control command:
`SOUR:BB:DM:TRIG:SOUR INT`

Internal (Baseband A/B)

The trigger event is executed by the trigger signal from the second path (two-path instruments only).

Remote-control command:
`SOUR:BB:DM:TRIG:SOUR OBAS`

External (TRIGGER 1/2)

The trigger event is executed with the aid of the active edge of an external trigger signal. The trigger signal is supplied via the TRIGGER 1 or TRIGGER 2 connector.

The polarity, the trigger threshold and the input impedance of the TRIGGER input can be set in the **Global Trigger Settings** menu.

Remote-control command:
`SOUR:BB:DM:TRIG:SOUR BEXT`

Trigger Delay - Digital Modulation

Sets trigger signal delay in symbols on external triggering or on internal triggering via the second path.

This enables the R&S AMU to be synchronized with the device under test or other external devices.

Note:
The delay can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:DM:TRIG:EXT:DEL 3`
`SOUR:BB:DM:TRIG:OBAS:DEL 3`

Trigger Inhibit - Digital Modulation

Sets the duration for inhibiting a new trigger event subsequent to triggering. The input is to be expressed in symbols.

In the **Retrigger** mode every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of samples.

This parameter is only available on external triggering or on internal triggering via the second path.

Note:
The trigger inhibit can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:DM:TRIG:EXT:INH 0`
`SOUR:BB:DM:TRIG:OBAS:INH 0`

The marker output signal for synchronizing external instruments is configured in the **Marker Settings** section **Reconfigure Marker**.

Marker x - Digital Modulation

Selects a marker signal for the associated MARKER output.

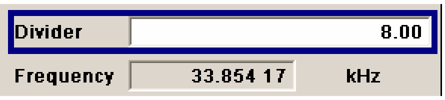
CList

A marker signal that is defined in the selected control list is generated.

Remote-control commands:
```
SOUR:BB:DM:TRIG:OUTP1:MODE CLIS
SOUR:BB:DM:CLIS:SEL 'control_dm'
```

Pulse

A regular marker signal is generated. The clock frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when **Pulse** is selected, and the resulting pulse frequency is displayed below it.



Remote-control commands:
```
SOUR:BB:DM:TRIG:OUTP1:MODE PULS
SOUR:BB:DM:TRIG:OUTP1:PULS:DIV 4
SOUR:BB:DM:TRIG:OUTP1:PULS:FREQ?
```

Pattern

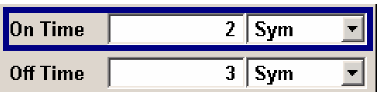
A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when **pattern** is selected.

Remote-control commands:
```
SOUR:BB:DM:TRIG:OUTP1:MODE PATT
SOUR:BB:DM:TRIG:OUTP1:PATT #B1111,4
```

ON/OFF ratio

A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.

The ON time and OFF time are each expressed as a number of symbols and are set in an input field which opens when **ON/OFF ratio** is selected.



Remote-control commands:
```
SOUR:BB:DM:TRIG:OUTP1:MODE RAT
SOUR:BB:DM:TRIG:OUTP1:OFFT 20
SOUR:BB:DM:TRIG:OUTP1:ONT  20
```

The **Marker Delay** section can be used to set a delay for the markers.

Marker x Delay - Digital Modulation

Enters the delay between the marker signal at the marker outputs and the start of the signal.

The input is expressed as a number of symbols.

If the setting "**Fix marker delay to dynamic range**" is enabled, the setting range is restricted to the dynamic range. In this range the delay of the marker signals can be set without restarting the marker and signal.

The allocation of marker signals to the outputs is described in the section "*Marker Output Signals*", page 4.162.

Remote-control command:
`SOUR:BB:DM:TRIG:OUTP2:DEL 20`

Current Range without Recalculation - Digital Modulation

Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

The delay can be defined by moving the setting mark.

Remote-control command:
`SOUR:BB:DM:TRIG:OUTP:DEL:MAX?`
`SOUR:BB:DM:TRIG:OUTP:DEL:MIN?`

Fix marker delay to current range - Digital Modulation

Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:DM:TRIG:OUTP:DEL:FIX ON`

The clock source is selected in the **Clock Settings** section.

Clock Source - Digital Modulation

Selects the clock source (also see section "*Clock Signals*", page 4.156).

Internal

The internal clock reference is used.

Remote-control command:
`SOUR:BB:DM:CLOC:SOUR INT`

External

The external clock reference is fed in as the symbol clock or a multiple thereof via the CLOCK connector. The chip rate must be correctly set to an accuracy of ± 2 % (see data sheet).

The polarity of the clock input can be changed with the aid of **Global Trigger/Clock/External Input** Settings.

In the case of two-path instruments this selection applies to path A.

Remote-control command:
`SOUR:BB:DM:CLOC:SOUR EXT`

Clock Mode - Digital Modulation

Enters the type of externally supplied clock.

Symbol

A symbol clock is supplied via the CLOCK connector.

Remote-control command:
`SOUR:BB:DM:CLOC:MODE SYMB`

Multiple Symbol

A multiple of the symbol clock is supplied via the CLOCK connector, the symbol clock is derived internally from this.

The **Multiplier** window provided allows the multiplication factor to be entered.

Note:
This setting is not possible if the serial or parallel external data source is selected.

Remote-control command:
`SOUR:BB:DM:CLOC:MODE MSYM`
`SOUR:BB:DM:CLOC:MULT 4`

Bit

A bit clock is supplied via the CLOCK connector; the symbol clock is derived internally from this.

Note:
This setting is not possible if the serial or parallel external data source is selected.

Remote-control command:
`SOUR:BB:DM:CLOC:MODE BIT`

Symbol Clock Multiplier - Digital Modulation

Enters the multiplication factor for clock type **Multiple**.

Remote-control command:
`SOUR:BB:DM:CLOC:MULT 4`

Measured External Clock - Digital Modulation

Displays the measured frequency of the external clock signal. This enables the user to permanently monitor the frequency of the externally introduced clock.This information is displayed only if the external clock source has been selected.

Remote-control command:
`CLOC:INP:FREQ?`

Global Trigger/Clock/Input Settings - Digital Modulation

Calls the **Global Trigger/Clock/Input Settings** menu. This menu is used among other things for setting the trigger threshold, the input impedance and the polarity of the clock and trigger inputs. In the case of two-path instruments these settings are valid for both paths. The parameters in this menu affect all digital modulations and standards, and are described in the section "*Global Trigger/Clock/Input Settings - Setup - Environment*".

Arbitrary Waveform Generator ARB

Introduction - ARB

The Arbitrary Waveform Generator is an I/Q modulation source forming an integral part of the R&S AMU. It can be used to output any externally calculated modulation signals (e.g. using the) or internally generated multicarrier signals.

The Arbitrary Waveform Generator is incorporated in the Baseband Generator (B9/B10/B11)) option. The Baseband Main Module (B13) option is also required. The three Baseband Generator options feature different ARB memory sizes (see data sheet). Apart from the memory size, however, the three options offer the same functionality, either one can be installed.

In the case of two-path instruments, at least one further Baseband Generator (B9/B10/B11) option is needed for waveform output in the second path. Using this option a waveform can be read in on path B and then either routed via path A or added to the signal on path A with a frequency offset that can be set. When path B is fully expanded with a second option Baseband Main Module (B13) the waveform can be output on **I/Q Out B**.

Note:
The signal output on I/Q Out B requires a second option for differential output (option AMU-B16, Differential I/Q Out) and a second option for digital output (option AMU-B18, Digital I/Q Out).

Waveform files can be loaded into the instrument via one of the computer interfaces (USB - memory stick, or Ethernet interface - network drive) or via the IEC bus. The instrument can process waveforms generated by Windows software package **WinIQSIM2**, which is available on the documentation CD-ROM.

It is also possible to transfer signals that have been calculated using a mathematical program such as Matlab (see also Application Note 1MA28, IQWizard - I/Q Signal Measurement and Conversion, which can be obtained by visiting the Rohde&Schwarz web site at http://www.rohde-schwarz.com).

The R&S AMU can actually generate ARB waveforms internally. These files are created and saved in the **ARB** menu.

It is possible to use either predefined or subsequently defined markers that are sent to the marker outputs in synchronicity with the I/Q output signals. The markers have to be selected in the menu and a delay can be selected by the user (see "*Trigger/Marker/Clock - ARB MOD Menu*", page 4.225).

Multi-segment waveforms consisting of a combination of multiple waveforms can be defined in order to enable rapid alternation between different waveforms with differing test signals. Such waveforms can be used in test systems, for example. Each segment represents a completely independent waveform that is output with its own marker and clock settings. The entire multi-segment waveform is loaded into memory. The segment intended to be output at any given moment can be selected by the user. It is therefore possible to alternate between the individual waveform segments without experiencing any delay due to the loading operation.

If very high switchover speeds are required, the test signals can be continuously scrolled through with the aid of an external trigger. For this purpose the segments must have a common sample rate. If the combined waveforms have different sample rates, they can be adapted to a common sample rate by resampling. By the same procedure the instantaneous amplitude of the various waveforms can be scaled to a common rms level.

Typical applications for the multi-segment mode are described in the section "*Typical Applications for Multi-Segment Waveforms - ARB Menu*", page 4.239.

Multi-carrier waveforms consisting of up to 32 carriers modulated by user-selectable baseband signals can be created in order to simulate complex multi-carrier scenarios with different baseband signals (e.g. CDMA2000 or 3GPP FDD).

The ARB has been produced in the form of an interpolating ARB generator. The resampler operates in such a way that a modulation signal with a sample rate of less than 100 MHz is interpolated on the 100-MHz sample rate and then used as output.

The sample rate must satisfy the following condition:

$$\text{Sample rate x } 0.31 \geq \text{modulation bandwidth}$$

In the case of digital modulation: Sample rate = symbol rate (or chip rate) x oversampling

The value for the necessary oversampling is then calculated as follows:

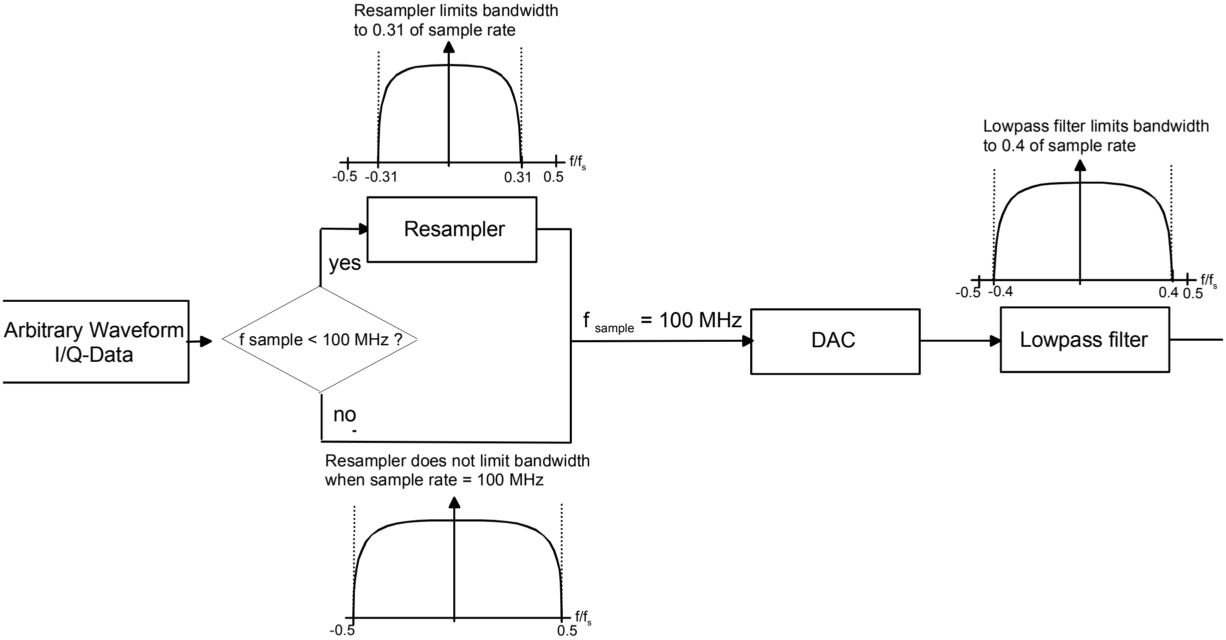
$$\text{Oversampling} \geq \frac{\text{modulation bandwidth}}{\text{symbol (chip) rate x } 0.31}$$

Example:

For the WCDMA digital standard with baseband filter √cos, $\alpha = 0.22$ the following value is therefore calculated for the necessary oversampling:

Modulation bandwidth = $\frac{(1+\alpha)}{2} = 0.61$, Oversampling $\geq \frac{0.61}{0.31} = 1.97$.

A modulation signal with a sample rate of exactly 100 MHz is passed directly to the Analog/Digital converter. The bandwidth is limited to 40 MHz by the lowpass filter only.



The reduced oversampling means that the signal duration is increased when the number of sample values is constant. Accordingly it is the case that when the duration is constant there is a reduction in the required number of sample values. In conventional ARB generators the minimum oversampling is normally held at 4. It therefore follows that with the above WCDMA system parameters and oversampling of 4 for the generation of a waveform with 10 frames (38 400 chips each) 1.5 Msamples are needed. The same waveform needs 740 ksamples in the R&S AMU due to the lower oversampling of 1.97.

Modulation signals generated with the aid of the **WinIQSIM** software can be optimized by selecting whole number oversampling or by defining a target sample rate, with the aim of achieving optimum exploitation of the maximum possible useful bandwidth, reducing the length of the waveform or obtaining the most extensive possible useful signal in the memory, according to need. Thus at the default target sample rate of 100 MHz, the maximum bandwidth of 40 MHz is available (see above, Signals with a sample rate of exactly 100 MHz).

Modulation signals can be generated without marker signals, whenever the marker functionality can be directly provided by the R&S AMU, thus increasing the maximum waveform length.

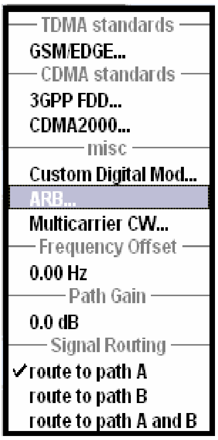
The resolution for the I/Q data is 16 bits (16 bits I, 16 bits Q) and there are 4 bits available for the markers. I/Q data and marker data are located in separate memory areas of the SDRAM and can be independently configured (for example the same output clock but different periods).

A memory size of 256 MB (B10) yields a maximum waveform length of 56 MSamples (36 bits for I,Q and 4 markers = 4.5 bytes; 256/4.5 ≈ 56 MSamples). The maximum waveform length increases to 64 MSamples if the internal hardware markers are used, in this case the complete memory is available for I/Q data (B11 = 16 MSamples).

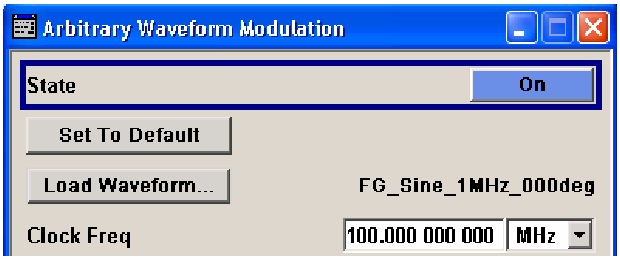
The minimum length of a waveform is 512 samples. If a waveform is shorter than this, it is automatically repeated until it reaches the minimum length.

ARB Menu

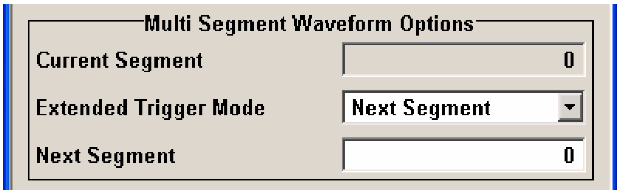
The menu for setting the ARB can be opened either in the **Baseband** block or by using the MENU key under **Baseband**.



The **ARB** menu is divided into an upper and a lower general part together with a **Marker** section.



The upper part of the menu is used for powering up, selecting and configuring ARB modulation.



The section **Multi Segment Waveform Options** is only indicated if a multi-segment waveform is loaded. In this part, the segment to be output is selected.

The buttons in the lower part of the menu open submenus for setting triggers and clocks, for configuring a sinusoidal test signal and for calculating a multi-segment waveform or a multicarrier waveform.

ARB MOD Main Menu

The upper part of the menu is used for powering up, selecting and configuring ARB modulation.

State - ARB

Enables/disables ARB modulation.

Switching on this standard turns off all the other digital standards and digital modulation types on the same path.

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

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

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

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

Remote-control command:
`SOUR:BB:ARB:STAT ON`

Set To Default - ARB

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

Remote-control commands:
SOUR:BB:ARB:PRES

Parameter	Value
State	Off
Trigger	
Mode	Auto
Source	Internal
Ext. Delay	0
Ext. Inhibit	0
Trigger Signal	
Mode	Auto
Source	Internal
External Delay	0
Inhibit	0
Marker Signal	
State	Off
CH. 1 Mode	Restart
CH. 2 Mode	Restart
CH. 3 Mode	Restart
CH. 4 Mode	Restart
Shift in Samples	0
Pulse Frequency	1 kHz
Pattern	'0'
ON/OFF ratio	1.1
Clock	
Frequency	1 MHz
Source	Intern
Delay	0
Sine Signal	
Frequency	1 kHz
Samples per Period	100
Phase Offset	90 DEG

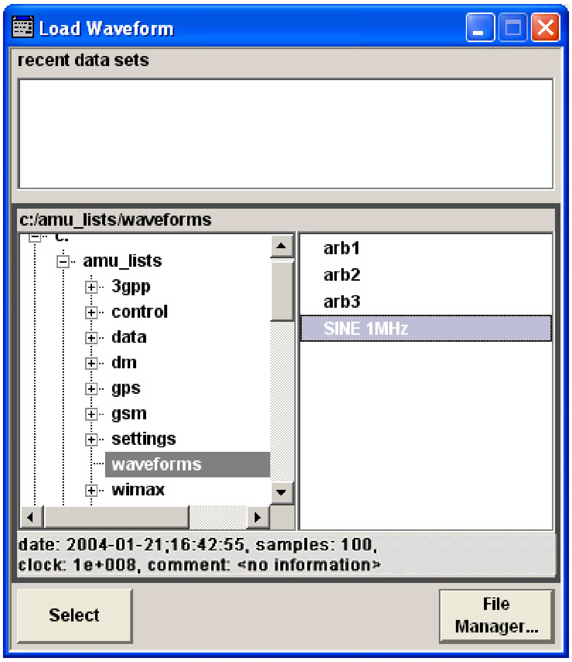
Load Waveform - ARB

Calls the **File Select** menu for loading the waveform file.

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

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

The **File Manager...** button leads to the file manager (see chapter 3).



Remote-control command:
```
Example for a file in the default directory:
SOUR:BB:ARB:WAV:SEL 'Wave1'
Example for a file in a different directory:
SOUR:BB:ARB:WAV:SEL 'd:\user\wave\Wave1.wv'
```

Clock Frequency - ARB

Displays or enters the ARB output clock rate.

When the waveform file is loaded, this value is automatically set to the clock rate defined in the file (Clock tag). The user can subsequently alter the value if necessary.

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

Remote-control command:
```
SOUR:BB:ARB:CLOC 10 MHz
```

The section **Multi Segment Waveform Options** of the menu is only displayed if a multisegment waveform is loaded.

Current Segment - ARB

Indication of the waveform segment that is currently output.

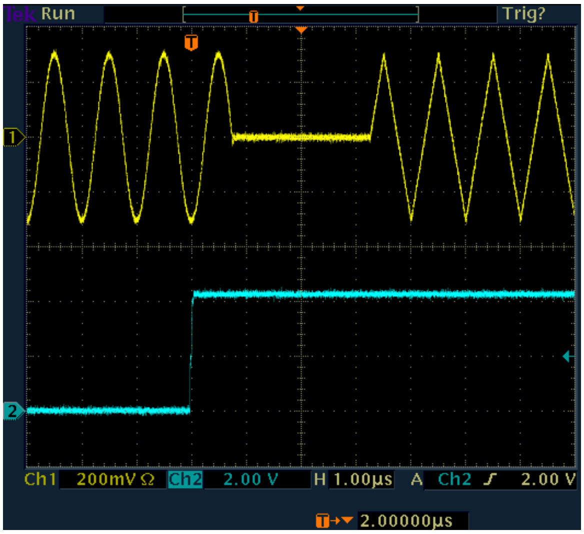
Remote-control command:
`SOUR:BB:ARB:WSEG`

Extended Trigger Mode - Multi Waveform ARB

Sets the extended trigger mode in the case of a multi-segment waveform.. Extended trigger mode defines how the switch between segments will take place:

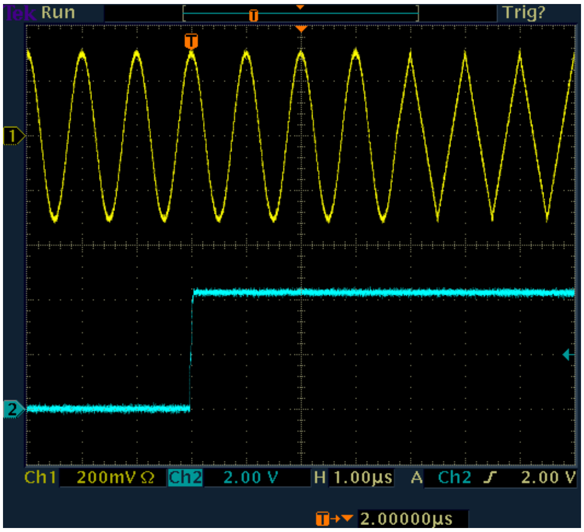
When **Same Segment** and **Next Segment** are selected, the current segment ceases to be output as soon as a new segment is entered in **Next Segment**, and the new segment starts to be output after a system-imposed signal gap.

The following figure shows an example of the transition from a sinewave signal segment to a sawtooth segment (I channel, above) in the case of external triggering (below).



When **Next Segment Seamless** is selected and a new segment is entered in **Next Segment**, the new segment is not output until the whole of the current segment has been output (wrap around). In this case the signal transition is seamless (see **Next Segment Seamless**). A seamless switchover is only possible in the case of segments that have the same sample rate.

The following figure shows an example of the seamless transition from a sinewave signal segment to a sawtooth segment (I channel, above) in the case of external triggering (below).



Extended trigger mode also defines the sequence in which segments will be output:

When **Internal Trigger Source** is selected it is possible to switch to any other segment by changing the entry in **Next Segment**. By selecting **Extended Trigger Mode** it is possible to define whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around).

Likewise when **External Trigger Source** is selected it is possible to switch to any other segment by changing the entry in **Next Segment**. It is also possible to scroll sequentially to the next available segment in the waveform by activating a trigger. The segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again. By selecting **Extended Trigger Mode** it is possible to define whether the new segment is generated immediately or only after the previous segment has been fully output (wrap around).

When a multi-segment waveform is loaded, generation of the signal starts at the segment defined in **Next Segment**.

The trigger settings in the **Trigger, Marker, Clock** submenu are similarly active. The possible combinations for the two trigger modes are specified in detail in the parameter description below.

Same Segment

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

Signal generation takes place differently according to the trigger selected in the Trigger menu:

In the case of **Trigger = Auto**, output starts at once and the segment is generated continuously. Trigger events are ignored.
If the segment is changed in **Next Segment**, output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).

In the case of **Trigger = Armed_Auto**, output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

In the case of **Trigger = Retrigger**, output starts at once and the segment is generated continuously, a trigger event causes a restart.
If the segment is changed in **Next Segment**, output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).

In the case of **Trigger = Armed_Retrigger**, output starts after the first trigger event. The segment is then generated continuously. Further trigger events cause a restart.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

In the case of **Trigger = Single**, output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart.
If the segment is changed in **Next Segment**, signal output is not stopped. The new segment is not output until a trigger occurs.

Remote-control command:
`SOUR:BB:ARB:TRIG:SMOD SAME`

Next Segment

Depending on the trigger setting, the segment selected under **Next Segment** is output either immediately or after a trigger event.

In the case of **internal Trigger = Auto**, output starts at once and the segment is generated continuously. Trigger events are ignored.
If the segment is changed in **Next Segment**, output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).

In the case of **internal Trigger = Armed_Auto**, output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

In the case of **internal Trigger = Single**, output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart.
If the segment is changed in **Next Segment**, signal

output is not stopped. The new segment is not output until a trigger occurs.

In the case of **External Trigger = Auto**, output starts at once and the segment is generated continuously. Each trigger event switches over to outputting the next segment. In this case there is a system-imposed signal gap (see above). The segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again.
If the segment is changed in **Next Segment**, output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).

In the case of **External Trigger = Armed_Auto**, output starts after the first trigger event. The segment is then generated continuously. Each trigger event switches over to outputting the next segment. In this case there is a system-imposed signal gap (see above). The segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

In the case of **External Trigger = Single**, output starts after the first trigger event. The segment is then generated once. Each trigger event switches over to outputting the next segment once. The segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again.
If the segment is changed in **Next Segment**, signal output is not stopped. The new segment is not output until a trigger occurs.

The remaining trigger modes (**Retrigger** and **Armed_Retrigger**) are not available.

Remote-control command:
`SOUR:BB:ARB:TRIG:SMOD NEXT`

Next Segment Seamless

The segment selected under **Next Segment** is output.

This mode is only available if all segments have the same sample rate.

In the case of **Internal** Trigger **= Auto**, output starts at once and the segment is generated continuously. Trigger events are ignored.
If the segment is changed in **Next Segment**, the new segment is output seamlessly after the output of the current segment is complete.

In the case of **internal Trigger = Armed_Auto**,

output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

In the case of **External** Trigger **= Auto**, output starts at once and the segment is generated continuously.
Each trigger event switches over to outputting the next segment once the output of the current segment has been completed. In each case segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again.
If the segment is changed in **Next Segment**, the new segment is output seamlessly after the output of the current segment is complete.

In the case of **External Trigger = Armed_Auto**, output starts after the first trigger event. The segment is then generated continuously. Each trigger event switches over to outputting the next segment once the output of the current segment has been completed. The segment currently being output is displayed at **Current Segment**. The next trigger event after the last segment causes the first segment to be output again.
If the segment is changed in **Next Segment**, signal output is stopped and the new segment is not output until a trigger occurs.

The remaining trigger modes (**Retrigger**, **Armed_Retrigger** and **Single**) are not available.

Remote-control command:
`SOUR:BB:ARB:TRIG:SMOD NSE`

Next Segment - ARB

Selects the waveform segment to be output next. It determines the start segment when switching on the ARB.

For an **internal trigger source**, switchover to any segment is performed by changing the entry at **Next Segment**. Depending on the selected **Extended Trigger Mode** the new segment is output either at once or only after the complete output (wrap around) of the previous segment.

For an **external trigger source**, switchover to any segment is also performed by changing the entry at **Next Segment**. In addition, consecutive switchover to the next segment is performed on the occurrence of each trigger event. The currently output segment is indicated at **Current Segment**. When the last segment of the multi-segment waveform has been output, the sequence starts again with the output of the first segment after the next trigger event.. Depending on the selected **Extended Trigger Mode** the new segment is output either at once or only after the complete output (wrap around) of the previous segment.

Remote-control command:
`SOUR:BB:ARB:WSEG:NEXT 1`

The lower part of the menu is used for setting triggers and clocks, as well as for file management. A simple sinewave signal can also be output for test purposes.

Trigger/Marker - ARB

Calls the Trigger and Marker menu.

This menu is used to select the trigger source, set the time delay on an external trigger signal and configure the marker output signals (see section "*Trigger/Marker/Clock - ARB MOD Menu*", page 4.225).

Remote-control command: n.a.

Execute Trigger - ARB

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than Auto are selected.

Remote-control commands:
```
SOUR:BB:ARB:TRIG:SOUR INT
SOUR:BB:ARB:SEQ RETR
SOUR:BB:ARB:TRIG:EXEC
```

Clock - ARB

Calls the Clock menu. The Clock menu is used to select the clock source (see section "*Trigger/Marker/Clock - ARB MOD Menu*", page 4.225).

Remote-control command: n.a.

Sine Testsignals - ARB

Calls the menu for generating sinusoidal test signals (see section "*Sine Test Signals - ARB MOD Menu*" page 4.233).

Remote-control command: n.a.

Multisegment - ARB

Calls the menu for calculating multi-segment waveforms (see section "*Create Multisegment Waveforms - ARB Menu*" page 4.234).

Remote-control command: n.a.

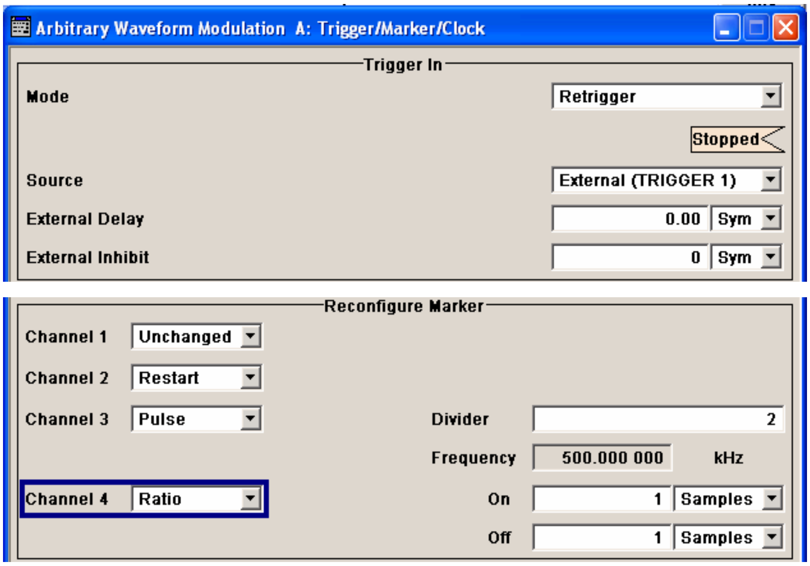
Multicarrier - ARB

Calls the menu for calculating multi-carrier waveforms (see section "*Create Multi-Carrier Waveforms - ARB Menu*" page 4.240).

Remote-control command: n.a.

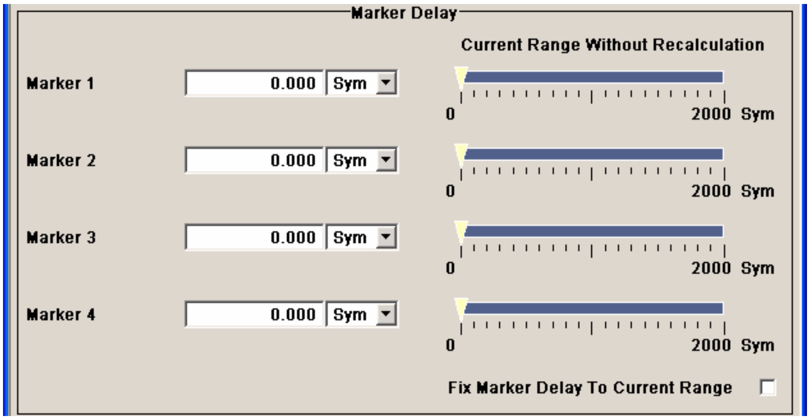
Trigger/Marker/Clock - ARB MOD Menu

The **Trigger/Marker/Clock** menu is used to enter settings for triggers and markers, and to select the clock source. The menu offers internal triggering as well as the two external trigger inputs TRIGGER 1 and 2, and in the case of two-path instruments it also offers internal triggering by the second path. The Trigger menu is accessed via the **ARB MOD** main menu.

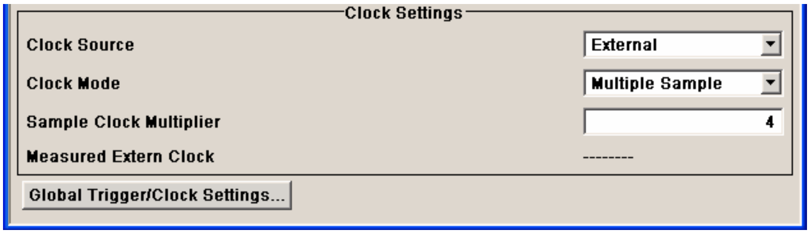


The **Trigger In** section is where the trigger for the waveform is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal output (**Running** or **Stopped**) is indicated for all trigger modes.

In the **Marker Mode** section markers can be defined in addition to the marker settings already defined in the waveform file.



The **Marker Delay** section is where a marker signal delay can be defined, either without restriction or restricted to the dynamic section, i.e., the section in which it is possible to make settings without restarting signal and marker output.



The **Clock Settings** section is where the clock source is selected and - in the case of an external source - the clock type.

The **Global Trigger/Clock Settings** button leads to a submenu for general trigger, clock and external input settings.

The **Trigger In** section is used to configure the trigger signal for the ARB modulation. The current status of waveform output is indicated for all trigger modes.

Trigger Mode - ARB

Selects trigger mode.

For multi-segment waveforms, signal output is determined by the Extended Trigger Mode also (see main menu)

Auto

The waveform or segment is output continuously. Signal output starts immediately when ARB modulation is enabled, trigger events are ignored.

Remote-control command:
`SOUR:BB:ARB:SEQ AUTO`

Retrigger

The waveform output continuously. Signal output starts immediately when ARB modulation is enabled, a trigger event (internal or external) causes a restart.

Remote-control command:
`SOUR:BB:ARB:SEQ RETR`

Armed_Auto

The waveform is output only when a trigger event occurs. Then the waveform is output continuously. Subsequent trigger events are ignored

Button **Arm** stops waveform output. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:ARB:SEQ AAUT`

Armed_Retrigger The waveform is output only when a trigger event occurs. Then the waveform is output continuously. Every subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Button **Arm** stops waveform output. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:ARB:SEQ ARET`

Single The waveform is output only when a trigger event occurs. Then the waveform is output once in the length specified in **Signal Duration**.

Every subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:ARB:SEQ SING`

Signal Duration Unit - ARB Defines the unit for the entry of the length of the signal sequence to be output in the **Single** trigger mode. Available units are samples or sequence length (SL).

Remote-control commands:
`SOUR:BB:ARB:TRIG:SLUN SAMP`

Signal Duration - ARB Enters the length of the signal sequence to be output in the **Single** trigger mode. The unit of the entry is defined unter **Signal Duration Unit**. It is possible to output deliberately just part of the waveform, an exact sequence of the waveform, or a defined number of repetitions of the waveform.

Remote-control commands:
`SOUR:BB:ARB:TRIG:SLEN 2`

Running - Stopped - ARB Displays the status of waveform output for all trigger modes.

Remote-control command:
`SOUR:BB:ARB:TRIG:RMOD?`
Response: `RUN` or `STOP`

Running The waveform is output; a trigger was (internally or externally) initiated in triggered mode.

For selection **Armed_Auto** and **Armed_Retrigger** waveform output can be stopped with the **Arm** button. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Stopped The Waveform output is stopped. The instrument waits for an internal or external trigger event to restart. ARB modulation is disabled (**State Off**).

Arm - ARB

Stops waveform output. This button appears only with **Running** signal output in the **Armed_Auto** and **Armed_Retrigger** trigger modes.

Signal output can be restarted by a new trigger (internally with **Execute Trigger** or externally).

Remote-control command:
`SOUR:BB:ARB:TRIG:ARM:EXEC`

Execute Trigger - ARB

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than Auto have been selected.

Remote-control commands:
```
SOUR:BB:ARB:TRIG:SOUR INT
SOUR:BB:ARB:SEQ RETR
SOUR:BB:ARB:TRIG:EXEC
```

Trigger Source - ARB

Selects trigger source.

Internal

The trigger event is executed by **Execute Trigger**. As a precondition a trigger mode other than **Auto** must be selected.

Remote-control command:
`SOUR:BB:ARB:TRIG:SOUR INT`

Internal (Baseband A/B)

The trigger event is executed by the trigger signal from the second path (two-path instruments only), depending on their setting. This makes it possible for instance to start the two paths synchronously or with a defined delay.

Remote-control command:
`SOUR:BB:ARB:TRIG:SOUR OBAS`

External (TRIGGER 1|2)

The trigger event is executed with the aid of the active edge of an external trigger signal. The trigger signal is supplied via the TRIGGER 1 or TRIGGER 2 connector.

The polarity, the trigger threshold and the input impedance of the TRIGGER input can be set in the **Global Trigger Settings** menu.

Note:
For multi-segment waveforms, an external trigger source can be used for cyclical output of the segments. Each trigger event starts the output of the next segment. After the last segment, the first segment is output again.

Remote-control command:
`SOUR:BB:ARB:TRIG:SOUR EXT | BEXT`

Trigger Delay - ARB

Sets trigger signal delay in samples on external triggering or on internal triggering via the second path.

This enables the R&S AMU to be synchronized with the device under test or other external devices.

Note:
The delay can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:ARB:TRIG:EXT:DEL 0`
`SOUR:BB:ARB:TRIG:OBAS:DEL 0`

Trigger Inhibit - ARB

Sets the duration for inhibiting a new trigger event subsequent to triggering. The input is to be expressed in samples.

In the **Retrigger** mode every trigger signal causes signal output to restart. This restart is inhibited for the specified number of samples:

This parameter is only available on external triggering or on internal triggering via the second path.

Note:
The trigger inhibit can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:ARB:TRIG:EXT:INH 0`
`SOUR:BB:ARB:TRIG:OBAS:INH 0`

In the **Marker Mode** section markers can be defined in addition to the marker settings already defined in the waveform file.

Marker x - ARB

Selects a marker signal on the MARKER outputs.

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

Unchanged

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

Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP1:MODE UNCH`

Restart

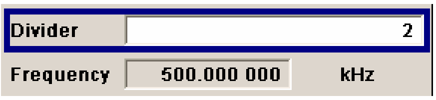
A brief marker signal is generated at the start of the waveform or segment.

Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP1:MODE REST`

Pulse

A regular marker signal is generated. The pulse frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when **Pulse** is selected, and the resulting pulse frequency is displayed below it.

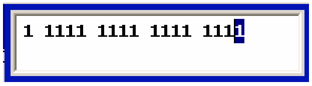
The precision of the frequency setting depends on the sampling rate. The maximum pulse frequency is equal to half of the sampling rate.



Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP1:MODE PULS`
`SOUR:BB:ARB:TRIG:OUTP1:PULS:DIV 4`
`SOUR:BB:ARB:TRIG:OUTP1:PFR?`

Pattern

A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when **pattern** is selected.

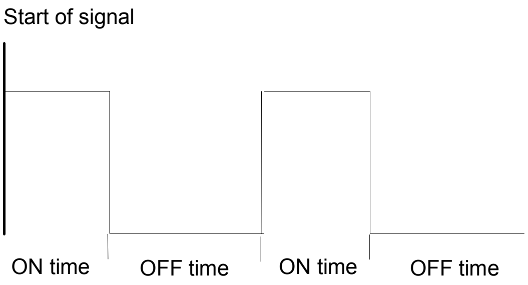


The pattern bits switch the marker signal to high and low state.

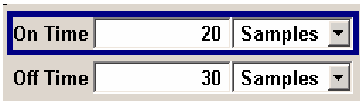
Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP1:MODE PATT`
`SOUR:BB:ARB:TRIG:OUTP1:PATT #B11001,5`

ON/OFF ratio

A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.



The ON time and OFF time are each expressed as a number of samples and are set in an input field which opens when **ON/OFF ratio** is selected.



Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP1:MODE RAT`
`SOUR:BB:ARB:TRIG:OUTP1:OFFT 30`
`SOUR:BB:ARB:TRIG:OUTP1:ONT  20`

The delays for the marker output signals are entered in the **Marker Delay** section.

Marker x Delay - ARB

Enters the delay between the marker signal at the marker outputs and the start of the signal.

The input is expressed as a number of samples. If the setting "**Fix marker delay to dynamic range**" is enabled, the setting range is restricted to the dynamic range. In this range the delay of the marker signals during signal output can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP2:DEL 2`

Current Range without Recalculation - ARB

Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP2:DEL:MAX?`
`SOUR:BB:ARB:TRIG:OUTP2:DEL:MIN?`

Fix marker delay to current range - ARB

Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:ARB:TRIG:OUTP:DEL:FIX ON`

The **Clock Settings** section is used to select the clock source.

Clock Source - ARB

Selects the clock source (also see section "*Clock Signals*", page 4.156).

Internal

The internal clock reference is used to generate the sample clock.

Remote-control command:
`SOUR:BB:ARB:CLOC:SOUR INT`

External

The external clock reference is fed in as the sample clock or a multiple thereof via the CLOCK connector.

The polarity of the clock input can be changed with the aid of Global Trigger/Clock Settings.

In the case of two-path instruments this selection applies to path A.

Remote-control command:
`SOUR:BB:ARB:CLOC:SOUR EXT`

Clock Mode - ARB

Enters the type of externally supplied clock.

Sample

A sample clock is supplied via the CLOCK connector.

Remote-control command:
`SOUR:BB:ARB:CLOC:MODE SAMP`

Multiple

A multiple of the sample clock is supplied via the CLOCK connector; the sample clock is derived internally from this.

The **Multiplier** window provided allows the multiplication factor to be entered.

Remote-control command:
`SOUR:BB:ARB:CLOC:MODE MSAM`

Sample Clock Multiplier - ARB

Enters the multiplication factor for clock type **Multiple**.

Remote-control command:
`SOUR:BB:ARB:CLOC:MULT 4`

Measured External Clock - ARB

(External Clock Source only)

Indicates the measured frequency of the external clock signal. Thus, screening of the external clock is possible.

The frequency is only indicated when external clock source is selected.

Remote-control command:
`CLOC:INP:FREQ?`

Global Trigger/Clock/Input Settings - ARB

Calls the **Global Trigger/Clock/Input Settings** menu. This menu is used among other things for setting the trigger threshold, the input impedance and the polarity of the clock and trigger inputs. In the case of two-path instruments these settings are valid for both paths.

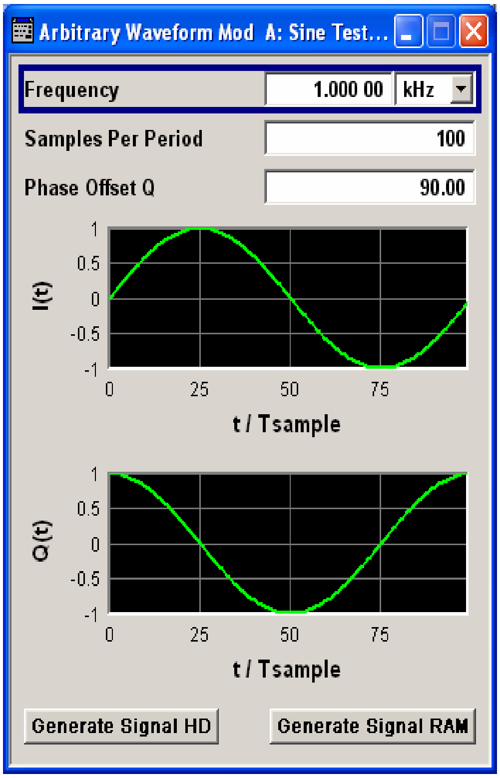
The parameters in this menu affect all digital modulations and standards, and are described in the section "*Global Trigger/Clock/Input Settings – Setup -Environment*".

Sine Test Signals - ARB MOD Menu

The **Sine Test Signals** menu is accessed via the **ARB MOD** main menu.

The menu can be used to configure a sinusoidal test signal. A sine wave is always generated on the I path, and optionally a sine wave of the same frequency but phase-shifted can be generated on the Q path.

The signal actually set is displayed in graphical form in the center of the menu.



Frequency - ARB

Enters the frequency of the test signal.

Remote-control command:
`SOUR:BB:ARB:TSIG:SINE:FREQ 2 MHz`

Samples per Period - ARB

Enters the number of sample values required from the sine wave per period.

The resulting clock rate must not exceed the maximum ARB clock rate (100 MHz). The number of sample values is automatically restricted by reference to the set frequency.

Remote-control command:
`SOUR:BB:ARB:TSIG:SINE:SAMP 35`

Phase Offset Q - ARB

Enters the phase offset of the sinewave signal on the Q channel relative to the sinewave signal on the I channel.

Remote-control command:
`SOUR:BB:ARB:TSIG:SINE:PHAS 75DEG`

Generate Signal HD - ARB

Generates a signal and saves it to a file.

The File Select window opens automatically and the signal can be stored as a waveform file.

Remote-control command: n.a.

Generate Signal RAM - ARB

Generates a signal and uses it as output straight away.

Remote-control command: n.a.

Create Multisegment Waveforms - ARB Menu

The **Multi-Segment...** menu is accessed via the **ARB** main menu.

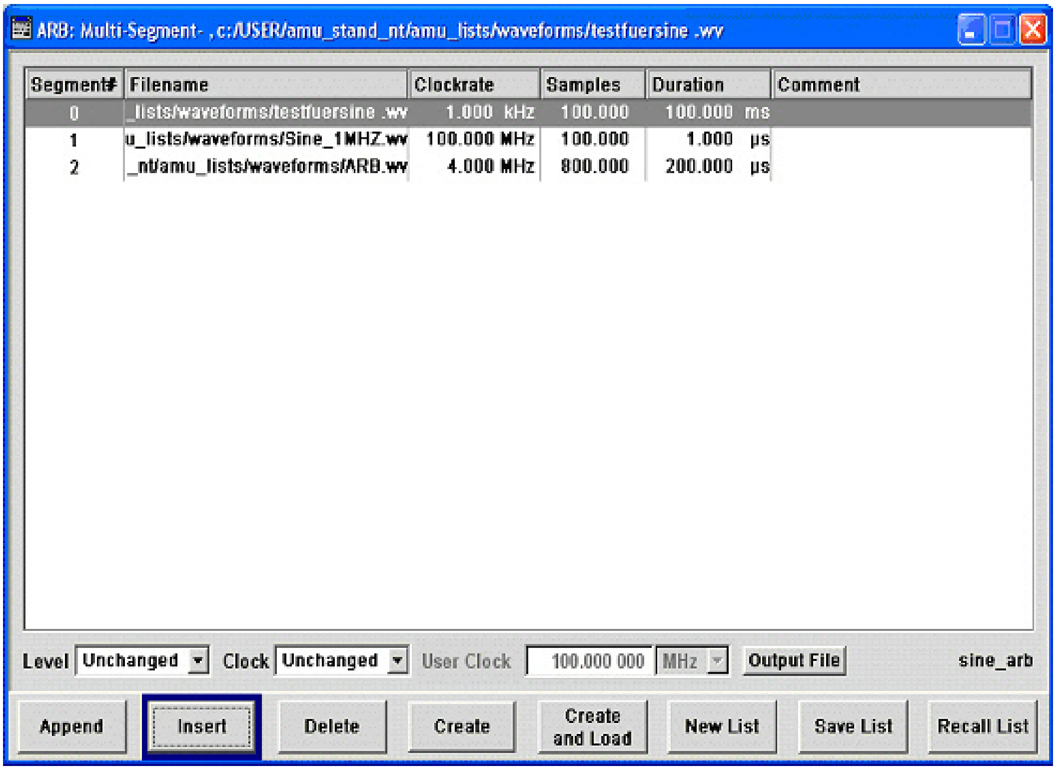
The menu can be used to create a multi-segment waveform from existing waveforms and save it under its own name. As with normal waveforms, the file extension is ***.wv**. Information on whether a file is a multi-segment waveform is displayed in the File menu with the tag information when a waveform is loaded.

If the combined waveforms have different sample rates, they can be adapted to a common sample rate by resampling. By the same procedure the instantaneous amplitude of the various waveforms can be scaled to a common rms level.

The configuration of a multi-segment waveform, that is to say details of how it is made up from different waveforms, the level and clock rate settings, and the file name, can be saved separately in a list. The file extension is ***.inf_mswv**. This method can be used to create any number of configurations as a basis for defining further multi-segment waveforms.

Example for the creation of a multi-segment waveform file.

1. Create empty list (**New List**)
2. Append two or more waveform files (**Append** or **Insert**)
3. Set level and clock mode (**Level** and **Clock**)
4. Enter file name (**Output File**)
5. Save configuration (**Save List**)
6. Save multi-segment waveform (**Create** or **Create and Load**)



Multi-Segment Table - Multi-Segment ARB

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

Remote-control commands: n.a.

Segment#

Indication of segment index. The segment index is used to select the segment to be output.

The segment index also defines the sequence of the output during external triggering in the **Next Segment** or **Next Segment Seamless** trigger modes.

File Name

Indication of the path and waveform file name of the segment.

Clock Rate

Indication of the clock rate of the segment.

The polarity of the clock input can be changed with the aid of **Global Trigger/Clock Settings**.

Duration

Indication of the segment duration.

Samples

Indication of the number of samples in the segment.

Comment

Indication of the comment on the segment.

Level - Multi-Segment ARB Defines the level mode for the multi-segment waveform.

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

`Remote-control command:`
`SOUR:BB:ARB:CONF:LEV:MODE UNCH`

Equal RMS Segments are output so that all segments have the same rms value. The **Level** display applies to all segments.

Remote-control command:
`SOUR:BB:ARB:CONF:LEV:MODE ERMS`

Clock - Multi-Segment ARB Selects the clock rate mode for the multi-segment waveform.

Unchanged A segment is output with the clock rate defined in the file.

If segments have different clock rates, extended trigger mode **Next Segment** allows internal segment switchovers only (**Internal** trigger source).

Extended trigger mode **Next Segment Seamless** can only be selected if all segments have the same clock rate.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:CLOC:MODE UNCH`

Highest All segments are output at the highest available clock rate.

This mode provides very short switchover times between segments. The time for calculating the multi-segment waveform is increased since the individual segments have to be resampled.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:CLOC:MODE HIGH`

User All segments are output at the clock rate defined in **User Clock**.

This mode provides very short switchover times between segments. The time for calculating the multi-segment waveform is increased since the individual segments have to be resampled.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:CLOC:MODE USER`

User Clock - Multi-Segment ARB

Defines the sample rate used for multi-segment waveform output in case of Clock Mode **User**.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:CLOC 50MHz`

Output file - Multi-Segment ARB

Opens the **File** menu, where the file name of the multi-segment waveform which has to be calculated can be entered.

The multi-segment waveform is saved under this name by clicking the **Create** or **Create and Load** button.

A name must also be entered here before the list can be saved as a configuration file (**Save List**). In this case the name is needed for internal storage procedures. It is entered as the default name for the multi-segment waveform file when loading the list.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:OFIL "Multi1"`

Append - Multi-Segment ARB

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

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:SEGM:APP 'arb2'`

Insert - Multi-Segment ARB

Opens the file menu to enter the file name of the waveform file to be inserted. The new waveform is inserted above the marked line.

Remote-control command: n.a.

Delete- Multi-Segment ARB

Deletes the selected segment.

Remote-control command: n.a.

Create- Multi-Segment ARB

Creates a new multi-segment waveform using the current table entries. This multi-segment waveform is saved with the file name specified in **Output File**. If no file name is specified, the File Manager opens so that the file name can be entered. As with normal waveforms, the file extension is ***.wv**.

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

Remote-control command:
`SOUR:BB:ARB:WSEG:CRE "conf_16"`

(in remote control the configuration file to be used for the creation of the multi-segment waveform is defined with the command:

`SOUR:BB:ARB:WSEG:CRE` or `SOUR:BB:ARB:WSEG:CLO`.

The file name of the waveform file is always determined with the command:

`SOUR:BB:ARB:WSEG:CONF:OFIL 'wv_name'`)

Create and Load- Multi-Segment ARB

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

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

Depending on the configuration of the multi-segment waveform, calculation may take some time.

Following this the **Create Multi-Segment Waveform File** submenu is closed and the new multi-segment waveform is loaded. The digital standard **ARB** is activated and the first segment of the waveform is output in accordance with the trigger settings.

Remote-control command:
`SOUR:BB:ARB:WSEG:CLO "conf_16"`

(in remote control the configuration file to be used for the creation of the multi-segment waveform is defined with command:

`SOUR:BB:ARB:WSEG:CRE` or `SOUR:BB:ARB:WSEG:CLO`.

The file name of the waveform file is always determined with the command:

`SOUR:BB:ARB:WSEG:CONF:OFIL 'wv_name')`

New List- Multi-Segment ARB

Deletes all entries of the table. A new configuration table is created.

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:SEL "new_mseg"`

Save List- Multi-Segment ARB

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

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

Before a multi-segment configuration file can be saved, a file name must be entered in **Output File**, since this is saved with the configuration file for internal purposes. This file name is also used as the default name for the multi-segment waveform when loading the configuration file.

Remote-control command: n.a.

(in remote control the configuration file to be used for the creation of the multi-segment waveform is defined with the command:

`SOUR:BB:ARB:WSEG:CRE` or `SOUR:BB:ARB:WSEG:CLO`.

The file name of the waveform file is always determined with the command:

`SOUR:BB:ARB:WSEG:CONF:OFIL 'wv_name')`

Recall List- Multi-Segment ARB

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

Remote-control command:
`SOUR:BB:ARB:WSEG:CONF:SEL "multi_seg2"`

Typical Applications for Multi-Segment Waveforms - ARB Menu

High Speed Switchovers

To test DUTs/chips using different test signals at high throughput requires extremely fast switchovers (for instance when testing ATE devices during manufacture). The following settings enable switching times of approx. 5 µs and the test signals are scrolled through with the aid of an external trigger signal.

Trigger Mode = **Auto**

Trigger Source = **External Trigger 1 or 2**

If the waveforms have different sample rates:

Clock Mode = **Highest** or **User** (when creating the waveform in the Multi-segment Editor)

Flexible Dynamic Switchovers

When testing DUTs using different test signals, it may be necessary to switch dynamically and flexibly between any of the test signals, for instance depending on the outcome of the previous test. When using remote control via an external computer, the following settings enable switching times of approx. 20 ms for segments with the same sample rate and approx. 200 ms for segments with different sample rates.

Extended Trigger Mode = **Next Segment**

Trigger Mode = **Auto**

Trigger Source = **Internal**

Flexible Dynamic Switchovers without Signal Interruptions

Testing receivers requires a continuous output of different test signals without interrupting the signal. The test signals then produce a complex total signal with no signal gaps on switchover. Control procedures can use a simulated back channel of the receiver (trigger line or remote control).

Switching times depend on the length of the segment currently being output, since switchover to the next segment does not take place until the current segment comes to an end.

Extended Trigger Mode = **Next Segment Seamless**

Trigger Mode = **Auto**

Trigger Source = **Internal or External**

If the waveforms have different sample rates:

Clock Mode = **Highest** or **User** (when creating the waveform in the Multi-Segment Editor)

Create Multi-Carrier Waveforms - ARB Menu

The **Multi-Carrier...** menu is accessed via the **ARB** main menu.

The menu can be used to create a multi-carrier waveform and save it under its own name. As with normal waveforms, the file extension is ***.wv**. Information on clock rate, number of samples and creation day is displayed in the File menu when a waveform is loaded.

Multi-carrier waveforms of up to 32 modulated carriers can be configured. The carriers are equally spaced and centered toward the baseband DC line. The carrier spacing is adjustable within the total available baseband bandwidth of 80 MHz. Each carrier can be separately defined in terms of power, phase and modulated input signal. Optionally, crest factor optimization can be applied.

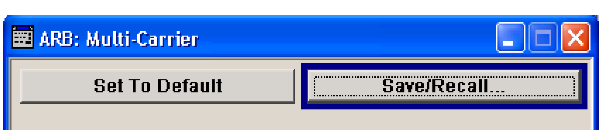
Thus, multi-carrier waveforms can be very easily configured as broadband test signals and used for such purposes as transmitter or receiver tests. In addition. Even complex multi-carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Example for the creation of a multi-carrier waveform file.

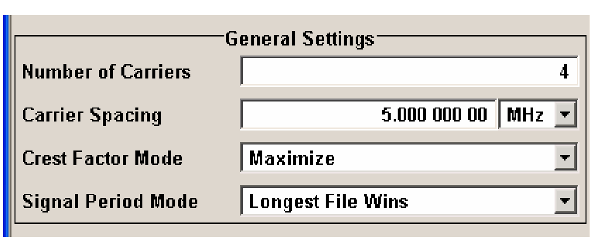
1. Configure general settings
2. Configure carrier table
3. Enter file name of multi-carrier waveform (**Output File**)
4. Save and load multi-carrier waveform (**Create** or **Create and Load**)

ARB Multi-Carrier Submenu

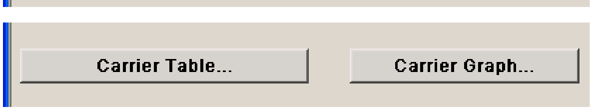
The **Multi-Carrier** submenu is divided into the following sections.



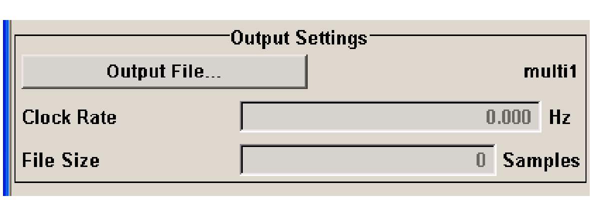
The upper part of the menu is used for calling the default settings and saving and recalling the submenu settings.



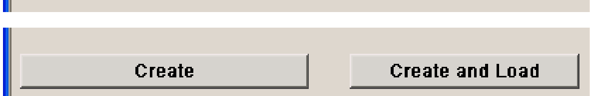
The **General Settings** section is used to configure the main multi-carrier waveform.



The buttons in the middle part of the menu open submenus for defining the carrier table. The carrier settings can be checked in the graphical **Carrier Graph…** submenu.



The **Output Settings** section indicates the name, the size and the clock rate of the multi-carrier waveform (after calculation).



The buttons in the lower part of the menu activate creation and optionally loading of multi-carrier waveform files into the main ARB menu.

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

Set to Default - ARB Multi-Carrier

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

Remote-control command:
`SOUR:BB:ARB:MCAR:PRES`

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

Save/Recall Frame - ARB Multi-Carrier

Calls the **Save/Recall** menu.

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

Remote-control command:
`SOUR:BB:ARB:MCAR:SETT:CAT?`
`SOUR:BB:ARB:MCAR:SETT:LOAD 'M_carr1'`
`SOUR:BB:ARB:MCAR:SETT:STORLOAD 'M_carr2'`

The **General Settings** section is used to configure the Multi-Carrier signal.

Number of Carriers - ARB Multi-Carrier

Sets the number of carriers for the multi-carrier waveform.

By default the multi-carrier table lists 1 carrier. A maximum of 32 carriers can be configured and activated.

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

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR:COUN 22`

Carrier Spacing - ARB Multi-Carrier

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

The carriers are arranged 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 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).*

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR:SPAC 10 kHz`

Crest Factor Mode - ARB Multi-Carrier

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

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

The following modes are available:

Off

There is no automatic setting for minimizing or maximizing the crest factor. The **Phase** setting as defined in the carrier table is in use.

Remote-control command:
`SOUR:BB:ARB:MCAR:CFAC:MODE OFF`

Minimize

The crest factor is minimized by internally calculating optimized carrier phases. The Phase setting displayed in the carrier table is invalid.

Remote-control command:
`SOUR:BB:ARB:MCAR:CFAC:MODE MIN`

Maximize

The crest factor is maximized by internally calculating optimized carrier phases. The Phase setting displayed in the carrier table is invalid.

Remote-control command:
`SOUR:BB:ARB:MCAR:CFAC:MODE MAX`

Signal Period Mode - ARB Multi-Carrier

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

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

Note:
Wrap-around and timing problems may occur when I/Q signals of different length are used. Thus, demodulation of a carrier may be difficult or even impossible. It is therefore recommended to consider the timing already when creating the input I/Q files or to adjust the signal duration to the carrier which is subsequently 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.

Remote-control command:
`SOUR:BB:ARB:MCAR:TIME:MODE LONG`

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.

Remote-control command:
`SOUR:BB:ARB:MCAR:TIME:MODE SHOR`

User

The signal period can be set by the user in the **Signal Period** field. Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

Remote-control command:
`SOUR:BB:ARB:MCAR:TIME:MODE USER`

Signal Period - ARB Multi-Carrier

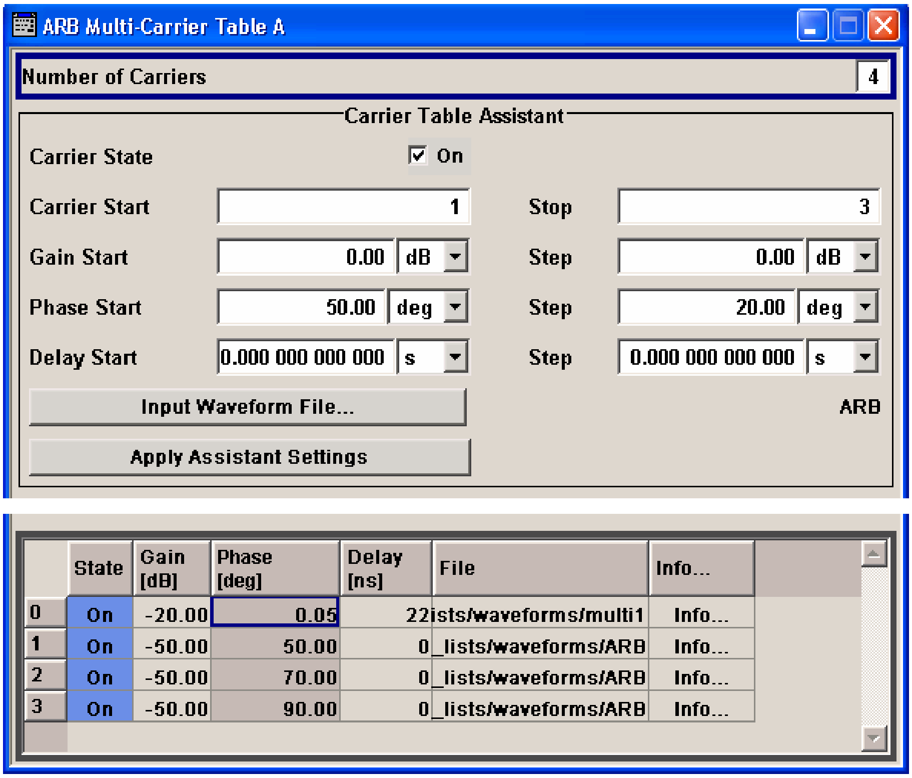
Sets the signal period in Signal Duration Mode **User**. Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

Remote-control command:
`SOUR:BB:ARB:MCAR:TIME 1s`

The buttons in the middle part of the menu open submenus for defining the carrier table. The carrier settings can be checked in the graphical **Carrier Graph** submenu. The **Carrier Table Assistant** section can be used to set a selectable carrier range.

Carrier Table Submenu - ARB Multi-Carrier

Calls the table for configuring individual carriers. A selectable carrier range can be set with the aid of the optional **Carrier Table Assistant** The multi-carrier configuration can be checked with the aid of the **Carrier Graph**.



The **Carrier Table Assistant** serves as a optional mean to quickly set up a multi-carrier scenario within a specified carrier range.

Number of Carriers - ARB Multi-Carrier

Defines the number of carriers of the multi-carrier waveform.

This parameter is identical to that in the **General Setting** section.

Remote-control command:
`SOUR:BB:ARB:MCAR:COUN 22`

Carrier State - ARB Multi-Carrier

Switches the carriers in the range **Carrier Start** to **Carrier Stop** on/off.

Remote-control command
`SOUR:BB:ARB:MCAR:EDIT:CARR:STAT ON`

Carrier Start - ARB Multi-Carrier

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

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:STAR 2`

Carrier Stop - ARB Multi-Carrier

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

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR:CARR:STOP 20`

Gain Start - ARB Multi-Carrier

Sets the gain of the carrier marked by **Carrier Start**.

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:POW 0 dB`

Gain Step - ARB Multi-Carrier

Sets the step width that is used to increment the gain

The resulting carrier gain in the carrier table equals:

GainStart + n Gain Step*

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

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:POW:STEP -0.2 dB`

Phase Start - ARB Multi-Carrier

Sets the phase of the carrier marked by **Carrier Start**.

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:PHAS 0`

Phase Step - ARB Multi-Carrier

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

The resulting phase in the carrier table equals:

PhaseStart + n PhaseStep*

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

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:PHAS:STEP 1DEG`

Delay Start - ARB Multi-Carrier

Sets the delay of the carrier marked by **Carrier Start.**.

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:DEL 0`

Delay Step - ARB Multi-Carrier

Sets the step width that is used to increment the delay

The resulting delay in the carrier table equals:

Delay*Start + n* DelayStep*

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

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:DEL:STEP 10us`

Input Waveform File - ARB Multi-Carrier

Calls the **File** menu for selecting the inputfile with the I/Q signal to be modulated onto all carriers of the selected carrier range.

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:FILE "iq_test"`

Apply Assistant Settings - ARB Multi-Carrier

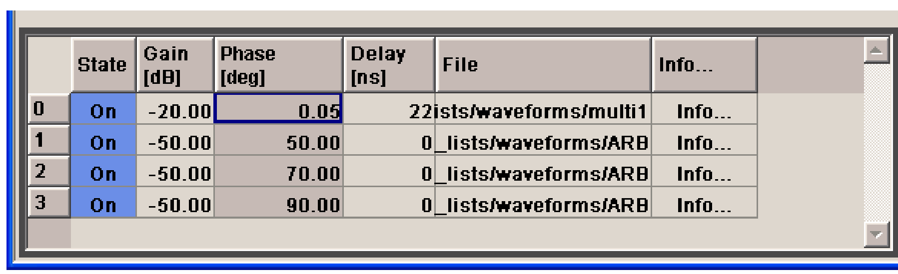
Transfer the assistant settings to the carrier table.

Remote-control command:
`SOUR:BB:ARB:MCAR:EDIT:CARR:EXEC`

Carrier Table - ARB Multi-Carrier

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

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



	State	Gain [dB]	Phase [deg]	Delay [ns]	File	Info...
0	On	-20.00	0.05	22	ists/waveforms/multi1	Info...
1	On	-50.00	50.00	0	_lists/waveforms/ARB	Info...
2	On	-50.00	70.00	0	_lists/waveforms/ARB	Info...
3	On	-50.00	90.00	0	_lists/waveforms/ARB	Info...

No.

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

Remote-control command:
- individual carriers can be set using the commands:
`SOUR:BB:ARB:MCAR:CARR:..`
by specifying the index in the parameter.

State

Switches On/Off a carrier.

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR2:STAT ON`

Gain

Sets the gain of a carrier.

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR2:POW -30dB`

Phase

Sets the starting phase of a carrier.

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR2:PHAS 0DEG`

Delay

Sets the starting delay of a carrier.

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR2:DEL 2US`

File

Calls the **File** menu for selecting the input file with the I/Q signal to be modulated onto the carrier.

Remote-control command:
`SOUR:BB:ARB:MCAR:CARR2:FILE "iq_test"`

Info

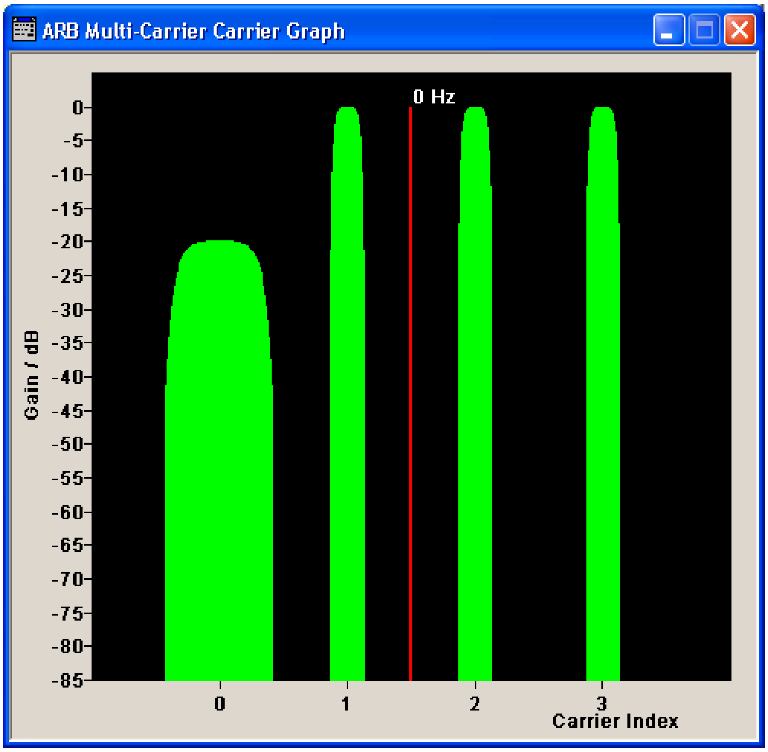
Indicates the sample rate, number of I/Q value pairs (number of samples), and the resulting signal period of the selected I/Q input file.

Remote-control command: n.a.

Carrier Graph - ARB Multi-Carrier

Calls a graphical representation of the current multi-carrier configuration in the frequency domain.

The height of the bars corresponds to the chosen gain of each individual carrier. The bandwidth of the carriers signals is indicated by the width of the bars.



The **Output Settings** section in the multi-carrier main menu indicates the name, the size and the clock rate of the currently calculated multi-carrier output file.

File - ARB Multi-Carrier

Opens the **File** menu, where the output file name of the multi-carrier waveform which has to be calculated can be entered.

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

Remote-control command:
`SOUR:BB:ARB:WCAR:OFIL "Multi1"`

Clock Rate - ARB Multi-Carrier

Displays the resulting sample rate at which the multi-carrier waveform is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers, carrier spacing and input sample rate of the leftmost or rightmost carriers.

Remote-control command
`SOUR:BB:ARB:MCAR:CLOC?`

File Size - ARB Multi-Carrier

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

Remote-control command:
`SOUR:BB:ARB:MCAR:SAMP?`

Create - ARB Multi-Carrier

Creates a new multi-carrier waveform defined by the multi-carrier table and General Setting entries.

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

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

Remote-control command:
`SOUR:BB:ARB:WCAR:CRE`
(in remote control the file name of the multi-carrier waveform file is determined with command:
`SOUR:BB:ARB:WCAR:OFIL 'wv_name'`)

Create and Load - ARB Multi-Carrier

Creates a new multi-carrier waveform defined by the multi-carrier table and General Setting entries and loads it subsequently in the **ARB** main menu.

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

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

Remote-control command:
`SOUR:BB:ARB:WCAR:CLO`
(in remote control the file name of the waveform file is determined with command:
`SOUR:BB:ARB:WCAR:OFIL 'wv_name'`)

Typical Applications for Multicarrier Waveforms - ARB Menu

High Power Amplifiers of multi-carrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance. A standard transmitter test might be quickly setup by the following instructions.

- Load a standardized 3GPP downlink test model, e.g. **Test Model 1_16**; Set State to **ON**
- Create a 3GPP Testmodel ARB file by activating **Generate Waveform File**.
- Setup a multi-carrier scenario with 4 carriers and a carrier spacing of 5 MHz.
- Apply the input file containing the previously generated 3GPP testmodel to all 4 carriers.

Multicarrier Continuous Wave

Introduction - Multicarrier CW

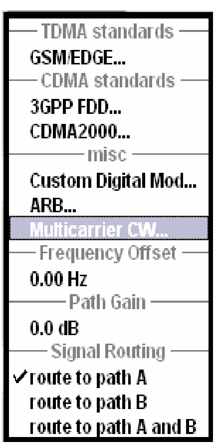
The R&S AMU can generate a Multicarrier CW signal with user-definable offset from carrier, based on a selection of up to 8192 unmodulated carriers. Each carrier can be separately set and switched on, or multiple carriers can be jointly configured. Automatic start phase setting is provided in order to minimize the crest factor.

Multicarrier CW signals can be very easily configured as broadband test signals and used for such purposes as receiver tests.

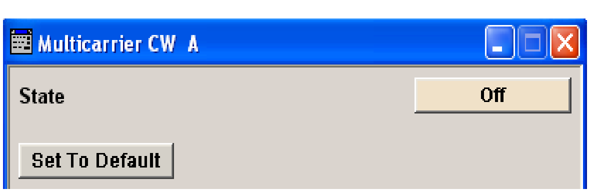
The equipment layout for generating multicarrier signals includes the options baseband main module (B13), baseband generator (B9/B10/B11) and multicarrier CW (K61).

When path B is fully expanded with a second option Baseband Main Module (B13) the modulation signal can be output on **I/Q Out B**.

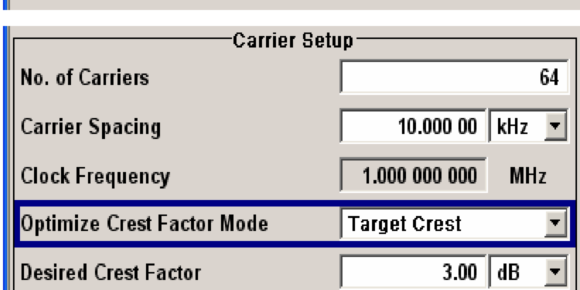
The menu for setting a Multicarrier CW signal can be opened either in the Baseband function block or in the menu tree for the MENU key under Baseband.



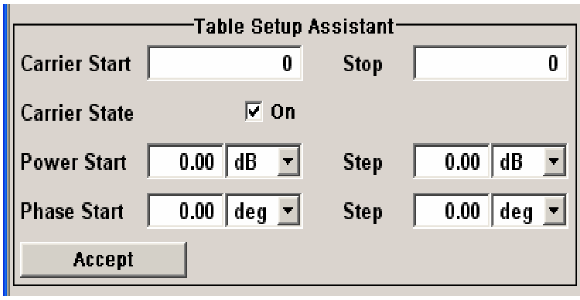
The **Multicarrier CW** menu is divided into the following sections.



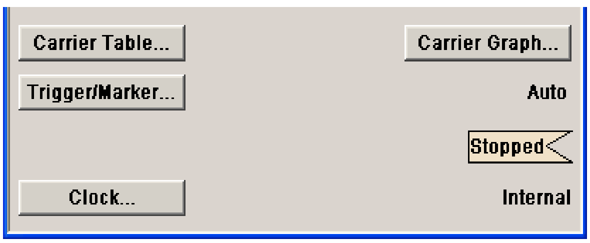
The upper part of the menu is used for powering up the Multicarrier CW and calling the default settings.



The **Carrier Setup** section is used to configure the Multicarrier CW signal.



The **Table Setup Assistant** section can be used to set a selectable carrier range.



The buttons in the lower part of the menu open submenus for defining carrier tables and for configuring triggers, markers and clocks. The carrier settings can be checked in the graphical **Carrier Graph** submenu.

Multicarrier CW Main Menu

The upper part of the menu is used for powering up the Multicarrier CW signal and calling the default settings.

State - Multicarrier CW

Enables/disables the Multicarrier CW.

Switching on this standard turns off all the other digital standards and digital modulation modes on the same path.

Since Multicarrier CW signals are computed in arbitrary waveform mode, changes to the settings of individual carriers are not adopted until the **Accept** button is pressed. This applies to the settings in the **Table Setup Assistant** menu section and the **Carrier Table** submenu.

Remote-control command:
`SOUR:BB:MCCW:STAT ON`

Set to Default - Multicarrier CW

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

Remote-control command:
`SOUR:BB:MCCW:PRES`

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

Parameter	Value
Trigger	
Mode	Auto
Source	Internal
Ext. Delay	0
Ext. Inhibit	0
Marker	
Channel 1...4	Restart
Clock	
Source	Internal
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
Power	0 dB
Phase	0°

The **Carrier Setup** section is used to configure the Multicarrier CW.

Number of Carriers - Multicarrier CW

Sets the number of carriers for the Multicarrier CW signal.

By default the multicarrier table already lists 64 carriers that are preset to the settings State = ON, Power = 0 dB, Phase = 0°.

When entering fewer carriers than the table contains, the approach is generally to delete the superfluous entries from the table, and when entering more carriers than the table contains the missing entries are usually added at the end of the table.

Remote-control command:
`SOUR:BB:MCCW:CARR:COUN 64`

Carrier Spacing - Multicarrier CW

Sets the spacing between carriers for the Multicarrier CW signal.

The carriers are arranged symmetrically around the HF carrier.

The total bandwidth = *(Number of carriers - 1) * Carrier spacing*; the result must not exceed 80 MHz.

Remote-control command:
`SOUR:BB:MCCW:CARR:SPAC 10 kHz`

Clock Frequency - Multicarrier CW

Displays the clock rate at which the multicarrier 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.

Remote-control command:
`SOUR:BB:MCCW:CLOC?`

Optimize Crest Factor - Multicarrier CW

Selects the mode for automatically minimizing the crest factor.

The carrier start phases are automatically set to this.

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

A very high crest factor arises when the carriers have an identical start phase, since the carriers are periodically superposed and very high peak voltages occur in relation to the rms voltage values.

Methods of reducing the crest factor differ with regard to both the optimization achievable and the time required for computation.

The following modes are available:

Off
There are no automatic settings for minimizing the crest factor. The **Phase** setting has an effect.

Remote-control command:
`SOUR:BB:MCCW:CFAC:MODE OFF`

Chirp
Very rapid crest factor optimization regardless of the number of carriers. A minimal crest factor of < 3 dB is only obtained for multicarrier signals in which all carriers are switched on and the power of the carriers is identical. In a configuration which differs from this, the achievable crest factor is worse.

Remote-control command:
`SOUR:BB:MCCW:CFAC:MODE CHIR`

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

Note:
Optimization can be cancelled at any time, and the current value being displayed at that moment is then used.

Remote-control command:
`SOUR:BB:MCCW:CFAC:MODE SLOW`

Desired Crest Factor - Multicarrier CW

Enters the desired crest factor.

This is only possible when the optimization **Target Crest** has been selected.

Remote-control command:
`SOUR:BB:MCCW:CFAC 3 dB`

The **Table Setup Assistant** section can be used to set a selectable carrier range. The carrier table can be edited in the **Carrier Table** submenu.

Carrier Start - Multicarrier CW

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

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:STAR 2`

Carrier Stop - Multicarrier CW

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

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:CARR:STOP 202`

Carrier State - Multicarrier CW

Switches the carriers in the carrier range on/off.

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:STAT ON`

Power Start - Multicarrier CW

Sets the power of the starting carrier.

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:POW 0 dB`

Power Step - Multicarrier CW

Sets the width of the step with which the power will be changed from carrier to carrier.

The carrier power that is set with *Power + n* Power Step* must be within the valid value range -80 dB to 0 dB.

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:POW:STEP -0.2 dB`

Phase Start - Multicarrier CW

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

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:PHAS 0`

Phase Step - Multicarrier CW

Sets the width of the step with which the phase will be changed from carrier to carrier.

The phase that is set with *Phase + n* Phase Step* must be within the valid value range 0° to 360°.

This setting is only available for Optimize Crest Factor Mode = Off.

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:PHAS:STEP 1DEG`

Accept - Multicarrier CW

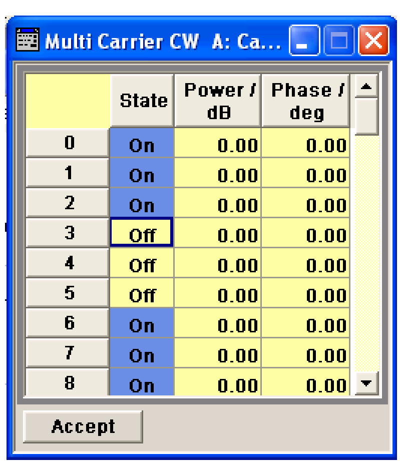
Adopts the carrier range setting into the table (Carrier Table).

Remote-control command:
`SOUR:BB:MCCW:EDIT:CARR:EXEC`

The lower part of the menu is used to open submenus for configuring carrier tables and for setting triggers, markers and clocks.

Carrier Table - Multicarrier CW

Calls the table for configuring individual carriers. This configuration can be checked with the aid of the **Carrier Graph**.



The table displays the settings of all available carriers. Carriers in the On state are highlighted. All carrier parameters can be edited in the table.

The Multicarrier CW signal is only computed when the **Accept** button is pressed. Whenever the table contains settings that have not yet been adopted with the **Accept** button, the background is yellow.

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

No.

This is the carrier index.

Remote-control command:
- (individual carriers can be set using the commands `SOUR:BB:MCCW:CARR:`.. by specifying the index in the parameter.
All the carriers in a multicarrier configuration can also be set using a value list with the commands `SOUR:BB:MCCW:CARR:LIST...`)

State

Switch a carrier on/off

Remote-control command:
`SOUR:BB:MCCW:CARR:LIST:STAT ON,OFF,..`
`SOUR:BB:MCCW:CARR:STAT 2,ON`

Power

Sets the power of a carrier.

Remote-control command:
`SOUR:BB:MCCW:CARR:LIST:POW -3,-3,.`
`SOUR:BB:MCCW:CARR:POW 2,-30dB`

Phase

Sets the starting phase of a carrier.

Remote-control command:
`SOUR:BB:MCCW:CARR:LIST:PHAS 0,0,..`
`SOUR:BB:MCCW:CARR:PHAS 2, 0DEG`

Accept

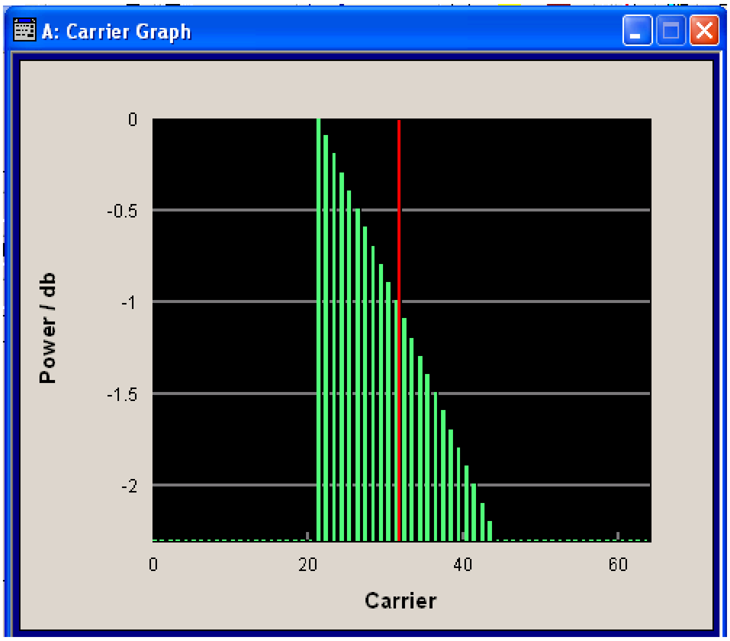
Transfer the settings in the carrier table into the instrument.

Remote-control command: n.a.
(the values specified when the command is given are adopted immediately)

Carrier Graph - Multicarrier CW

Calls a graphical representation of the chosen carrier configuration.

The carriers are on the X-axis and the colored bars represent those carriers which are in the On state. Power is on the Y-axis, and the height of the bars corresponds to the chosen power of each individual carrier.



Trigger-Marker - Multicarrier CW

Calls the **Trigger/Marker** menu. This menu is used to select the trigger source, set the time delay on an external trigger signal and configure the marker output signals (see section "*Trigger/Marker/Clock Menu - Multicarrier CW*", page 4.257).

Remote-control command: n.a.

Clock - Multicarrier CW

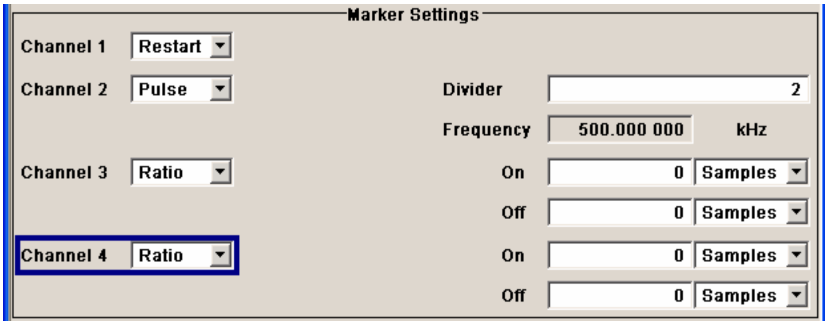
Calls the Clock menu. The Clock menu is used to select the clock source (see section "*Trigger/Marker/Clock Menu - Multicarrier CW*", page 4.257).

Remote-control command: n.a.

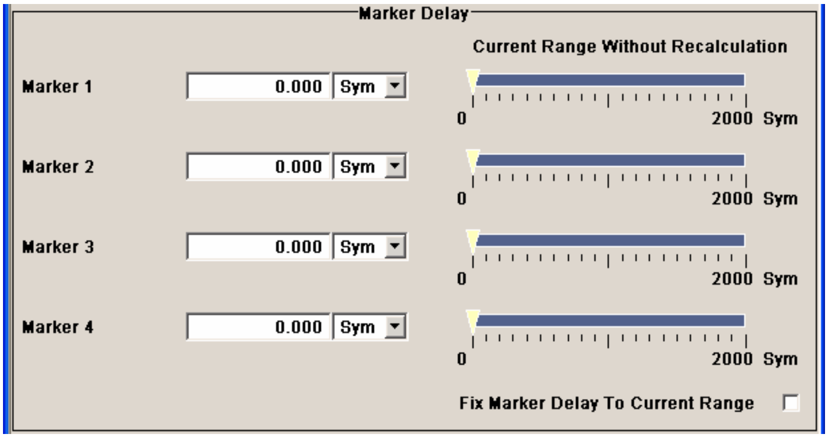
Trigger/Marker/Clock Menu - Multicarrier CW

The Trigger menu is accessed via the **Multicarrier CW** main menu.

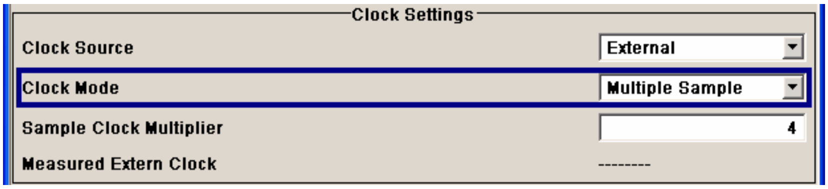
The **Trigger In** section is where the trigger for the waveform is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation (**Running** or **Stopped**) is indicated for all trigger modes.



The **Marker Settings** section is where the marker signals at the MARKER output connectors are configured.



The **Marker Delay** section is where a marker signal delay can be defined, either without restriction or restricted to the dynamic section, i.e., the section in which it is possible to make settings without restarting signal and marker generation.



The **Clock Settings** section is where the clock source is selected and - in the case of an external source - the clock type.

The **Global Trigger/Clock Settings** button leads to a submenu for general trigger, clock and external input settings

The **Trigger In** section is used to configure the trigger signal for the Multicarrier CW modulation. The current status of signal generation is indicated for all trigger modes.

Trigger Mode - Multicarrier CW

Selects trigger mode.

Auto

The multicarrier signal is generated continuously.

Remote-control command:
`SOUR:BB:MCCW:SEQ AUTO`

Retrigger

The multicarrier signal is generated continuously. A trigger event (internal or external) causes a restart.

Remote-control command:
`SOUR:BB:MCCW:SEQ  RETR`

Armed_Auto

The multicarrier signal is generated only when a trigger event occurs. Then the multicarrier signal is generated continuously.

pressing the button **Arm** stops the signal generation. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:MCCW:SEQ  AAUT`

Armed_Retrigger

The multicarrier signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.

Pressing the button **Arm** stops the signal generation. A subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:MCCW:SEQ ARET`

Single

The multicarrier signal is generated only when a trigger event occurs. Then the signal is output once in the length specified in **Signal Duration**. Every subsequent trigger event (internal with **Execute Trigger** or external) causes a restart.

Remote-control command:
`SOUR:BB:MCCW:SEQ SING`

Trigger Signal Duration - Multicarrier CW

Enters the length of the signal sequence to be output in the **Single** trigger mode.

The input is to be entered in sequence length (SL). The output can be just a defined part of the waveform, a sequence of the waveform or a defined number of repetitions of the wafveform.

Remote-control commands:
`SOUR:BB:MCCW:TRIG:SLEN 2`

Running - Stopped - Multicarrier CW

Displays the status of multicarrier signal generation for all trigger modes. This display appears only when Multicarrier CW is enabled (**State On**).

Remote-control command:
`SOUR:BB:MCCW:TRIG:RMOD?`
Response: `RUN` or `STOP`

Running

The multicarrier signal is generated; a trigger was (internally or externally) initiated in triggered mode.

If Armed_Auto and Armed_Retrigger have been selected, generation of signals can be stopped with the Arm button. A new trigger (internally with Execute Trigger or externally) causes a restart.

Stopped The signal is not generated, and the instrument waits for a trigger event (internal or external).

Arm - Multicarrier CW

Stops multicarrier signal generation. This button appears only with **Running** signal generation in the **Armed_Auto** and **Armed_Retrigger** trigger modes.

Signal generation can be restarted by a new trigger (internally with **Execute Trigger** or externally).

Remote-control command:
`SOUR:BB:MCCW:TRIG:ARM:EXEC`

Execute Trigger - Multicarrier CW

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than Auto have been selected.

Remote-control command:
```
SOUR:BB:MCCW:TRIG:SOUR INT
SOUR:BB:MCCW:SEQ RETR
SOUR:BB:MCCW:TRIG:EXEC
```

Trigger Source - Multicarrier CW

Selects the trigger source.

Internal The trigger event is executed by **Execute Trigger**. As a precondition a trigger mode other than **Auto** must be selected.

Remote-control command::
`SOUR:BB:MCCW:TRIG:SOUR INT`

Internal (Baseband A/B) The trigger event is executed by the trigger signal from the second path (two-path instruments only).

Remote-control command:
`SOUR:BB:MCCW:TRIG:SOUR OBAS`

External (TRIGGER 1|2) The trigger event is executed with the aid of the active edge of an external trigger signal. The trigger signal is supplied via the TRIGGER 1 or TRIGGER 2 connector.

The polarity, the trigger threshold and the input impedance of the TRIGGER input can be set in the **Global Trigger Settings** menu.

Remote-control command:
`SOUR:BB:MCCW:TRIG:SOUR EXT | BEXT`

Trigger Delay - Multicarrier CW

Sets a trigger signal delay in samples by external triggering or by internal triggering via the second path.

This enables the R&S AMU to be synchronized with the device under test or other external devices.

Note
The delay can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:MCCW:TRIG:EXT:DEL 0`
`SOUR:BB:MCCW:TRIG:OBAS:DEL 0`

Trigger Inhibit - Multicarrier CW

Sets the duration for inhibiting a new trigger event subsequent to triggering. The input is to be expressed in samples.

In the **Retrigger** mode every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of samples:

This parameter is only available on external triggering or on internal triggering via the second path.

Note:
The trigger inhibit can be set separately for each of the two paths.

Remote-control command:
`SOUR:BB:MCCW:TRIG:EXT:INH 0`
`SOUR:BB:MCCW:TRIG:OBAS:INH 0`

The settings for the marker output signals are entered in the **Marker Mode** section.

Marker Channel x - Multicarrier CW

Selects a marker signal for the associated MARKER output.

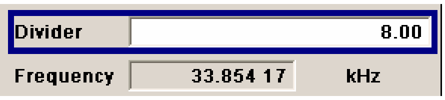
Restart

A brief marker signal is generated at the start of the waveform.

Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP1:MODE REST`

Pulse

A regular marker signal is generated. The pulse frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when **Pulse** is selected, and the resulting pulse frequency is displayed below it.



Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP1:MODE PULS`
`SOUR:BB:MCCW:TRIG:OUTP1:PULS:DIV 4`
`SOUR:BB:MCCW:TRIG:OUTP1:PULS:FREQ?`

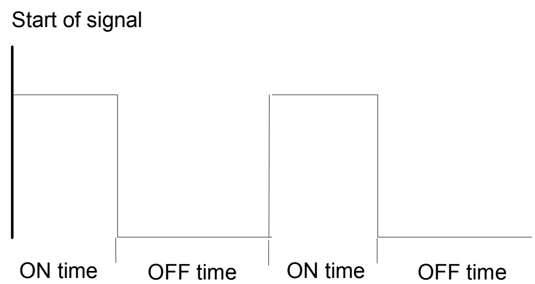
Pattern

A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when **Pattern** is selected.

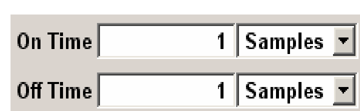
Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP1:MODE PATT`
`SOUR:BB:MCCW:TRIG:OUTP1:PATT #H00,8`

ON/OFF ratio

A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.



The ON time and OFF time are each expressed as a number of samples and are set in an input field which opens when **ON/OFF ratio** is selected.



Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP1:MODE RAT`
`SOUR:BB:MCCW:TRIG:OUTP1:OFFT 20`
`SOUR:BB:MCCW:TRIG:OUTP1:ONT  20`

The delays for the marker output signals are entered in the **Marker Delay** section.

Marker x Delay - Multicarrier CW

Enters the delay between the marker signal at the marker outputs and the start of the signal.

The input is expressed as a number of samples. If the setting "**Fix marker delay to dynamic range**" is enabled, the setting range is restricted to the dynamic range. In this range the delay of the marker signals can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP2:DEL 2`

Current Range without Recalculation - Multicarrier CW

Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

The delay can be defined by moving the setting mark.

Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP2:DEL:MAX?`
`SOUR:BB:MCCW:TRIG:OUTP2:DEL:MIN?`

Fix marker delay to current range - Multicarrier CW

Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal.

Remote-control command:
`SOUR:BB:MCCW:TRIG:OUTP:DEL:FIX ON`

The **Clock Settings** section can be used to select the clock source.

Clock Source - Multicarrier CW

Selects the clock source (also see section "*Clock Source - Multicarrier CW*", page 4.156).

Internal

The internal clock reference is used to generate the sample clock.

Remote-control command:
`SOUR:BB:MCCW:CLOC:SOUR INT`

External

The external clock reference is fed in as the sample clock or a multiple thereof via the CLOCK connector.

The polarity of the clock input can be changed with the aid of **Global Trigger/Clock Settings**.

In the case of two-path instruments this selection applies to path A.

Remote-control command:
`SOUR:BB:MCCW:CLOC:SOUR EXT`

Clock Mode - Multicarrier CW

Enters the type of externally supplied clock.

Sample

A sample clock is supplied via the CLOCK connector.

Remote-control command:
`SOUR:BB:MCCW:CLOC:MODE SAMP`

Multiple

A multiple of the sample clock is supplied via the CLOCK connector; the sample clock is derived internally from this.

The **Multiplier** window provided allows the multiplication factor to be entered.

Remote-control command:
`SOUR:BB:MCCW:CLOC:MODE MSAM`

Sample Clock Multiplier - Multicarrier CW

Enters the multiplication factor for clock type **Multiple**.

Remote-control command
`SOUR:BB:MCCW:CLOC:MULT 4`

Measured External Clock - Multicarrier CW

Indicates of the measured frequency of the external clock signal. This enables the user to permanently monitor the frequency of the externally introduced clock.

This information is displayed only if the external clock source has been selected.

Remote-control command:
`CLOC:INP:FREQ?`

Global Trigger-Clock-Input Settings - Multicarrier CW

Calls the **Global Trigger/Clock/Input Settings** menu. The trigger threshold, the input impedance and the polarity of the clock and trigger inputs can be set in this menu.

In two-path instruments these settings are valid for both paths.

The parameters in this menu affect all digital modulations and standards, and are described in the section "*Global Trigger/Clock/Input Settings – Setup -Environment*".

Contents Chapter 5 - Remote Control - Basics

5 Remote Control - Basics

Introduction - Remote Control Basics

This chapter provides:

- Instructions on how to set up the instrument for remote control operation.
- A general introduction to remote control of programmable instruments. This includes the description of the command structure and syntax according to the SCPI standard, the description of command execution and of the status registers.

The remote control commands of the instrument are described in detail after each related Instrument Function section. In addition, the description of each menu parameter is linked to the related remote control command.

A list is provided for users of the R&S AMU Baseband Generator and Fading Simulator, which shows all commands that are compatible with the command set of the R&S AMU.

In chapter 6, all remote control functions are described in detail. The subsystems are listed by alphabetical order according to SCPI. All commands and their parameters are listed by alphabetical order in the command list at the end of chapter 6. A list is provided for users of the R&S AMU, which shows all commands that are compatible with the command set of the R&S AMU.

The instrument is equipped with the following interfaces for remote control:

- IEC/IEEE bus interface according to standard IEC 625.1/IEEE 488.2
- LAN interface: the network card uses 10/100/1000Mbps Ethernet IEEE 802.3u; the protocol is based on the VXI-11 standard.
- USB interface (slave USB)
  The master USB interfaces can be used for a firmware update and for connecting peripherals such as mouse and keyboard.

The connectors are located at the rear of the instrument and permit a connection to a controller for remote control either directly or via a local area network (LAN). The remote control interfaces and their interface functions are described in chapter 8.

SCPI (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. The instrument supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of instrument control commands, error handling and the status registers. The tutorial "Automatic Measurement Control – A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Not all of the commands supported by the instrument are taken from the SCPI standard, however, their syntax follows SCPI rules.

This section assumes basic knowledge of programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

The requirements that the SCPI standard places on command syntax, error handling and configuration of the status registers are explained in detail in the following sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

The program examples for IEC/IEEE-bus programming are all written in VISUAL BASIC. A condition for programming in VISUAL BASIC is that the modules NIGLOBAL (Niglobal.bas) and VBIB32 (Vbib_32.bas) are added to the projects.

Note:

*Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the device status. Therefore, control programs should always define an initial device status (e.g. with the command *RST) and then implement the required settings.*

Getting Started

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions. As a prerequisite, the IEC/IEEE-bus address, which is factory-set to 28, must not have been changed.

- Connect instrument and controller using IEC/IEEE-bus cable and switch them on.
- Write and start the following program on the controller:

```
CALL IBFIND("DEV1", generator%)                          'Open port to the instrument
CALL IBPAD(generator%, 28)                               'Inform controller about instrument address
CALL IBWRT(generator%, "*RST;*CLS")                      'Reset instrument
CALL IBWRT(generator%, "IQ:OUTP:POW:PEP 0.5V")           'Set peak envelope power to 0.5 V
CALL IBWRT(generator%, "IQ:OUTP:ANAL:STAT ON")           'Switch on the analog I/Q outputs of path A
CALL IBWRT(generator%, "BB:DM:FORM FSK2")                'Set modulation type to FSK2
CALL IBWRT(generator%, "BB:DM:STAT ON")                  'Switch on digital modulation
```

- To return to manual operation, press the LOCAL key at the front panel.

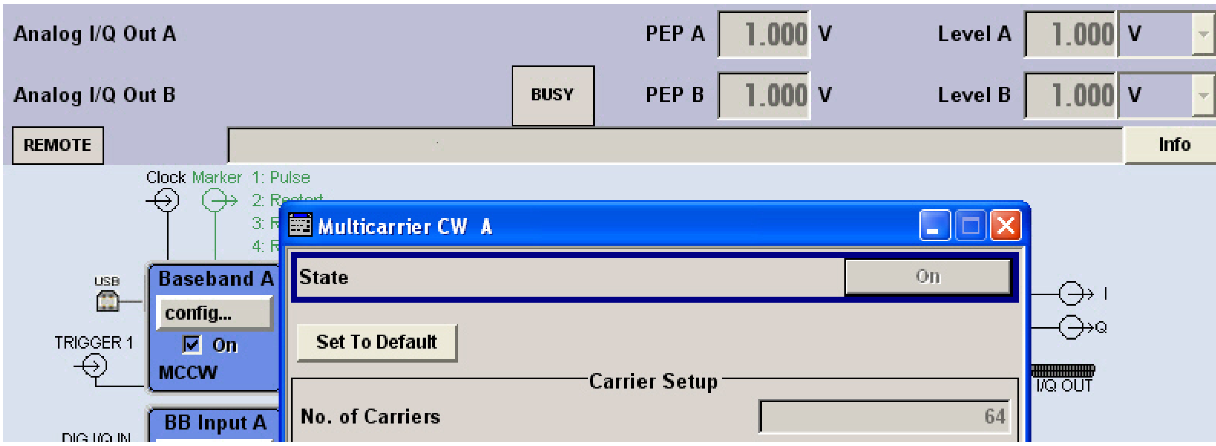
Switchover to Remote Control

On power-on, the instrument is always in the manual operating state and can be operated via the front panel controls or via mouse and external keyboard.

In case of remote control via the IEC/IEEE bus, the instrument is set to remote control (REMOTE status) by means of an addressed command.

With remote control via Ethernet, remote control is not automatically set by means of a command. The instrument must be explicitly set to the REMOTE state, e.g. by sending the interface command **&GTR** (go to remote).

In the REMOTE state, instrument control from the front panel or via mouse and keyboard is disabled. Menus can be opened, however, e.g. to verify settings. Buttons and setting fields are displayed in gray and cannot be activated. REMOTE is displayed in the status line.



The instrument remains in the REMOTE mode until local control is selected either manually with the [LOCAL] key on the front panel or with the interface command **&GTL** via the remote-control interface.

Switching from manual operation to remote control and vice versa does not affect the remaining instrument settings.

In the remote control mode, the front-panel keys and an external mouse or keyboard that may be connected can be disabled with command `:SYST:KLOC ON`. Menus cannot be opened in this case and switchover from remote control to manual operation is only possible by means of a remote-control command. Inadvertent switchover with the [LOCAL] key is not possible in this case.

Operation of the [LOCAL] key alone can be disabled with interface command **&LLO.**

Remote Control via IEC/IEEE Bus

To be able to control the instrument via the IEC/IEEE bus, instrument and controller must be linked by an IEC/IEEE-bus cable. An IEC/IEEE-bus card, the card drivers and the program libraries for the programming language used must be provided in the controller.

The controller must address the instrument with the set IEC/IEEE-bus address. The IEC/IEEE bus address of the instrument is factory-set to 28. It can be changed manually in the **Environment - GPIB** menu or via IEC/IEEE bus with command `SYSTem:COMMunicate:GPIB: ADDRess` . Addresses 0 to 30 are permissible.

Manually: **Setup - Remote - GPIB ...**

Via IEC/IEEE bus:

```
CALL IBFIND("DEV1", generator%)                    'Open port to the instrument
CALL IBPAD(generator%, 28)                         'Inform controller about old address
CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 18")   'Set instrument to new address
CALL IBPAD(generator%, 18)                         'Inform controller about new address
```

Sending the first command starts remote control operation.

Return to manual operation is possible via the front panel or the IEC/IEEE bus.

Manually:

- Press *the* LOCAL *key.*

Notes:

Before the transition, command processing must be completed as otherwise transition to remote control is performed immediately.

The LOCAL *key can be disabled by the interface message &LLO (see chapter 8, section "IEC/IEEE-Bus Interface Functions") in order to prevent unintentional transition. In this case, transition to manual mode is only possible via the IEC/IEEE bus.*

The LOCAL *key can be enabled again by deactivating the REN line of the IEC/IEEE bus (see chapter 8, section "IEC/IEEE Bus Interface").*

Via IEC/IEEE bus:

...

`CALL IBLOC(generator%)` 'Set instrument to manual operation

...

Remote Control via LAN Interface

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol.

Caution!

It is recommend to enable the Windows Firewall again after termination of remote control via LAN in order to protect the instrument from an attack of hostile users or programs via the net.

Software for instrument control and the VISA program library must be installed on the controller. Instrument control is via the VXI-11 standard protocol.

Only the IP address or the computer name is required for link setup. The IP address/computer name is part of the "resource name" used by the programs for identification and control of the instrument. The resource name has the form:

TCPIP::ipaddr::inst0::INSTR

ipaddr has to be replaced by the IP address or the computer name of the instrument.

For instance, if the instrument has the IP address 192.1.2.3, TCPIP::192.1.2.3::inst0::INSTR is the valid resource name. Specification of **inst0** in the resource name is optional. In this example, also TCPIP::192.1.2.3::INSTR is therefore a valid resource name.

A resource name with computer name could be TCPIP::RSSM1::INSTR, for instance.

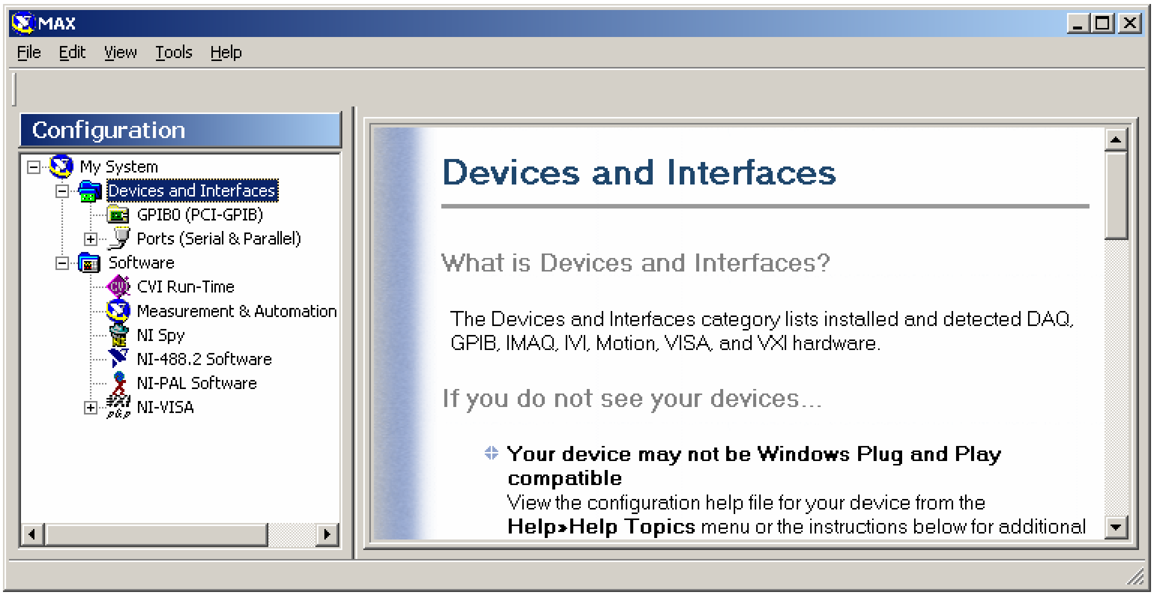
TCPIP designates the network protocol used and **INSTR** indicates that the VXI-11 protocol is used.

If several instruments are connected to the network, each instrument has its own IP address and associated resource name. The controller identifies these instruments by means of the resource name.

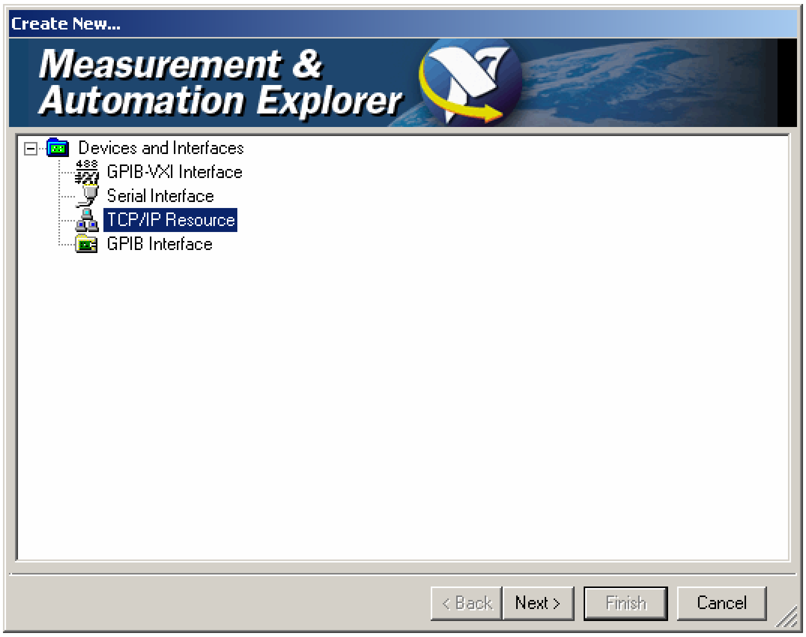
In the example below, the program 'Measurement & Automation Explorer' from National Instruments is used for setting up an Ethernet remote-control link. Link setup with this program is easy and first tests can be performed. The R&S AMU is preconfigured for networks using DHCP (dynamic host configuration protocol). If this configuration is used, the computer name must be entered at the position of the IP address. It is also possible to assign a fixed IP address to the instrument (see chapter 1, section "*Connection to the Network*").

Setting up Control of the R&S AMU in the 'Measurement & Automation Control' Program.

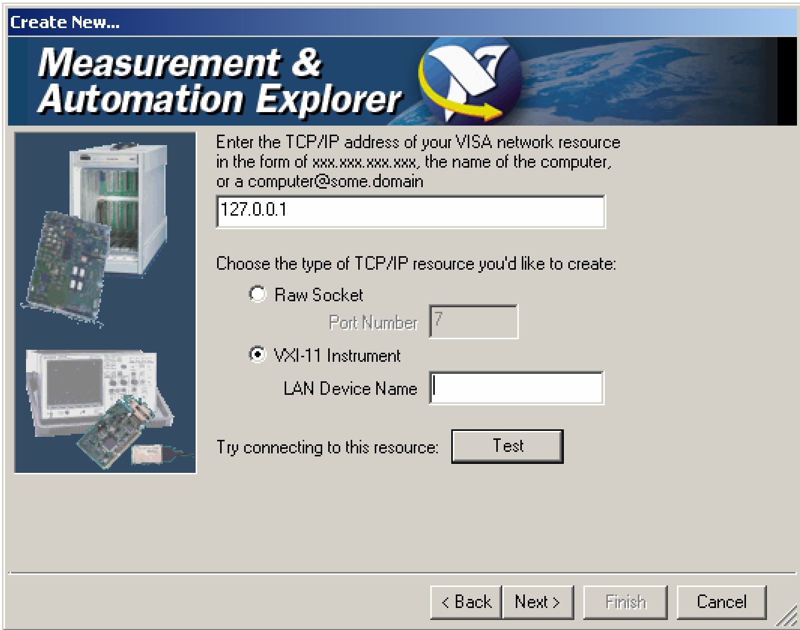
- Start program on the controller
- Open the **Create new** menu with the right mouse key.



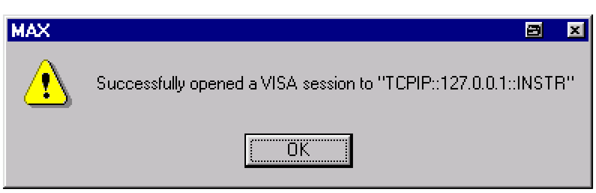
- Select **TCP/IP Resource** and open the next page of the **Create new** menu with the right mouse key.

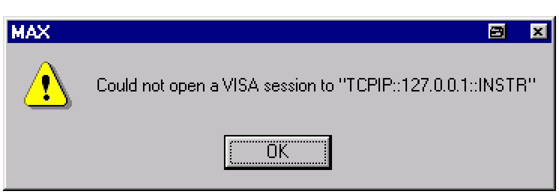


- Enter the IP address of the R&S AMU and select **VXI-11 Instrument** (the computer name may be entered instead).

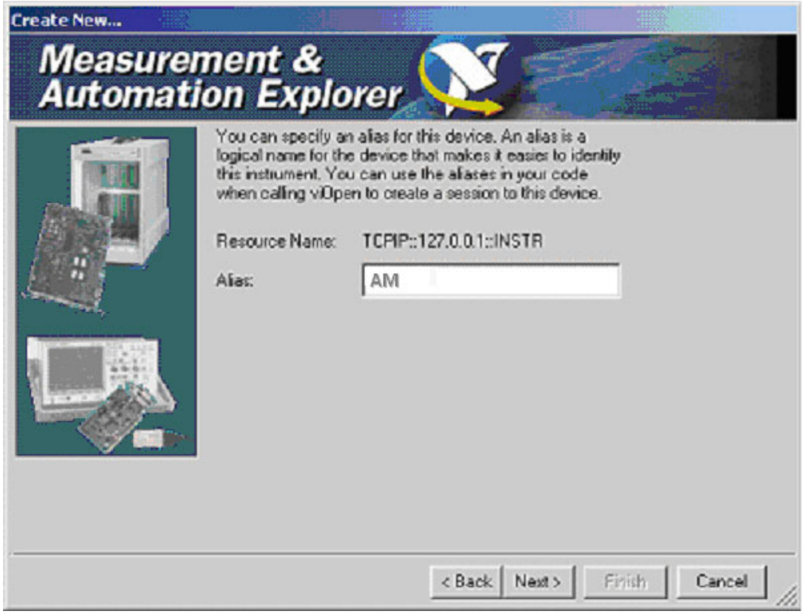


- Press the **Test** button
  A message indicates whether the link to the R&S AMU can be set up or not. If a connection cannot be set up, check whether the controller and the instrument are connected to the network (network cable) and switched on. Correct spelling of the IP address or the computer name can also be checked. For further error location, inform the network administrator. In large networks, specification of additional addresses may be required for link setup, e.g. gateway and subnet mask, which are known to the network administrator.

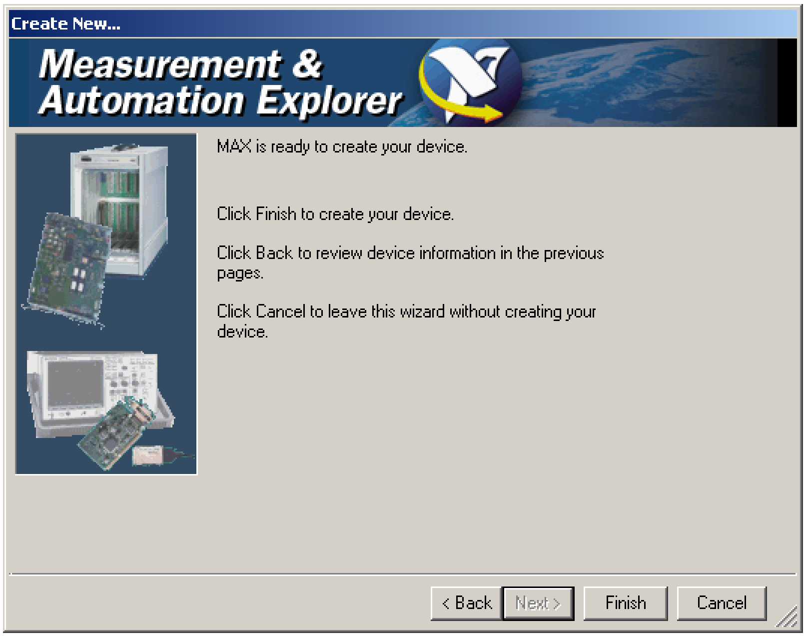




- Press the **Next** button. An alias name for the instrument can be entered in the next window. This name must not be mistaken for the computer name. It is only used for instrument identification within the program and displayed in the menu as an option in case of an Ethernet link.

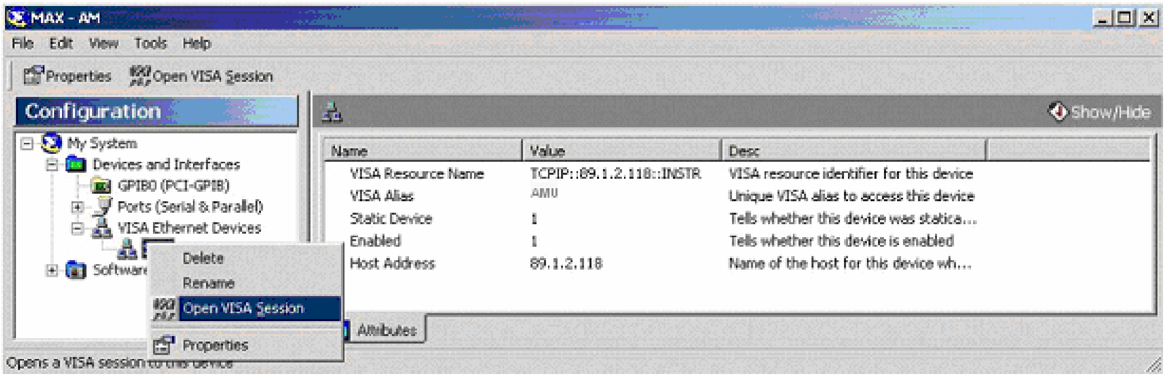


- Press **Next** and then the **Finish** button.
  The instrument is now registered in the program and can be addressed via the resource or alias name.

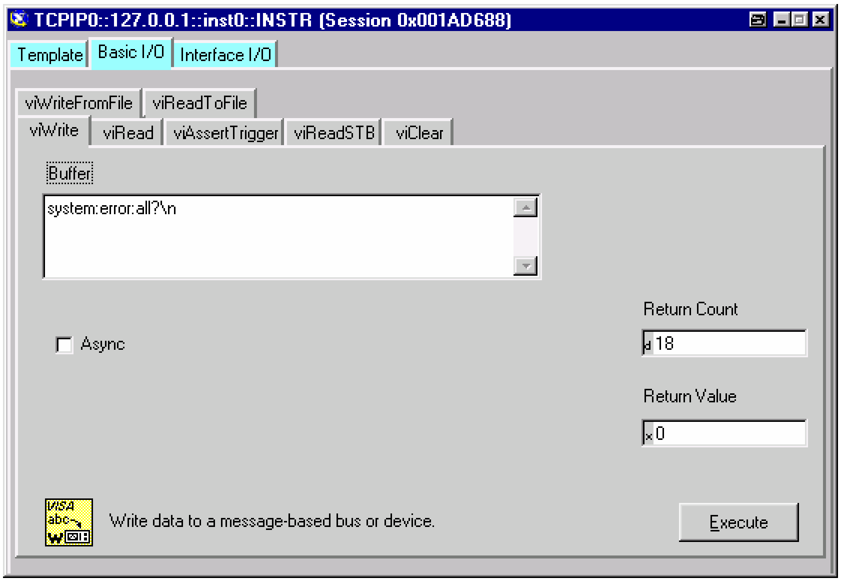


Starting the Measurement & Automation program for remote control of the R&S AMU

- Start the program on the controller
- In the **Configuration** window**,** open **Instruments and Interfaces** and select R&S **AM** (= Alias) under **VISA Ethernet Devices**.
- Open the menu by clicking on **Open VISA Session** with the right mouse key.



- On the **viWrite** tab under **Basic I/O**, commands can be sent to the instrument; instrument responses are displayed on the **viRead** tab
  (for further program operation refer to the online help of the program).



Return to manual operation is possible via the front panel or the LAN interface.

Manually:

- Press *the* [LOCAL] *key.*

Notes:

The [LOCAL] key can be disabled by the universal command &LLO (see chapter 8, section VXI-11 Interface Messages) in order to prevent unintentional transition. In this case, transition to manual mode is only possible via remote control.

The [LOCAL] key can be enabled again by the interface message &NREN (see chapter 8, section VXI-11 Interface Messages).

Via IEC/IEEE bus:

...

`CALL IBLOC(generator%)` 'Set instrument to manual operation

...

Interface and Device Messages

The messages transferred via the data lines of the IEC/IEEE-bus (see chapter 8, section "*IEC/IEEE Bus Interface*") or via a TCP/IP network can be divided into two groups:

– **interface messages** and

– **device messages.**

Interface Messages

Interface messages are transferred on the data lines of the IEC/IEEE bus, the ATN control line being active. They are used for communication between controller and instrument and can only be sent by a computer which has the function of an IEC/IEEE bus controller.

Interface commands can be further subdivided into

- **universal commands**
- **addressed commands**

Universal commands act on all devices connected to the IEC/IEEE-bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in chapter 8, section "*IEC/IEEE Bus Interface*".

If an Ethernet connection is present, signalling via a hardware control line is not required. The IEC/IEEE-bus interface commands are emulated (see chapter 8, section "*LAN Connector*").

Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the IEC/IEEE-bus, the "ATN" control line not being active. ASCII character set is used.

If an Ethernet connection is present, signalling via a hardware control line is not required.

The device messages are equal for the different interfaces (IEC/IEEE bus and Ethernet). A distinction is made according to the direction in which they are sent:

Commands (Program Messages) are messages the controller sends to the instrument. They operate the device functions and request information.

The commands are subdivided according to two criteria:

1. According to the effect they have on the instrument:

Setting commands cause instrument settings such as a reset of the instrument or setting the frequency.

Queries cause data to be provided for output on the IEC/IEEE bus, e.g. for identification of the device or polling a parameter value. Queries are formed by directly appending a question mark to the header.

2. According to their definition in standard IEEE 488.2 and SCPI:

Common commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standardized status registers, reset and selftest.

Instrument control commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee Device-specific extensions following the SCPI rules are permitted by the standard.

Device responses (Response Messages and Service Request) are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. section "*Responses to Queries*", page 5.14).

Structure and syntax of the device messages are described in the following section.

SCPI Command Structure and Syntax

The commands consist of a so-called header and, in most cases, one or more parameters. The header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Note:
The commands used in the following examples are not in every case implemented in the instrument.

Common Commands

Common commands consist of a header preceded by an asterisk "*" and one or more parameters, if any.

Examples:

`*RST`	RESET, resets the device
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable register
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register.

Instrument control commands

Hierarchy**:** Instrument control commands are of hierarchical structure (see figure below). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system

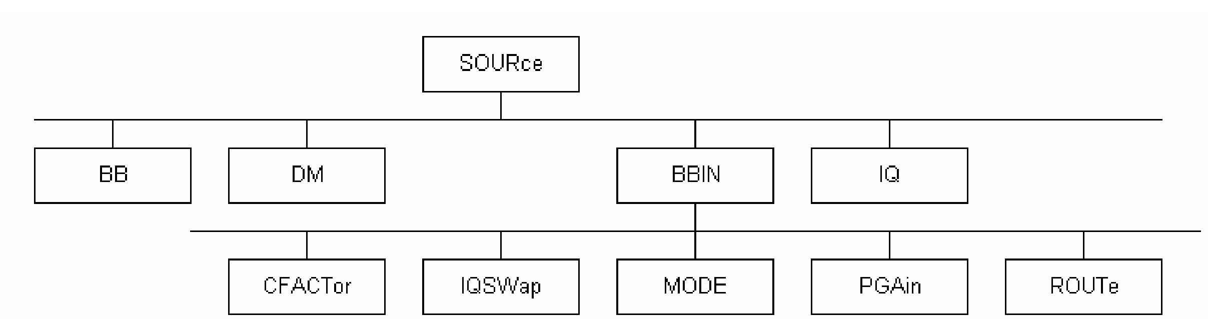
Example: `:SOURce`

This key word denotes the command system `SOURce`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: `SOURce:BB:DM:CODing GRAY`
'sets the coding of digital modulation to gray.

This command lies in the fourth level of the SOURce.



Example for the tree structure of the SCPI command systems; the `SOURce` system

Multiple key words

Some key words occur on several levels within one command system. Their effect depends on the structure of the command, i. e. on the position in the command header they are inserted in.

Example: `SOURce:IQ:OUTPut:STATe ON`

This command contains key word STATe in the fourth command level. It switches the active outputs of the **I/Q Out** block on and off.

`SOURce:IQ:OUTPut:DIGital:STATe ON`

This command contains key word STATe in the fifth command level. It switches the digital output of the I/Q signal on and off.

Optional key words:

Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in this manual. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by omitting optional key words.

Example: `[:SOURce]:IQ:OUTPut[:ANALog]:OFFSet:Q 200 mV`

This command sets the Q offset of the signal to 200 mV. The following command effects the same:

`[:SOURce]:IQ:OUTPut:OFFSet:Q 200 mV`

Note:
An optional key word must not be omitted if its effect is specified in detail by a numeric suffix. In the R&S AMU, this for instance applies to the keyword SOURce which can be omitted for path A = SOURce1 but must be specified for path B = SOURce2.

Long and short form:

The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permitted.

Example: `STATus:QUEStionable:ENABle 1 ≡ STAT:QUES:ENAB 1`

Note:
Upper-case and lower-case notation only serves to distinguish the two forms in the manual, the instrument itself does not distinguish upper-case and lower-case letters.

Parameters:

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". A few queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of the types of parameter, refer to section *Parameters*, page 5.14.

Example: `SOURce:IQ:OUTPut:ANALog:BIAS:Q? MAXimum`

Response: `2.7`

This query requests the maximal value (2.7 V) for the amplifier bias of the Q signal component.

Numeric suffix: If a device features several functions or features of the same kind, e.g. several inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1. Optional keywords must be specified if they select a function with the suffix.

Example: `SOURce2:BB:DM:STATe ON`

This command activates digital modulation for path B. The keyword `SOURce` must be specified in the command. For path A, the keyword is optional and can be omitted.

Note:
In case of remote control, suffix counting may differ from the numbers of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.
Some standards define a fixed numbering, starting with 0. With GSM, for instance, slots are counted from 0 to 7. In the case of remote control, the slots are selected with the suffixes 1 to 8.
If the numbering differs in manual operation and remote control, it is indicated with the respective command.

Structure of a Command Line

A command line may consist of one or several commands. It is terminated by an EOI together with the last data byte.

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon. A colon ":" at the beginning of a command marks the root node of the command tree.

Example: `":SOUR:BB:IMP:IQR 4PCT; :SOUR:IQ:OUTP:TYPE DIFF"`

This command line contains two commands. The first command is part of the IMPairment system and is used to set the imbalance for the digital I/Q channels. The second command is part of the OUTPut system and sets the analog output type to DIFFerential.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

Example: `":SOURce:BB:IMPairment:IQRatio 4PCT; :SOURCE:BB:IMPairment:IQRatio?"`

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the SOURce command system, subsystem BB and subsystem IMPairment, i.e. they have three common levels.The first command sets the imbalance for the digital I/Q channels. The second command queries the imbalance and returns the currently value.

When abbreviating the command line, the second command begins with the level below `SOURce:BB:IMPairment`. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

`"SOUR:BB:IMP:IQR 4PCT; IQR?"`

Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1. The requested parameter value is transmitted without command header.

   Example: `":SOURce:BBIN:ROUTe?"` Answer: `AB`

2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values

   Example: `":SOURce:BB:POFFset? MAX"` Answer: `359.89`

3. Boolean values are returned as 0 (for OFF) and 1 (for ON).

   Example: `":SOUR:IQ:OUTP:STAT?"` Answer (for ON): `ON` or `1`

4. Text (character data) is returned in a short form

   Example: `":SOUR:IQ:OUTP:DISPlay?"` Answer (for ANALog): `ANAL`

Parameters

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description.

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the values must be in the value range –9.9E37 to 9.9E37. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed.

Units

In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

Example:
`:SOURce:BBIN:FOFFset 1MHZ = SOURce:BBIN:FOFFset 1E6`

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the `PCT` string.

Example:
`:SOURce:BB:IMPairment:IQRatio 4PCT`

Special numeric values

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.

In the case of a query, the associated numerical value is provided.

Example:
Setting command:
`:SOURce:IQ:OUTPut:ANALog:POWer:LEVel MAXimum`

Query:
`:SOURce:IQ:OUTPut:ANALog:POWer:LEVel?` Answer: `1`

`MIN/MAX` `MINimum` and `MAXimum` denote the minimum and maximum value

`DEF` `DEFault` denotes a preset value. This value conforms to the default setting, as it is called by the *RST command.

`UP/DOWN` `UP`, `DOWN` increases or reduces the numerical value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.

`INF/NINF` `INFinity`, Negative INFinity (`NINF`) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device responses.

`NAN` Not A Number (`NAN`) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are division by zero, subtraction or addition of infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. ON or OFF is returned by a query.

Example:
Setting command:
`:SOUR:IQ:OUTP:STAT ON`

Query:
`:SOUR:IQ:OUTP:STAT?` Answer: `1`

Text

Text parameters observe the syntax rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example:
Setting command:
`:SOURce:BB:DM:CLOCK:MODE SYMBol`

Query:
`:SOURce:BB:DM:CLOCK:MODE?` Answer: `SYMB`

Strings

Strings must always be entered within quotation marks (' or ").

Example:

```
DIAGnostic:MEASure:POINt? 'DIAG_UNICOD_INT_ROUT' or
                          "DIAG_UNICOD_INT_ROUT"
```

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter with definite length has the following structure:

Example: `MMEMory:DATA test_file.wv, #45168xxxxxxxx`

Test_file.wv denotes the name of the file to which the data are written. The comma is followed by the binary data block. The hash symbol # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted.

Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

: The colon separates the key words of a command. In a command line the separating semicolon marks the uppermost command level.

; The semicolon separates two commands of a command line. It does not alter the path.

, The comma separates several parameters of a command.

? The question mark forms a query.

***** The asterisk marks a common command.

" Quotation marks introduce a string and terminate it.

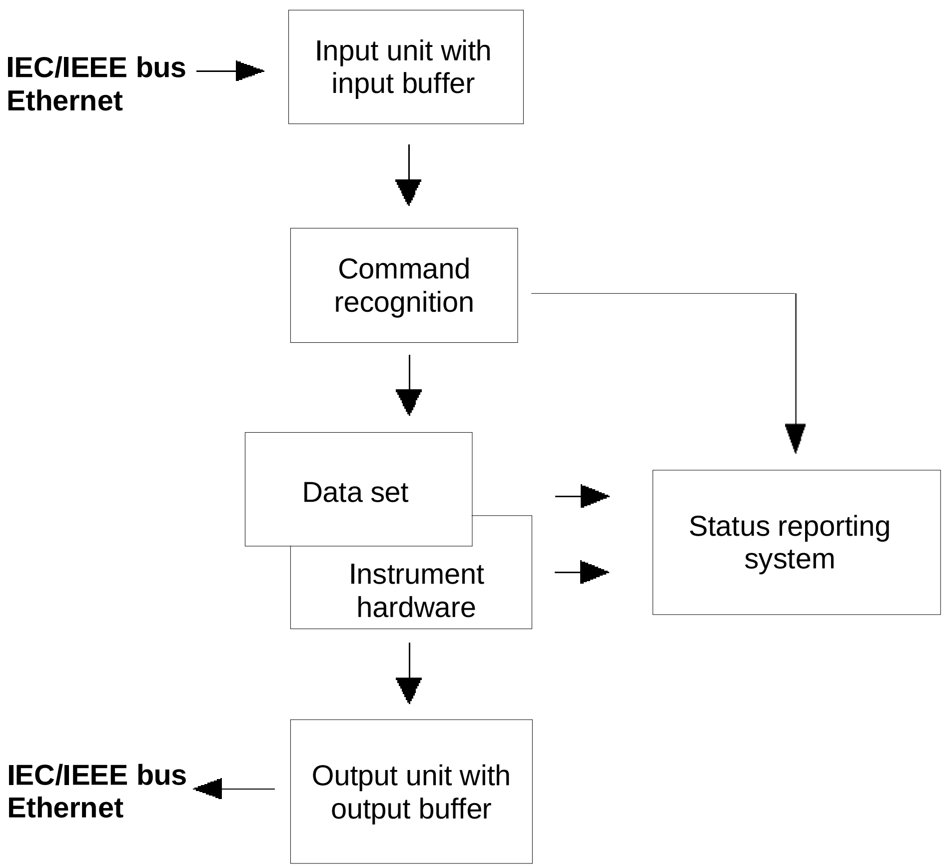
The hash symbol # introduces binary, octal, hexadecimal and block data.

Binary: #B10110
Octal: #O7612
Hexa: #HF3A7
Block: #21312

A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

Instrument Model and Command Processing

The block diagram in the figure below shows how SCPI commands are serviced in the instrument. The individual components work independently and simultaneously. They communicate with each other by means of so-called "messages".



Instrument model in the case of remote control via IEC/IEEE bus or TCP/IP network

Input Unit

The input unit receives commands character by character from the IEC/IEEE bus or via the Ethernet and collects them in the input buffer. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.

If the input buffer is full, the traffic is stopped and the data received up to then is processed. Subsequently the traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The receipt of a DCL clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before. Each recognized command is immediately transmitted to the data set but not executed immediately.

The command recognition detects syntax errors in the commands and transfers them to the status reporting system. The rest of a command line after a syntax error is analyzed further if possible and serviced. After the syntax test, the value range of the parameter is checked, if required.

If the command recognition detects a delimiter or a DCL, it also requests the data set to perform the necessary instrument hardware settings. Subsequently it is immediately prepared to process further commands. This means that new commands can already be serviced while the hardware is still being set ("overlapping execution").

Data Base and Instrument Hardware

The expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation etc. The controller is not included. The term "database" denotes a database that manages all the parameters and associated settings required for setting the instrument hardware.

Setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. power) into the data set, however, only passes them on to the hardware when requested by the command recognition. As this is only ever effected at the end of a command line, the order of the setting commands in the command line is not relevant.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that execution is not possible, an "execution error" is signaled to the status reporting system. All alterations of the data set are canceled, the instrument hardware is not reset. Due to the delayed checking and hardware setting, however, impermissible instrument states can be set for a short period of time within one command line without this leading to an error message. At the end of the command line, however, a permissible instrument state must have been reached again.

Example:

With **Custom Digital Modulation**, the settable FSK deviation depends on the set symbol rate (in case of FSK modulation). The R&S AMU responds as follows:

Assuming the set symbol rate is 100 ksymb/s, i.e. the permissible value range for FSK deviation is 1 kHz to 150 kHz. A deviation of 300 kHz should be set. To do so, the symbol rate has to be changed to 150 ksymb/s. The following commands are sent:

1. All commands in one program message:

   ```
   :SOUR:BB:DM:FORM FSK2; :SOUR:BB:DM:FSK:DEV 300kHz; :SOUR:BB:DM:SRAT
   150kHz
   ```

   This command line yields the desired setting. Since a valid state is obtained at the end of the program message, no error message is issued.

2. Each command in a separate program message:

   ```
   :SOUR:BB:DM:FORM FSK2
   :SOUR:BB:DM:FSK:DEV 300kHz
   :SOUR:BB:DM:SRAT 150kHz
   ```

The command for setting the FSK deviation is rejected and an execution error is generated. At the time when this command is processed, the previous setting of the symbol rate (100 ksymb) is still valid, i.e. the value for the FSK deviation is outside the permissible value range. The two other commands are set.

3. The two first commands in one program message, the third command in a separate program message.

```
:SOUR:BB:DM:FORM FSK2; :SOUR:BB:DM:FSK:DEV 300kHz
```

```
:SOUR:BB:DM:SRAT 150kHz
```

The command for setting the FSK deviation is rejected and an execution error is generated. At the time when this command is processed, the previous setting of the symbol rate (100 ksymb) is still valid, i.e. the value for the FSK deviation is outside the permissible value range. The two other commands are executed.

This example shows that it is advisable to send interdependent commands in one program message as in this case the sequence in which they are sent is irrelevant.

Queries induce the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in section "*Status Reporting System*", page 5.20.

Output Unit

The output unit collects the information requested by the controller, which it receives from the data set management. It processes it according to the SCPI rules and makes it available in the output buffer.

If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit sends the error message "Query UNTERMINATED" to the status reporting system. No data are sent on the IEC/IEEE bus or via the Ethernet , the controller waits until it has reached its time limit. This behavior is specified by SCPI.

Command Sequence and Command Synchronization

What was said above makes clear that overlapping execution is possible in principle for all commands. Equally, setting commands within one command line are not absolutely serviced in the order in which they have been received.

In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line.

In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By suitable programming, the controller can be forced to wait for the respective action to occur (see table).

Synchronization with *OPC, *OPC? and *WAI

Command	Action	Programming the controller
*OPC	Sets the Operation Complete bit in the ESR after all previous commands have been executed.	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Stops command processing until 1 is returned. This is only the case after the Operation Complete bit has been set in the ESR. This bit indicates that the previous setting has been completed.	Sending *OPC? directly after the command whose processing should be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Sending *WAI directly after the command whose processing should be terminated before other commands are executed.

Status Reporting System

The status reporting system stores information on errors which have occurred. This information is stored in the error queue. The error queue can be queried via IEC/IEEE bus or via the Ethernet.

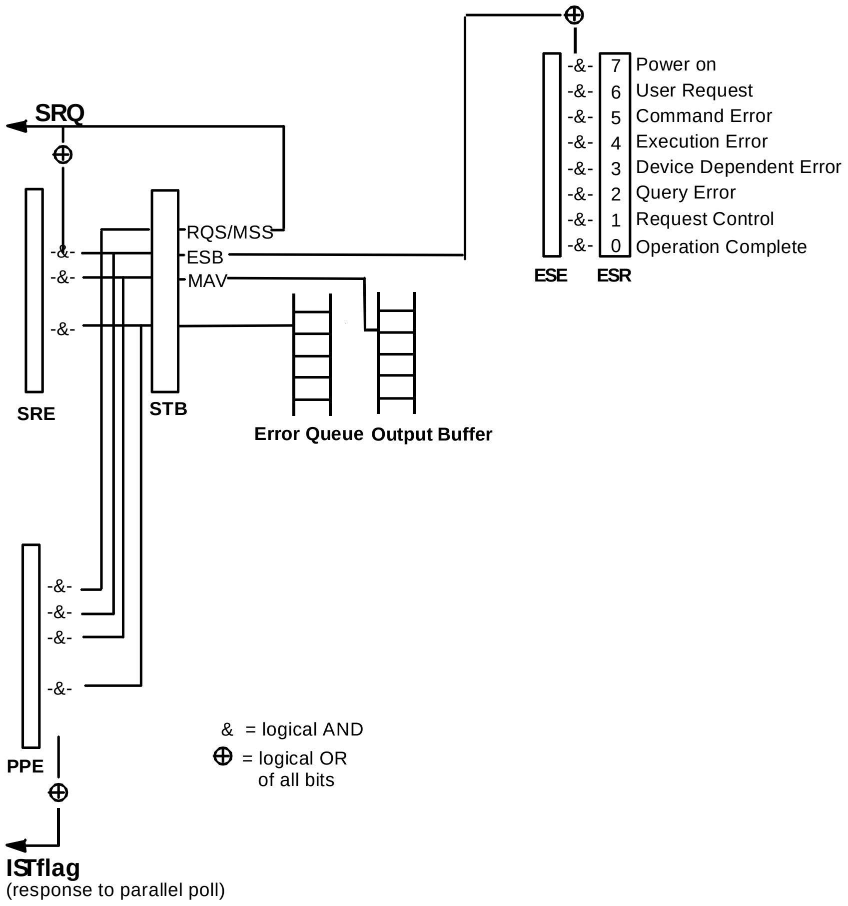
The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills an analog function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB.

Overview of the Status Register

The following figure shows the status registers used in the R&S AMU.



Overview of status registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB is linked to the SRE. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the IEC/IEEE bus or via the Ethernet, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there.

The SRE can be set using command "*SRE" and read using "*SRE?".

Meaning of the bits used in the status byte

Bit no.	Meaning
0...1	Not used
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with Remote control.
3	Not used
4	**MAV bit** (Message available) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller.
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	**MSS bit** (Master-Status-Summary-Bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable register SRE.
7	Not used

IST-Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. section "*Parallel Poll*, page 5.24") or using the command "`*IST?`".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The IST flag results from the ORing of all results. The PPE can be set using commands "*PRE" and read using command "`*PRE?`".

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is defined in IEEE 488.2. The event status register can be read out using command "*ESR?".

The ESE is the associated ENABle part. It can be set using the command "*ESE" and read using the command "*ESE?".

Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
1	not used
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue.
4	**Execution Error** This bit is set if a received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue.
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue.
6	**User Request** This bit is set on pressing the LOCAL key, i.e., when the instrument is switched over to manual operation.
7	**Power On** (supply voltage on) This bit is set on switching on the instrument.

Application of the Status Reporting System

In order to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed. There are several methods, which are outlined in the following.

Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. As evident from section "*Overview of the Status Register*", page 5.21, an SRQ is always initiated if one or several of bits 2, 4 or 5 of the status byte are set and enabled in the SRE. Each of these bits combines the information of the error queue or the output buffer. In order to use the possibilities of the service request effectively, all bits should be set to "1" in the enable registers SRE and ESE.

Example:

Use command "*OPC" to generate an SRQ

- `CALL IBWRT(generator%, "*ESE 1")` set bit 0 of ESE (Operation Complete)
- `CALL IBWRT(generator%, "*SRE 32")` set bit 5 of SRE (ESB)

After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

Serial Poll

In a serial poll, just as upon the command "`*STB`", the status byte of an instrument is queried. However, the query is made via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The VISUAL BASIC command for executing a serial poll is "`IBRSP()`". The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the IEC/IEEE bus or via the Ethernet.

Parallel Poll

In a parallel poll, the controller uses a single command to request up to eight instruments to transmit one bit of information each on the data lines, i.e., to set the data line allocated to each instrument to a logical "0" or "1". In addition to the SRE register, which determines the conditions under which an SRQ is generated, there is a parallel poll enable register (PPE). This register is ANDed with the STB bit by bit, considering bit 6 as well. The results are ORed, the result is possibly inverted and then sent as a response to the parallel poll of the controller. The result can also be queried without parallel poll by means of the command "`*IST?`".

The instrument first has to be set for the parallel poll using the VISUAL BASIC command "`IBPPC()`". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "`IBRPP()`".

The parallel poll method is mainly used to find out quickly which one of the instruments connected to the IEC/IEEE bus has sent a service request. To this effect, SRE and PPE must be set to the same value.

Query by Means of Commands

Each part of any status register can be read by means of queries. The individual commands are listed in the description of the STATus Subsystem. The returned value is always a number that represents the bit pattern of the register queried. This number is evaluated by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Error Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages that can be looked at in the ERROR menu via manual operation or queried via the IEC/IEEE bus or via the Ethernet using command "`SYSTem:ERRor?`". Each call of "`SYSTem:ERRor?`" provides <u>one</u> entry from the error queue. If no error messages are stored there any more, the instrument responds with `0, "No error"`.

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

Reset Values of the Status Reporting Systems

Commands `*RST`, `*DCL` and `SYSTem:PRESet` and switching on the supply voltage also affect the status reporting system. None of the commands, except for `*RST` and `SYSTem:PRESet` influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Resetting the Status Reporting System

Event / Effect	Switching on supply voltage Power-On-Status-Clear 0	 1	DCL,SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
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) Every command being the first in a command line, i.e. immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer

Contents - Chapter 6 "Remote Control - Description of Command"

Remote-Control Commands - Description of Commands

In the following, all remote-control commands will be presented in detail with their parameters and the ranges of numerical values.

An introduction to remote control and the status registers is given in chapter 5.

Notation

All commands implemented in the instrument are first listed in tables and then described in detail, arranged alphabetically according to the command subsystems. The notation is adapted to the SCPI standard. The SCPI conformity information is included in the individual description of the commands.

Table of Commands

Command: In the command column, the table provides an overview of the commands.

Parameter: The parameter column indicates the requested parameters together with their specified range.

Unit: The unit column indicates the basic unit of the physical parameters.

Remark: In the remark column an indication is made on:

- whether the command does not have a query form,
- whether the command has only one query form.

Individual description The individual description contains the complete notation of the command. An example for each command, the *RST value and the SCPI information are included as well.

The options that are required to execute the command are listed. In case of dependencies between commands they are also indicated.

Upper/lower case notation

Upper/lower case letters are used to mark the long or short form of the keywords of a command in the description (see chapter 5). The instrument itself does not distinguish between upper and lower case letters.

Special characters | A selection of keywords with an identical effect exists for several commands. These keywords are indicated in the same line; they are separated by a vertical stroke. Only one of these keywords needs to be included in the header of the command. The effect of the command is independent of which of the keywords is used.

Example: `SOURce:BB:MCCW:CARRier:LIST:PHASe |:POWer`

A vertical stroke in parameter indications marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is used.

The two following commands with identical meaning can be created:

Example: `SYST:ERR:NEXT? = STAT:QUE:NEXT?`

The commands query the oldest entry in the error queue and then delete it.

Example: Selection of the parameters for the command

`SOURce:BBIN:ROUTe A| B | AB`

If parameter A is selected, the signal is routed to path A, in case of AB the signal is routed to path A and path B.

[ ] Keywords in square brackets can be omitted when composing the header (cf. chapter 5, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards.

Parameters in square brackets can be incorporated optionally in the command or omitted as well.

{ } Parameters in braces can be incorporated optionally in the command, either not at all, once or several times..

Description of parameters

Due to the standardization, the parameter section of SCPI commands consists always of the same syntactical elements. SCPI has therefore specified a series of definitions, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<...>) and will be briefly explained in the following (see also chapter 5, section "Parameters").

<Boolean> This keyword refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword **OFF** or by the numeric value 0, the "on" state is indicated by **ON** or any numeric value other than zero. Parameter queries are always returned the numeric value 0 or 1.

<numeric_value>

<num> These keywords mark parameters which may be entered as numeric values or may be set using specific keywords (character data).

The following keywords given below are permitted:

MINimum	This keyword sets the parameter to the smallest possible value.
MAXimum	This keyword sets the parameter to the largest possible value.
DEFault	This keyword is used to reset the parameter to its default value.
UP	This keyword increments the parameter value.
DOWN	This keyword decrements the parameter value.

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

Example: `SOURce:FREQuency? MAXimum`

'returns the maximum possible numeric value of the center frequency as result.

<arbitrary block program data>

This keyword is provided for parameters of a binary data block.

Command Description

Common Commands

The common commands are taken from the standard IEEE 488.2 (IEC 625.2). Identical commands have an identical effect in different instruments. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands affect the status reporting system, which is described in detail in chapter 5 "*Remote Control - Basics*".

Command	Parameters	Default unit	Remark
*CLS			Clear status; no query
*ESE	0 ... 255		Event status enable
*ESR?	0 ... 255		Standard event status query; query only
*IDN?			Identification query; query only
*IST?	0 ... 255		Individual status query; query only
*OPC			Operation complete
*OPT?			Option identification query; query only
*PRE	0 ... 255		Parallel poll register enable
*PSC	0 | 1		Power on status clear
*RCL	1 ... 10		Recall
*RST			Reset; no query
*SAV	1 ... 10		Save
*SRE	0 ... 255		Service request enable
*STB?			Status byte query; query only
*TRG			Trigger; no query
*TST?			Self test query; query only
*WAI			Wait to continue; no query

***CLS?**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR), and the EVENt part of the QUEStionable and OPERation register to zero. The command does not change the enable and transition parts of the registers. It deletes the output buffer.

***ESE** 0 ... 255

EVENT STATUS ENABLE sets the event status enable register to the specified value. The *ESE? query command returns the content of the event status enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the content of the event status register in decimal form (0 ... 255) and then sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the instrument identification. The instrument type, serial number and firmware version are returned. Example:

Rohde&Schwarz, AMU 200A, 1141.2005k02/000000,02.45.0.3-061.06.06 (Release)

***IST?**

INDIVIDUAL STATUS QUERY returns the content of the IST flag in decimal form (0 **|** 1). The IST flag is the status bit which is sent during a parallel poll.

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all previous commands have been processed. This bit can be used to trigger a service request.

***OPC?**

OPERATION COMPLETE QUERY returns a 1 when all previous commands have been processed. It is important to ensure that the timeout set at the IEC/IEEE bus is long enough.

***OPT?**

OPTION IDENTIFICATION QUERY queries the options configured in the instrument and returns a list of the installed options. The options are separated by commas.

***PRE** 0 ... 255

PARALLEL POLL REGISTER ENABLE sets the parallel poll enable register to the specified value. The *PRE? query command returns the content of the parallel poll enable register in decimal form.

***PSC** 0 **|** 1

POWER ON STATUS CLEAR determines whether the content of the ENABle registers are retained or reset at power on.

Parameters:	**0**	The content of the status registers is retained at power on. If the status registers ESE and SRE are configured accordingly, this may cause a service request to be triggered at power on.
	1	The content of the status registers is reset at power on.

The **query** *PSC? retrieves the contents of the Power-on-Status-Clear flag. The answer is either 0 or 1.

***RCL** 0 ... 10

RECALL calls up the instrument status which was stored under the specified number using the `*SAV` command or using the `MMEMory:STORe:STATe` command. "0" corresponds to the power-on state, unless a new instrument setting was stored under this number in the meantime using the `MMEMory:STORe:STATe` command. This command can also be used to call up the 3 intermediate instrument states which are stored with `*SAV`.

***RST**

RESET resets the instrument to a defined default state. The command has the same effect as pressing the PRESET key. The default setting is given in the description of the commands.

Fading and transient recorder are only preset by this command.

***SAV**

SAVE stores the current device state under the specified number (see also *RCL). The command is used to store the 3 intermediate instrument states and to store the current instrument state internally when the instrument is switched off. This state is then restored at power on

***SRE** 0 ... 255

SERVICE REQUEST ENABLE sets the service request enable register to the specified value. Bit 6 (MSS enable bit) remains 0. This command determines the conditions under which a service request is triggered. The *SRE? query command reads out the content of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY reads out the content of the status byte in decimal form.

***TRG**

TRIGGER triggers all actions which are waiting for a trigger event. Specific trigger events can be triggered by means of the "TRIGger" command system (sweep and lists) or the SOURce subsystems (baseband).

***TST?**

SELF TEST QUERY triggers all self tests of the instrument and outputs an error code in decimal form (see Service Manual supplied with the instrument).

***WAI**

WAIT-to-CONTINUE does not allow subsequent commands to be processed until all previous commands have been executed and all signals are in their transient condition.

Preset Commands

The preset commands are not bundled in one subsystem. Therefore, they are listed separately in this section. In addition, a specific preset command is provided for each digital standard and for the fader. These specific commands are described in the associated subsystems.

Three presetting actions are available:

1. Activating the default state of all instrument functions (`*RST`)
2. Activating the preset state of the parameters related to the selected signal path (`SOURce<[1]:2>:PRESet`)
3. Activating the preset state of all parameters that are not related to the signal path (`DEVice:PRESet`)

Command	Parameters	Default unit	Remark
DEVice:PRESet			No query
*RST			No query
SOURce<[1]|2>:Preset			No query

DEVice:PRESet

The command presets all parameters which are not related to the signal path. This includes preseting the LF generator and bit/block error measurement.

The command triggers an event and therefore has no query form and no *RST value.

Example: "`DEV:PRES`"
'presets all instruments settings that are not related to the signal path.

*RST value	Resolution	Options	SCPI
-	-		Device-specific

*RST

RESET resets the instrument to a defined default state. The command has the same effect as pressing the PRESET key. The default setting is given in the description of the commands.

Fading and transient recorder are only preset by this command.

SOURce<[1]:2>:PRESet

The command presets all parameters which are related to the selected signal path.

This includes option 'Baseband In'. Fading and transient recorder are only preset by command `*RST`.

The suffix under SOURce distinguishes the paths:
SOURce[1] = path A
SOURce2 = path B

The command triggers an event and therefore has no query form and no *RST value.

Example: "`SOUR:PRES`"
'presets all settings that are related to signal path A.'

*RST value	Resolution	Options	SCPI
-	-		Device-specific

BERT and BLER Subsystems

These subsystems contain the commands for the bit and block error rate measurement. Since the commands for these two subsystems are essentially identical, they are summarized in the following section.

Command	Parameters	Default unit	Remarks
BERT:RESult			Query only
BERT:SEQuence	AUTO | SINGle		
BERT:SETup:CLOCk[:POLarity]	RISing | FALLing		
BERT:SETup:DATA[:POLarity]	NORMal | INVerted		
BERT:SETup:DENable	OFF | LOW | HIGH		
BERT:SETup:IGNore	OFF | ONE | ZERO		
BERT:SETup:MCOunt	0.0 ... 4294967295.0		
BERT:SETup:MERRor	0.0 ... 4294967295.0		
BERT:SETup:RESTart:STATe	ON | OFF		
BERT:SETup:TYPE	PRBS9 | PRBS11 | PRBS15 | PRBS16 | PRBS20 | PRBS21 | PRBS23		
BERT:STARt			No query
BERT:STATe	ON | OFF		
BERT:STOP			No query
BERT:UNIT	ENGineering | SCIentific | PCT | PPM		
BLER:RESult			Query only
BLER:SEQuence	AUTO | SINGle		
BLER:SETup:CLOCk[:POLarity]	RISing | FALLing		
BLER:SETup:CORDer	LSB | MSB		
BLER:SETup:DATA[:POLarity]	NORMal | INVerted		
BLER:SETup:DENable	LOW | HIGH		
BLER:SETup:MCOunt	0.0 ... 4294967295.0		
BLER:SETup:MERRor	0.0 ... 4294967295.0		
BLER:SETup:TYPE			Query only
BLER:STARt			No query
BLER:STATe	ON | OFF		
BLER:STOP			No query
BLER:UNIT	ENGineering | SCIentific | PCT | PPM		
[SOURce:]INPut:BERT:IMPedance	G50 | G1K		
[SOURce:]INPut:BERT:THReshold	0.01 .. 2.0	Volt	
TRIGger:BERT[:IMMediate]			No query
TRIGger:BLER[:IMMediate]			No query

BERT:RESult?

BLER:RESult?

Queries the result of the last BER measurement/BLER measurement. The response consists of seven results separated by commas. In the first measurement following the start, intermediate results for the number of data bits/data blocks, error bits/errors and error rate are also queried. In the following measurements (only for `BERT:SEQ AUTO`/for `BLER:SEQ AUTO`) only the final results of each single measurement are queried.

Note:
At the end of a measurement, the restart of a new one is delayed until the first measurement result has been queried with ***BERT:RES?****. The resulting brief measurement interruption is irrelevant because the subsequent measurement will be synchronized within 24 data bits.*

This command is a query and has therefore no *RST value.

Parameters: **Value 1** Number of checked data bits/data blocks.

Value 2 Number of error bits/errors.

Value 3 Error rate. If no termination criterion has been reached since the beginning of the measurement, the current quotient of "Number of error bits/errors" and "Number of data bits/data blocks" is entered. As soon as at least one final result has been reached in continuous measurement, the most recent final result is entered.

Value 4 Status of measurement.
1 = Measurement has been terminated, i.e. the number of data bits/data blocks or error bits/errors preset by the commands "`:BERT|BLER:SETup:MCOunt`" and "`:BERT|BLER:SETup:MERRor`" has been reached, or the measurement has been stopped by the command "`:BERT|BLER:STOP`".
0 = Measurement has not been terminated.

Value 5 Status of clock line.
1 = Clock line active.
0 = Clock line not active.

Value 6 Status of data line.
1 = Data line active (only clocked data is detected; if the clock signal is missing, a data change is also not detected).
0 = Data line is not active.

Value 7 Synchronization status.
1 = The measurement is synchronized, i.e. the clock and data lines are active and the "Number of error bits/errors" to "Number of data bits/data blocks" ratio is better than 0.1, so that the measurement ratio can be assumed to be realistic.
0 = The measurement is not synchronized.

Example: "BERT:RES?"
'queries the result of the bit error rate measurement.

Response: "1000,5,5E-4,1,1,1,1"
'the measurement has been terminated, and synchronization has been performed. Out of 1000 data bits, 5 error bits were measured, yielding an error rate of 0.005.

*RST value	Resolution	Options	SCPI
-		K80	Device-specific

BERT:SEQuence AUTO | SINGle

BLER:SEQuence AUTO | SINGle

Selects the type of measurement: single or continuous measurement.

Parameters: **AUTO**
Continuous measurement. If one or both termination criteria are met, the measurement in progress is terminated. At the end of a measurement, the restart of a new one is delayed until the first measurement result has been queried with BERT:RES?. The resulting brief measurement interruption is irrelevant because the subsequent measurement will be synchronized within 24 data bits.

SINGle
Single measurement. A single measurement must be started with :TRIG:BERT. A single measurement is terminated once the set number of data bits/blocks or number of errors is reached.

Example: "BERT:SEQ SING"
'selects single measurement.

"TRIG:BERT"
'starts the single measurement.

*RST value	Resolution	Options	Dependencies	SCPI
AUTO	-	K80	These commands are automatically set to AUTO by BERT:STARt or BLER:STARt	Device-specific

BERT:SETup:CLOCk[:POLarity] RISing | FALLing

BLER:SETup:CLOCk[:POLarity] RISing | FALLing

Sets the polarity of the active slope of the feedback clock.

Parameters: **RISing**
The positive slope of the clock signal is active.

FALLing
The negative slope of the clock signal is active.

Example: "`BERT:SET:CLOC FALL`"
'selects the falling slope of the clock signal as the active slope.

*RST value	Resolution	Options	SCPI
RISing		K80	Device-specific

BLER:SETup:CORDer LSB | MSB

Sets the byte order of the checksum (CRC).

Parameters: **LSB** The checksum starts with the least significant byte.

MSB The checksum starts with the most significant byte.

Example: "`BLER:SET:CORD MSB`"
'the checksum starts with the most significant byte.

*RST value	Resolution	Options	SCPI
LSB		K80	Device-specific

BERT:SETup:DATA[:POLarity] NORMal | INVerted

BLER:SETup:DATA[:POLarity] NORMal | INVerted

Sets the polarity of the feedback data bits.

Parameters: **NORMal** High level stands for a logic 1, low level for a logic 0.

INVerted Low level stands for a logic 1, high level for a logic 0.

Example: "`BERT:SET:DATA INV`"
'sets inversion of data signal.

*RST value	Resolution	Options	SCPI
NORMal		K80	Device-specific

BERT:SETup:DENable OFF | HIGH | LOW

BLER:SETup:DENable OFF | HIGH | LOW

Activates/deactivates the use of the **Data Enable** signal and the polarity of the signal if it is used. The **Data Enable** signal marks the data that is actually to be evaluated for the BER measurement. Any data in addition to the PRBS sequence is masked and thus not evaluated (e.g. sync, preambles, other channels, etc that are present in the data bits supplied by the DUT).

Parameters:

OFF Any signal at the **Data Enable** input is ignored; all data at the BERT data input is used for the measurement.

HIGH The **Data Enable** signal is used. The only data measured is the data at the BERT data input during a **high level** of the Data Enable signal. The measurement is interrupted during a low level of the Data Enable signal.

LOW The **Data Enable** signal is used. The only data measured is the data at the BERT data input during a **low level** of the Data Enable signal. The measurement is interrupted during a high level of the Data Enable signal.

Example: `"BERT:SET:DEN HIGH"`
'the measurement is interrupted during the low level of the **Data Enable** input.

*RST value	Resolution	Options	SCPI
OFF		K80	Device-specific

BERT:SETup:IGNore ONE | OFF | ZERO

Activates/deactivates ignoring of pure "0" or "1" bit sequences at least 32 bits long. Activating excludes faulty frames from the measurement. In the case of some mobile radio standards, pure "0" or "1" bit sequences are generated when errors (e.g. an incorrect checksum) are detected within a frame. These sequences, instead of the frame data, are provided for the BER measurement and signal that the frame in question should not be used for the measurement.

Parameters:

OFF
Pattern Ignore is not active.

ONE
Bit sequences consisting of 32 or more consecutive "1" data are not used (i.e. ignored) for the BER measurement.

ZERO
Bit sequences consisting of 32 or more consecutive "0" data are not used (i.e. ignored) for the BER measurement.

Example: `"BERT:SET:IGN ONE"`
'specifies that bit sequences of "1" data at least 32 bits long are not used for the measurement.

*RST value	Resolution	Options	SCPI
OFF		K80	Device-specific

BERT:SETup:MCOunt 0.0 ... 2^32-1

BLER:SETup:MCOunt 0.0 ... 2^32-1

Enters the number of transmitted data bits/data blocks to be checked before the measurement is terminated. With a BER measurement, data that was suppressed by `BERT:SETup:DENable` is not counted. This termination criterion always terminates the measurement after the specified number of data bits/data blocks. Starting from this point, the fourth value is output with 1 (= terminate measurement) if the result is queried with `:BERT|BLER:RES?`. If the continuous measurement mode (`BERT|BLER:SEQ AUTO`) has been selected, the measurement is restarted once the results have been queried.

Example: `"BERT:SET:MCO 1E6"`
'sets a measurement over 1000000 data bits.

`"BLER:SET:MCO 1E3"`
'sets a measurement over 1000 data blocks.

*RST value	Resolution	Options	SCPI
BERT: 10 000 000 BLER: 100 000		K80	Device-specific

BERT:SETup:MERRor 0.0 ... 2^32-1

BLER:SETup:MERRor 0.0 ... 2^32-1

Enters the number of errors to occur before the measurement is terminated. This termination criterion always terminates the measurement after the specified number of errors. Starting from this point, the fourth value is output with 1 (= terminate measurement) if the measurement result is queried with `:BERT|BLER:RES?`.

Example: `"BERT:SET:MERR 1E4"` 'sets a measurement over 1000 errors.

*RST value	Resolution	Options	SCPI
100		K80	Device-specific

BERT:SETup:RESTart:STATe ON | OFF

Activates/deactivates an external restart of the BER measurement.

Parameters:

OFF The reset signal for the BER measurement is generated internally. This setting is suitable for PRBS sequences that run continuously and thus ensure uninterrupted repetition.

ON The reset signal for the BER measurement is fed via the **Restart** input of the BERT interface.
If the PRBS sequence cannot be continued uninterruptedly, the BER measurement must be stopped at the end of the data sequence and subsequently restarted at the beginning of the new data sequence. The measurement is stopped and started via a 0-1-0 slope of the **Restart** signal. A transition from logic 0 to 1 causes a partial result to be generated and the measurement to be stopped. A transition from 1 to 0 starts the measurement for the next subinterval. This measurement is synchronized anew. If the R&S AMU is used as a data source, a signal in which a single 1 was coded at the end of the data sequence can be used as a restart signal at the R&S AMU marker output. This causes the BER measurement to stop briefly at the end of the data sequence and start again. Partial results (number of data and error bits) are added up until the predefined total number of data or error bits is reached or exceeded. The measurement is reset by **Pattern Ignore** or **Data Enable**, regardless of its status.

Example: `"BERT:SET:REST:STAT ON"` 'the external signal restarts the measurement.

*RST value	Resolution	Options	SCPI
OFF		K80	Device-specific

BERT:SETup:TYPE PRBS9 | PRBS11 | PRBS15 | PRBS16 | PRBS20 | PRBS21 | PRBS23

Selects the PRBS sequence. The data generated by the PRBS generator is used as a reference for the measurement.

Example: `"BERT:SET:TYPE PRBS15"`
'sets a pseudo random binary sequence consisting of 32767 bits.

*RST value	Resolution	Options	SCPI
PRBS9		K80	Device-specific

BLER:SETup:TYPE?

Queries the CRC polynomial used. CCITT CRC 16 : $G(x) = x^{16} + x^{12} + x^5 + x^1$. is the CRC polynomial supported.

This command is a query and therefore has no *RST value.

Example: `"BLER:SET:TYPE?"`
'queries the type of measurement.

Response: '`CRC16`'

*RST value	Resolution	Options	SCPI
-		K80	Device-specific

BERT:STARt

BLER:STARt

Starts a continuous measurement.

This command triggers an event and hence has no query and no *RST value.

Example: `"BERT:STAR"`
'starts a continuous measurement.

*RST value	Resolution	Options	Dependencies	SCPI
AUTO	-	K80	These commands automatically set `BERT:SEQuence` or `BLER:SEQuence` to `AUTO` and `BERT:STATe` or `BLER:STATe` to `ON`	Device-specific

BERT:STATe
BLER:STATe

Switches the measurement on/off. Depending on the selected mode, either a continuous measurement (BERT|BLER:SEQ AUTO) or a single measurement (BERT|BLER:SEQ SING) is carried out. A single measurement must be triggered (:TRIG:BERT|BLER).

Example: "BERT:SEQ SING"
'selects a single measurement.

"BERT:STAT ON"
'switches the BER measurement on.

":TRIG:BERT"
'starts a single measurement.

*RST value	Resolution	Options	Dependencies	SCPI
OFF	-	K80	These commands are automatically set to ON by BERT:STARt or BLER:STARt and to OFF by BERT:STOP or BLER:STOP	Device-specific

BERT:STOP
BLER:STOP

Stops an ongoing measurement.

This command triggers an event and hence has no query and no *RST value.

Example: "BERT:STOP"
'stops the measurement. To start a new measurement, the BER measurement must be switched on again by BERT:STATe ON.

*RST value	Resolution	Options	Dependencies	SCPI
-	-	K80	These commands automatically set BERT:STATe or BLER:STATe to OFF	Device-specific

BERT:UNIT ENGineering | SCIentific | PCT | PPM

BLER:UNIT ENGineering | SCIentific | PCT | PPM

Sets the unit for the error rate display on the screen. `BERT|BLER:RES?` always specifies the error rate as the quotient of "Number of errors" and "Number of data items", unaffected by this command.

Parameters:

ENGineering The error rate is output in exponential notation with the exponent –3 or –6.

SCIentific The error rate is output in scientific notation, i.e. standardized to one place to the left of the decimal.

PCT The error rate is output in percent.

PPM The error rate is output in parts per million.

Example: `"BERT:UNIT PPM"`
'selects the unit "ppm" for the display of the error rate.

*RST value	Resolution	Options	SCPI
ENG		K80	Device-specific

[SOURce:]INPut:BERT:IMPedance G50 | G1K

The command sets the impedance of the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**.

Example: `"INP:BERT:IMP G50"`
'the impedance of the BERT inputs is set to 50 Ohm to ground.

*RST value	Resolution	Options	SCPI
G1K	-	K80	Device-specific

[SOURce:]INPut:BERT:THReshold 0 ... 2.0 V

The command sets the high/low threshold of the BERT inputs **Clock**, **Data**, **Data Enable** and **Restart**. In the case of positive polarity, this threshold determines the point as of which a signal is high (active) or low (inactive).

Example: `"INP:BERT:THR 1 V"`
'a high/low threshold of 1 volt is set at the BERT inputs. The signal is high (active) for a signal voltage of 1 volt and higher.

*RST value	Resolution	Options	SCPI
1.00 V	-	K80	Device-specific

TRIGger:BERT[:IMMediate]

TRIGger:BLER[:IMMediate]

Triggers a single bit error rate or block error rate measurement if the single trigger mode (`BERT|BLER:SEQ SING`) is selected.

This command triggers an event and hence has no query and no *RST value.

Example: `"BERT:SEQ SING"`
'selects the single trigger mode.

`"TRIG:BERT"`
'starts a single bit error rate measurement.

*RST value	Resolution	Options	SCPI
-		K80	Device-specific

CALibration Subsystem

The CALibration system contains the commands for adjustment. Adjustment is triggered by the query commands. The response "0" indicates error-free adjustment, and the response "1" means that an error occurred during adjustment.

In case of two-path instruments with a second baseband signal path, adjustment can be set separately and independently for the two baseband signal paths A and B. The suffix under SOURce distinguishes the outputs:

CALibrate[1] = Baseband signal path A

CALibrate2 = Baseband signal path B

Command	**Parameters**	**Default unit**	**Remark**
CALibration:ALL[:MEASure]?			Query only
CALibration:BBIN[:MEASure]?			Query only
CALibration<[1]|2>:DAC[:MEASure]?			Query only

CALibration:ALL[:MEASure]?

The command starts all internal adjustments for which no external measuring equipment is needed. With two-path instruments, adjustment is performed for both paths.

Example: `"CAL:ALL:MEAS?"`
'starts the adjustment of all functions for the entire instrument.

Response: "0" 'adjustment has been performed successfully.

***RST value**	**Resolution**	**Options**	**SCPI**
-	-		Compliant

CALibration:BBIN[:MEASure]?

The command starts adjustment of the analog I/Q input. The I/Q input is adjusted with respect to DC offset and gain.

Example: `"CAL:BBIN:MEAS?"` 'starts the adjustment of the analog I/Q input.

Response: "0" 'adjustment has been performed successfully.

***RST value**	**Resolution**	**Options**	**SCPI**
-	-	Option B17	Compliant

CALibration<[1]|2>:DAC[:MEASure]?

The command starts adjustment of the DAC board.

Example: `"CAL:DAC:MEAS?"` 'starts the adjustment of the DAC board of path A.

Response: "0" 'adjustment has been performed successfully.

***RST value**	**Resolution**	**Options**	**SCPI**
-	-	-	Compliant

CLOCk Subsystem

The CLOCk system contains the commands for configuration of the signals at the clock output and input connectors.

Command	Parameters	Default unit	Remarks
CLOCk:INPut:FREQuency			Query only
CLOCk:INPut:SLOPe	POSitive | NEGative		
CLOCk:OUTPut:MODE	BIT | SYMBol		
CLOCk:OUTPut:SOURce			Query only

CLOCk:INPut:FREQuency

The command sets the measured frequency of the external clock signal. An external clock reference must be supplied at the CLOCK input.

The command is a query command and therefore does not have an *RST value.

Example: `"CLOC:INP:FREQ?"`
'queries the measured frequency of the external clock reference.

*RST value	Resolution	Options	SCPI
	-	B9/10/11 and B13	Device-specific

CLOCk:INPut:SLOPe POSitive | NEGative

The command sets the active slope of an externally applied clock signal at the CLOCK connector.

Example: `"CLOC:INP:SLOP NEG"`
'the active slope of the external clock signal at the CLOCK connector is the falling slope.

*RST value	Resolution	Options	SCPI
POSitive	-	B9/10/11 and B13	Device-specific

CLOCk:OUTPut:MODE?

The command sets the output of bit or symbol clock pulses at the CLOCK OUT connector at the rear panel.

Example: `"CLOC:OUTP:MODE SYMB"`
'the internal symbol clock is output at the CLOCK OUT connector.

*RST value	Resolution	Options	SCPI
SYMBol	-	B9/10/11 and B13	Device-specific

CLOCk:OUTPut:SOURce?

The command queries the path for which the clock signal at the CLOCK OUT connector is to be output.

The command is a query command and therefore does not have an *RST value.

Example: "CLOC:OUTP:SOUR?"
'queries the path for which the clock signal at the CLOCK OUT connector is to be output.

Response: A
'the clock signal of path is output at the CLOCK OUT connector.

*RST value	Resolution	Options	SCPI
-	-	B9/10/11 and B13	Device-specific

DIAGnostic Subsystem

The DIAGnostic system contains the commands used for instrument diagnosis and servicing. SCPI does not define any DIAGnostic commands. All commands listed here are Device-specific. DIAGnostic commands are query commands which are not influenced by the *RST command.

In the case of two-path instruments, the numerical suffix under DIAGnostic distinguishes between path A and path B:

DIAGnostic[1] = path A

DIAGnostic2 = path B

Command	Parameters	Default unit	Remark
DIAGnostic<[1]|2>:BGINfo?	<module name>		Query only
DIAGnostic<[1]|2>:BGINfo:CATalog?			Query only
DIAGnostic:INFO:OTIMe?			Query only
DIAGnostic:INFO:POCounter?			Query only
DIAGnostic<[1]|2>:POINt:CATalog?			Query only
DIAGnostic<[1]|2>[:MEASure]:POINt?	<point name>		Query only

DIAGnostic<[1]|2>:BGINfo? <module name>

The command checks the modules available in the instrument using the variant and revision state.

If the command is sent without parameters being specified, a complete list of all modules is returned (the various entries are separated by commas). The length of the list is variable and depends on the instrument equipment configuration.

If the command is sent with parameters, a list of the specified modules is returned (the various entries are separated by commas). A list of modules names can be called up using the `DIAG:BGIN:CATalog?` command.

Each entry for one module consists of four parts which are separated by space characters:

Module name Module stock number incl. variant Module revision Module serial number.

The path for which the query is performed is determined by the numerical suffix.

Example: `"DIAG:BGIN:CAT?"`
'queries the instrument configuration of path A.

Response: `MBRD,SATT3C,BBINS,BBINR,BBOUT,....`
'returns the data of all available modules.

`"DIAG:BGIN? 'MBRD'"`
'queries the configuration of the motherboard of path A.

Response: `MBRD 1141.3501.02 1.5.3 100023`
'module motherboard with stock number 1141.3501.01 has revision 1.5.3 and serial number 100023.

*RST value	Resolution	Options	SCPI
-	-	DIAGnostic2 only with second option B13 or B9/10/11	Device-specific

DIAGnostic<[1]|2>:BGINfo:CATalog?

The command queries the names of the assemblies available in the instrument.

A complete list of all assemblies is returned (the various entries are separated by commas). The length of the list is variable and depends on the instrument equipment configuration.

The path for which the query is performed is determined by the numerical suffix.

Example: `"DIAG2:BGIN:CAT?"`
'queries the names of the assemblies of path B.

Response: `MBRD,SATT3C,BBINS,BBINR,BBOUT,....`

*RST value	Resolution	Options	SCPI
-	-	DIAGnostic2 only with second option B13 or B9/10/11	Device-specific

DIAGnostic:INFO:OTIMe?

The command queries the number of operation hours

Example: `"DIAG:INFO:OTIM?"`
'queries the operation hours.

Response: `"100023"`
'the instrument was operated for 100023 hours up to now.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

DIAGnostic:INFO:POCounter?

The command queries the number of power-on events.

Example: `"DIAG:INFO:POC?"`
'queries the number of power on events.

Response: `"123"`
'the instrument was switched on for 123 times up to now.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

DIAGnostic<[1]|2>:POINt:CATalog?

The command queries the test points available in the instrument. A detailed description of the test points can be found in chapter 3, section "Trouble Shooting" of the Service Manual (on CD-ROM, supplied with the instrument).

Example: `"DIAG:POIN:CAT?"`
'queries the test points available in the instrument.

Response: `'DIAG_BBINS_GND,DIAG_BBINS_IIN,DIAG_BBINS_QIN,...`

*RST value	Resolution	Options	SCPI
-	-	DIAGnostic2 only with second option B13 or B9/10/11	Device-specific

DIAGnostic<[1]|2>[:MEASure]:POINt?

The command triggers voltage measurement at the specified test point and returns the measured voltage. A detailed description of the test points can be found in chapter 3, section "Trouble Shooting" of the Service Manual (on CD-ROM, supplied with the instrument).

A list of the available test points for the respective path can be queried using the `DIAG<[1]|2>:POIN:CAT?` command.

Example: `"DIAG:POIN? 'DIAG_BBINS_IIN'"`
'triggers measurement at the test point DIAG_BBINS_IIN of path A.

Response: `0.5`
'the voltage at the test point is 0.5 volt.

*RST value	Resolution	Options	SCPI
-	-	DIAGnostic2 only with second option B13 or B9/10/11	Device-specific

FORMat Subsystem

The FORMat subsystem contains the commands which determine the format of the data that the R&S AMU returns to the controller. This affects all query commands which return a list of numerical data or block data. Reference is made to this in the descriptions of the commands.

The data format is set simultaneously for both paths.

Command	Parameters	Default unit	Remark
FORMat:BORDer	NORMal | SWAPped		
FORMat[:DATA]	ASCii | PACKed		
FORMat:SREGister	ASCii | BINary | HEXadecimal | OCTal		

FORMat:BORDer NORMal | SWAPped

The command determines the sequence of bytes within a binary block. This only affects blocks which use the IEEE754 format internally.

Parameters: **NORMal**
The R&S AMU expects (with setting commands) and sends (with queries) the least significant byte of each IEEE754 floating-point number first, and the most significant byte last.

SWAPped
The R&S AMU expects (with setting commands) and sends (with queries) the most significant byte of each IEEE754 floating-point number first, and the least significant byte last.

Example: `"FORM:BORD SWAP"`
'the data is transferred with the most significant bit first.

*RST value	Resolution	Options	SCPI
NORMal	-	-	Compliant

FORMat[:DATA] ASCii | PACKed

The command determines the data format which the R&S AMU uses to return data. When data is transferred from the control computer to the instrument, the instrument detects the data format automatically. In this case, the value set here is irrelevant.

Parameters: **ASCii**
Numerical data is transferred as plain text separated by commas.

PACKed
Numerical data is transferred as binary block data. The format within the binary data depends on the command. The various binary data formats are explained in the description of the parameter types.

Example: `"FORM ASC"`
'the data is transferred as ASCII data.

*RST value	Resolution	Options	SCPI
ASCii	-	-	Compliant

FORMat:SREGister ASCii | BINary | HEXadecimal | OCTal

The command determines the numerical format which is returned when the status registers are queried.

Parameters: **ASCii**
The register content is returned as a decimal number.

BINary
The register content is returned as a binary number. #B is placed in front of the number.

HEXadecimal
The register content is returned as a hexadecimal number. #H is placed in front of the number.

OCTal
The register content is returned as an octal number. #Q is placed in front of the number.

Example: `"FORM:SREG HEX"`
'the register content is returned as a hexadecimal number.

*RST value	Resolution	Options	SCPI
ASCii	-	-	Compliant

MMEMory Subsystem

The MMEMory subsystem (Mass Memory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

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, e.g. using the UNC format (Universal Naming Convention): '\\server\share'.

The default drive is determined using the command `MMEMory:MSIS <msus>`.

***Note**:*
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.

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). Where possible, special characters should not be used. Use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved by the operating system, e.g. CLOCK$, CON, AUX, COM1...COM4, LPT1...LPT3, NUL and PRN.

In the R&S AMU 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 the following table containing a list of the file types).

The two characters "*" and "?" function as "wildcards", i.e. they are used for selecting several files. The "?" character represents exactly one character, while the "*" character represents all characters up to the end of the file name. "*.*" therefore stands for all the 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 file name, or only the file name. 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 drive setting in the commands.

In the example below, the current instrument setting is always stored in the file `'test1.ss'` in the directory 'user' on the internal hard disk.

```
MMEM:STOR:STAT 0,"d:\user\test1.ss"
```

If the complete path including the drive letter is specified, the file is stored in the specified path.

```
MMEM:MSIS 'D:'
MMEM:STOR:STAT 0,"\user\test1.ss"
```

If the parameter only contains the path and file name, the default drive set with the `MMEM:MSIS` command is effective.

```
MMEM:MSIS  'd:\'
MMEM:CDIR  'user'
MMEM:STOR:STAT 0,"test1.ss"
```

If the parameter only contains the file name, the file is stored on the default drive `MMEM:MSIS` and in the default directory which was selected with the `MMEM:CDIR` command.

The data for **both** paths is always transferred simultaneously for all data transfer commands.

Table 6-1 List of file extensions assigned automatically in R&S AMU

List type	Contents	File suffix
Instrument State		
Instrument State	Instrument settings	*.savrcl
Arbitrary Waveform Generator		
Waveform, Multisegment Waveform	ARB waveforms	*.wv
Multisegment Configuration	Configuration info for multisegment waveforms	*.inf_mswv
DM		
Data List	Digital modulation data	*.dm_iqd
Control List	Data to control digital modulation	*.dm_iqc
GSM/EDGE		
Slot	User-defined slot data	*.gsm_slu
Frame	User-defined frame data	*.gsm_fu
3GPP FDD		
3GPP Settings	Complete setting of the 2GPP (FDD) dialog	*.3g
Channel Coding DPCH	Channel coding enhanced DPCH channels (uplink)	*.3g_ccod_ul
Channel Coding DPDCH	Channel coding enhanced DPDCH channels (downlink)	*.3g_ccod_dl
CDMA2000		
CDMA2000 Settings	Complete setting of the CDMA2000 dialog	*.cdma2k
WLAN		
WLAN Settings	Complete setting of the IEEE 802.11 WLAN dialog	*.wlan
WiMAX		
WiMAX Settings	Complete setting of the IEEE 802.16 WiMAX dialog	*.wimax
GPS		
GPS Settings	Complete setting of the GPS dialog	*.gps
TD-SCDMA		
TD-SCDMA Settings	Complete setting of the TD-SCDMA dialog	*.tdscdma

Command	Parameters	Default unit	Remark
MMEMory:CATalog?	<path>		Query only
MMEMory:CATalog:LENGth?			Query only
MMEMory:CDIRectory	<directory_name>		No query
MMEMory:COPY	<file_name>,<file_name>		No query
MMEMory:DATA	<file_name>[,<block>]		
MMEMory:DCATalog?			Query only
MMEMory:DCATalog:LENGth?			Query only
MMEMory:LOAD:STATe	0,<file_name>		No query
MMEMory:DELete	<file_name>		No query
MMEMory:MDIRectory	<directory_name>		No query
MMEMory:MOVE	<file_name>,<file_name>		No query
MMEMory:MSIS	<msus>		
MMEMory:RDIRectory	<directory_name>		
MMEMory:STORe:STATe	0,<file_name>		

MMEMory:CATalog? <path>

This command reads out the subdirectories and files in the specified directory. If no directory is specified, the default directory selected with the `MMEM:CDIR` command is read out on the default drive selected with the `MMEM:MSIS` command.

The response has the following format:

```
<used_bytes_in_this_directory>,<free_bytes_on_this_disk>,
"<file_name>,<file_type>,<filesize_in_bytes>",
"<file_name>,<file_type>,<filesize_in_bytes>", …
```

The command is a query command and therefore has no *RST value.

Parameters: **<file_name>**
File or directory name.

<file_type>
File type. There are the following file types: DIR (directory), ASCii (ASCII file), BINary (Binary file), and STATe (file with instrument settings).

<filesize_in_bytes>
File size. The size "0" is returned for a directory.

Example: `"MMEM:CAT? '\\Server\DATA\*.LOG'`
Reads back all files in \\Server\DATA with the extension ".LOG".

`"MMEM:CAT? 'd:\user'"`
'reads out all files at the highest directory level of the memory stick.

Response:

"'127145265,175325184,"test,DIR,0","temp,DIR,0","readme.txt,ASC,1324","state.savracl,STAT,5327","waveform.wv,BIN,2342"

'the directory `D:\User` contains the subdirectories `'test'` and `'temp'` as well as the files `'readme.txt'`, `'state.savrcl'` and `'waveform.wv'` which have different file types.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:CATalog:LENGth? <path>

This command reads out the number of files in the specified directory. If no directory is specified, the default directory selected with the `MMEM:CDIR` command is read out on the default drive selected with the `MMEM:MSIS` command.

The command is a query command and therefore has no *RST value.

Example: `"MMEM:CAT:LENG? 'e:\"`
'reads out the number of files at the highest directory level of the memory stick.

Response: "1"
'there is 1 file at the highest directory level of the memory stick.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

MMEMory:CDIRectory <directory_name>

This command changes the default directory. This directory is used for all subsequent MMEM commands if no path is specified with them. It is also possible to change to a higher directory using two dots '..' .

Example: `"MMEM:CDIR 'test'"`
'changes from the current directory level to the subdirectory `'test'`.

*RST value	Resolution	Options	SCPI
D:\	-		Compliant

MMEMory:COPY <source>[,<destination>]

This command copies the first specified file to the second specified file. Instead of just a file, this command can also be used to copy a complete directory together with all its files.

If <destination> is not specified, <source> is copied to the `MMEM:MSIS` drive and the `MMEM:CDIR` directory. Files which already exist with the same name in the destination directory are overwritten without an error message.

It is also possible to specify the path using another parameter. The command is:
MMEMory:COPY <file_source><msus_source>[,<file_destination>,<msus_destination>]

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:COPY 'D:\USER\TEST1.SVARCL','E:'"`
'copies the file `'test1.savrcl'` in the USER directory on the internal hard disk to the memory stick without changing the file name.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:DATA <file_name>[,<binary block data>]
MMEMory:DATA? <file_name>

MMEMory:DATA **<file_name>[,<binary block data>]**
This command writes the block data <binary block data> to the file identified by <file_name>. The IEC/IEEE bus terminator should be set to EOI in order to ensure correct data transfer.

The associated query command transfers the specified file from the R&S AMU to the IEC/IEEE bus and then on to the control computer. It is important to ensure that the intermediate memory on the control computer is large enough to take the file. In this case, the setting for the IEC/IEEE-bus terminator is irrelevant. This command can be used to read/transfer stored instrument settings or waveforms directly from/to the instrument.

The binary data block has the following structure: #234<block_data>
always comes first in the binary block
<number> indicates how many digits the subsequent length entry has (2 in example)
<number> indicates the number of subsequent bytes (34 in example)
<binary block data> binary block data for the specified length

Example: "`MMEM:DATA 'TEST1.WV',#3767<binary data>`"
'writes the block data to the file 'test1.wv'.

"`MMEM:DATA? 'TEST1.WV'`
'sends the data of the file 'Test1.wv' from the R&S AMU to the control computer in the form of a binary block.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:DCATalog? <path>

This command reads out the subdirectories of the specified directory. If no directory is specified, the default directory selected with the `MMEM:CDIR` command is read out. The directories are output in a list (the list entries are separated by commas).

The command is a query command and therefore has no *RST value.

Example: "`MMEM:DCAT?`
'reads out the subdirectories of the current directory.

Response: "'test', 'wave', 'digital'"
'the subdirectories 'test', 'wave' and 'digital' exist in the current directory.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

MMEMory:DCATalog:LENGth? <path>

This command reads out the number of subdirectories in the specified directory. If no directory is specified, the directory selected with the `MMEM:CDIR` command is read out.

Example: `"MMEM:DCAT:LENG`
'reads out the number of subdirectories in the current directory.

Response: "3"
'there are 3 subdirectories in the current directory.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

MMEMory:DELete <file_name>

This command deletes the specified file.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:DEL 'D:\USER\TEST1.SAVRCL'"`
'deletes the file `'Test1.savrcl'` in the USER directory on the internal hard disk.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:LOAD:STATe 0,<file_name>

This command loads the specified file stored under the specified name in an internal memory. If 0 is used, the instrument setting of the selected file is set directly in the R&S AMU. The *RCL command is used to load the immediate instrument setting (see the section "*Common Commands*", page 6.3).

If a number other than 0 is used when storing, the instrument setting must be activated using an *RCL command with this number after the file has been loaded.

Example: `"MMEM:LOAD:STAT 0,'D:\user\test1.savrcl'"`
'loads the file `'Test1.savrcl'` in the USER directory of the internal hard disk and activates the associated instrument setting.

`"MMEM:STOR:STAT 4,'D:\user\test4.savrcl'"`
'stores the file `'Test4.savrcl'` in the USER directory of the internal hard disk.

`"MMEM:LOAD:STAT 4,'D:\user\test4.savrcl'"`
'loads the file `'Test4.savrcl'` in the USER directory of the internal hard disk.

`"*RCL 4"`
'activates the instrument setting of the file `'Test4.savrcl'`.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:MDIRectory <directory_name>

The command creates a new subdirectory 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.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:MDIR 'carrier'"`
'creates the subdirectory `'carrier'` in the current directory.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

MMEMory:MOVE <file_source>,<file_destination>

This command renames an existing file if no path is specified for <file_destination>. Otherwise the file is moved to the specified path and stored under the original file name or, if specified, a new file name.It is also possible to specify the path using another parameter. The command is:
MMEMory:MOVE <file_source><msus_source>[,<file_destination>,<msus_destination>]

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:MOVE 'test1.savrcl','keep1.savrcl"`
'renames the file 'test1.savrcls' as 'keep1.savrcl'.

`"MMEM:MOVE 'test1.savrcl','\amu_one\keep1.savrcl"`
'moves the file 'test1.savrcl' to the subdirectory 'amu_one' and stores it there under the name 'keep1.savrcl'.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

MMEMory:MSIS <msus>

The command sets the drive (or network resource in the case of networks) using <msus> (MSIS = **M**ass **S**torage **I**dentification **S**tring). This setting is effective for all MMEMory commands where the drive is not explicitly specified in the parameter.

Example: `"MMEM:MSIS 'E:'"`
'selects the memory stick as the default drive.

*RST value	Resolution	Options	SCPI
D:\	-	-	Compliant

MMEMory:RDIRectory <directory_name>

The command deletes the specified subdirectory in the specified directory. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:RDIR 'carrier'"`
'deletes the subdirectory 'carrier' in the current directory.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

MMEMory:STORe:STATe 0,<file_name>

This command stores the current instrument setting in the specified file. If 0 is specified, the current instrument setting is stored directly in the specified file. The intermediate instrument settings can be stored using the *SAV command (see the section "*Common Commands*", page 6.3).

If a number other than 0 is specified, the instrument setting must first be stored in an internal memory with the same number using the common command *SAV.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"MMEM:STOR:STAT 0,'D:\USER\TEST1.ss'"`
'stores the current instrument setting in the file `'test1.ss'` in the USER directory on the internal hard disk.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

OUTPut Subsystem

The OUTPut system contains the commands which set the properties of the USER connectors.

In the case of two-path instruments with a second baseband signal path, the properties can be set separately and independently for the baseband outputs path A and B. The suffix under SOURce distinguishes the outputs:
OUTPut[1] = path A
OUTPut2 = path B

The Command `OUTPut:USER<1...4>:SOURce` affects the setting of the USER connectors and is without suffix in the OUTPut keyword.

Command	Parameters	Default unit	Remark
OUTPut:USER<1 ... 4>:SOURce	AMARk4 | BMARk4 | ABLank | BBLank | AHOP | BHOP | ACW | BCW | BBITclock | BBURst | ATRig | BTRig| BSYMbolclock | BATTenuator		

OUTPut<[1]|2>:USER<1 ... 4>:SOURce AMARk4 | BMARk4 | ABLank | BBLank | AHOP | BHOP | ACW | BCW | BBITclock| BSYMbolclock | BATTenuator | BBURst | ATRig | BTRig

The command selects the signal for the specified USER interface.

The numerical suffix under OUTPut is irrelevant for this command since the USER interfaces are not assigned to any particular path. Some signals which can be applied at the USER interface are permanently assigned (e.g. LEV-ATT control signal of path B), and some are assigned using a dedicated command (e.g. `OUTP:FHOP_CLK:SOURCe` for the FHOP_CLK control signal `OUTPUT:CW:SOURce` for the CW control signal).

Example: `"OUTP:USER2 BSYM"`
'causes the internally generated clock signal of path B to be output at the USER2 BNC connector.

`"OUTP:CLOC:MODE SYMB"`
'specifies that the internally generated clock pulse is a symbol clock pulse.

`"OUTP:CLOC:STAT ON"`
'activates the output of the symbol clock pulse at the USER2 output connector.

*RST value	Resolution	Options	SCPI
USER1 = AMARk4 USER2 = ACW USER3 = ABLank USER4 = ATRig	-	Signals of path B (e.g. BMARker4) are selectable only with second option B9/10/11	Device-specific

SOURce Subsystem

The SOURce subsystem contains the commands for configuring the digital and analog signals. In the case of two-path channels, the suffix 2 identifies the signals of path B under SOURce:
SOURce[1] = path A
SOURce 2 = path B

The keyword SOURce is optional with commands for path A can be omitted. For path B, the command must contain the keyword together with the suffix 2.

SOURce:AWGN Subsystem

The Source:AWGN subsystem contains the commands for setting the noise generator.

In the case of two-path instruments, the numerical suffix under SOURce distinguishes between noise generation in path A and path B.
SOURce[1] = path A
SOURce 2 = path B

The keyword SOURce is optional with commands for path A and can be omitted. For path B, the command must contain the keyword together with the suffix 2.

The keyword SOURce is optional and can be omitted.

Command	Parameters	Default unit	Remark
[SOURce<[1]|2>:]AWGN:BRATe	400 ... 250E6 bps		
[SOURce<[1]|2>:]AWGN:BWIDth	1kHz ... 80 MHz	Hz	
[SOURce<[1]|2>:]AWGN:BWIDth:NOISe?			Query only
[SOURce<[1]|2>:]AWGN:BWIDth:RATio	1 ... 80 000		
[SOURce<[1]|2>:]AWGN:DISP:MODE ANALog | DIGital	ANAL | DIG		
[SOURce<[1]|2>:]AWGN:ENRatio	<numeric_value>	dB	
[SOURce<[1]|2>:]AWGN:FREQuency:RESult			Query only
[SOURce<[1]|2>:]AWGN:FREQuency:TARGet	0 ... 50 MHz	Hz	
[SOURce<[1]|2>:]AWGN:MODE	ADD | ONLY | CW		
[SOURce<[1]|2>:]AWGN:POWer:MODE	SN | EN		
[SOURce<[1]|2>:]AWGN:POWer:NOISe	<numeric_value>	dB	
[SOURce<[1]|2>:]AWGN:POWer:NOISe:TOTal			Query only
[SOURce<[1]|2>:]AWGN:POWer:SIGNal	<numeric_value>	dB	
[SOURce<[1]|2>:]AWGN:POWer:SUM?		dBm	Query only
[SOURce<[1]|2>:]AWGN:POWer:SUM:PEP?		dBm	Query only
[SOURce<[1]|2>:]AWGN:SNRatio	-30dB ... +40dB	dB	
[SOURce<[1]|2>:]AWGN:STATe	ON | OFF		

[SOURce<[1]|2>:]AWGN:BRATe 400 ... 250E6 bps

This command sets the bit rate which is used for calculation of bit energy to noise power ratio from signal/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. Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

This command is available for mode **Additive Noise** (`SOUR:AWGN:MODE ADD`).

Example: "AWGN:BRAT?"
'queries the bit rate which is used for calculation of the E_b/N_0 value from the S/N value.

*RST value	Resolution	Options	SCPI
100 kbps	0.001 bps	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:BWIDth 1 kHz ... 80 MHz

This command sets the system bandwidth. The noise signal at the level which corresponds to the specified carrier/noise ratio is generated in the bandwidth specified here.

This command is available for modes **Additive Noise** and **Noise Only** (`SOUR:AWGN:MODE ADD|ONLY`).

Example: "AWGN:BWID 10 MHz"
'sets a system bandwidth of 10 MHz.

*RST value	Resolution	Options	SCPI
3.84 MHz	0.1 kHz	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:BWIDth:NOISe?

This command queries the real noise bandwidth.

This command is available for modes **Additive Noise** and **Noise Only** (`SOUR:AWGN:MODE ADD|ONLY`). The command is a query command and therefore has no *RST value.

Example: "AWGN:BWID:NOIS?"
'queries the noise bandwidth.

*RST value	Resolution	Options	SCPI
		B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:BWIDth:RATio 1.0 ... 80 000.0

This command sets the ratio of minimum real noise bandwidth to system bandwidth. The overall bandwidth "System BW x Minimum Noise/System BW Ratio" may not exceed 80 MHz. Therefore, the available value range depends on the selected system bandwidth.

This command is available for modes **Additive Noise** and **Noise Only** (`SOUR:AWGN:MODE ADD|ONLY`).

Example: "`AWGN:BWID:RAT 2`"
'sets a minimum noise/system bandwidth ratio of 2.

*RST value	Resolution	Options	SCPI
1	0.1	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:DISP:MODE ANALog | DIGital DISP

This command selects the display of output results for the analog (DACIF) or the digital (BBOUT) signal path.

Note:
This command is only available with the option R&S AMU-B18, Baseband Digital I/Q Out. If the instrument is not equipped with this option the parameters of the analog signal path are displayed.

This command is available for modes **Additive Noise** and **Noise Only**(`SOUR:AWGN:MODE ADD|ONLY`).

Parameters: **ANALog**
'the parameters of the analog signal path are displayed.

DIGital
'the parameters of the digital signal path are displayed.

Example: "`AWGN:MODE ONLY`"
'activates the generation of a pure noise for path A.

"`AWGN:DISP:MODE DIG`"
'displays the output results of the digital signal of path A.

*RST value	Resolution	Options	SCPI
ANAL	-	B13 and K62 Digital Output only with option B18 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:ENRatio -30 dB ... +30 dB

This command sets the ratio of bit energy to noise power density in **Additive Noise** mode.

For **Digital Standard** signals, the bit rate used for calculation of E_b/N_0 value from S/N value can be entered with command `SOUR:AWGN:BRAT`.

For **Custom Digital Mod** signals the bit rate used for calculation of E_b/N_0 value from S/N value is determined by the selected standard (`SOURce:BB:DM:STANdard`) and cannot be changed.

This command is available for mode **Additive Noise** (`SOUR:AWGN:MODE ADD`).

Example: `"AWGN:ENR 10"`
'sets a ratio of bit energy to noise power density of 10 dB.

*RST value	Resolution	Options	SCPI
0 dB	0.001 dB	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:FREQuency:RESulting

This command queries the actual frequency of the sine in the **CW Interferer** mode. The actual frequency may differ from the desired frequency, since the resolution is limited to 0.7 Hz.

The command is a query command and therefore has no *RST value.

Example: `"AWGN:FREQ:RES?"`
'queries the actual frequency of the interfering sine.

*RST value	Resolution	Options	SCPI
		B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:FREQuency:TARGet 0 Hz ... 50 MHz

This command sets the desired frequency of the sine in **CW Interferer** mode (`AWGN:MODE CW`). The resulting frequency may differ from the desired frequency because of the limited frequency resolution of 0.7 Hz.

Example: `"AWGN:FREQ:TARG 2kHz"`
'sets a frequency of 2 kHz for the interfering sine.

*RST value	Resolution	Options	SCPI
0 Hz	0.07 Hz	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:MODE ADD | ONLY | CW

This command selects the mode for generating the interfering signal.

Parameters: **ADD**
The AWGN noise signal is added to the baseband signal.

ONLY
The pure AWGN noise signal is modulated to the signal. The connection to the baseband is interrupted.

CW
The sine interfering signal is added to the baseband signal.

Example: "`AWGN:MODE ONLY`"
'activates the generation of a pure noise for path A.

"`AWGN:STAT ON`"
'switches on the generation of a pure noise for path A.

*RST value	Resolution	Options	SCPI
ADD	-	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:MODE SN | EN

This command selects the mode for setting the noise level.

This command is available for mode **Additive Noise** (`SOUR:AWGN:MODE ADD`).

Parameters: **SN**
The noise level is set on the basis of the value entered for the signal / noise ratio (`SOUR:AWGN:SNR`).

EN
The noise level is set on the basis of the value entered for the ratio of bit energy to noise power density (`SOUR:AWGN:ENR`).

Example: "`SOUR:AWGN:POW:MODE SN`"
'the noise level is set on the basis of the value entered for the signal/noise ratio (`SOUR:AWGN:SNR`).

*RST value	Resolution	Options	SCPI
SN		B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:NOISe -40 dB ... 30 dB

This command either sets or queries the noise level in the system bandwidth.

Additive Noise mode (`SOUR:AWGN:MODE ADD`):
The command queries the noise level which is derived from the entered S/N value.

Noise Only mode (`SOUR:AWGN:MODE ONLY`):
The command sets the noise level.

CW Interferer mode (`SOUR:AWGN:MODE CW`):
The command queries the interferer level which is derived from the entered S/N value.

This command is available for modes **Additive Noise, Noise Only** and **CW Interferer** (`SOUR:AWGN:MODE ADD|ONLY|CW`).

Example: "`SOUR:AWGN:POW:NOIS?`"
'queries the noise level in the system bandwidth.

Response: '`10`'
'the noise level in the system bandwidth is 10 dBm.

*RST value	Resolution	Options	SCPI
	0.01 dBm	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:NOISe:TOTal?

This command queries the noise level in the total bandwidth.

Note:
***Display Output Results For** the analog or digital signal path has to be set before.*

This command is available for modes **Additive Noise** and **Noise Only** (`SOUR:AWGN:MODE ADD|ONLY`).

The command is a query command and therefore has no *RST value.

Example: "`SOUR:AWGN:DISP:MODE DIG`"
'displays the parameters of the digital signal path.

"`SOUR:AWGN:POW:NOIS:TOT?`"
'queries the noise level in the total bandwidth.

Response: "15"
'the noise level in the total bandwidth is 15 dBm.

*RST value	Resolution	Options	SCPI
-	-	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:SIGNal -40 dB ... 30 dB

This command either sets or queries the signal level.The level of the noise signal is derived from the entered S/N value.

This command is available for modes **Additive Noise** and **CW Interferer** (`SOUR:AWGN:MODE ADD|CW`).

The command is a query command and therefore has no *RST value.

Example: "`SOUR:AWGN:POW:SIGN?`"
'queries the signal level.

Response: '`10`'
'the signal level is 10 dBm.

*RST value	Resolution	Options	SCPI
	0.01 dBm	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:SUM?

This command queries the overall level of the noise / interferer signal plus useful signal.

Note:
*In the modes Additive Noise the **Display Output Results For** (analog or digital) has to be set before.*

This command is available for modes **Additive Noise** and **CW Interferer** (`SOUR:AWGN:MODE ADD|CW`). The command is a query command and therefore has no *RST value.

Example: "`SOUR:AWGN:DISP:MODE ANAL`"
'displays the parameters of the analog signal path.

"`SOUR:AWGN:POW:SUM?`"
'queries the overall level of the noise signal plus useful signal.

*RST value	Resolution	Options	SCPI
		B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:POWer:SUM:PEP?

This command queries the peak envelope power of the overall signal comprised of the noise / interferer signal plus useful signal.

Note: *In the mode Additive Noise the **Display Output Results For** (analog or digital) has to be set before.*

This command is available for modes **Additive Noise** and **CW Interferer** (`SOUR:AWGN:MODE ADD|CW`). The command is a query command and therefore has no *RST value.

Example: `"SOUR:AWGN:DISP:MODE DIG"`
'displays the parameters of the digital signal path.

`"SOUR:AWGN:POW:NOIS:TOT?"`
'queries the noise level in the total bandwidth.

`"SOUR:AWGN:POW:SUM:PEP?"`
'queries the peak envelope power of the overall signal.

*RST value	Resolution	Options	SCPI
		B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:SNRatio -40 dB ... +30 dB

This command sets the signal / noise ratio or the signal / interferer ratio respectively.

This command is available for modes **Additive Noise** and **CW Interferer** (`SOUR:AWGN:MODE ADD|CW`).

Example: `"SOUR:AWGN:MODE ADD"`
'selects the mode **Additive Noise** for generating an AWGN signal in path A.

`"AWGN:SNR 10"`
'sets a signal/noise ratio of 10 dB.

*RST value	Resolution	Options	SCPI
0 dB	0.001 dB	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

[SOURce<[1]|2>:]AWGN:STATe ON | OFF

This command activates or deactivates the white noise (AWGN = Averaged White Gaussian Noise). The noise signal is either superimposed on the baseband signal (**Additive Noise** mode (`SOUR:AWGN:MODE ADD`)) or is output as a pure noise signal (**Noise Only** mode (`SOUR:AWGN:MODE ONLY`)). In addition, a sine with adjustable frequency offset to the baseband signal can be generated as an RFI signal (**CW Interferer** mode; `SOUR:AWGN:MODE CW`).

Example: `"AWGN:STAT ON"`
'activates the signal generator of path A "`AWGN:STAT ON`".

*RST value	Resolution	Options	SCPI
OFF	-	B13 and K62 SOURce2 only with a second option B13 and at least one of the options B9/10/11 or B17	Device-specific

SOURce:BB:DM Subsystem

Introduction - DM General Remote-Control Commands

The commands in the Source:BB:DM subsystem are described in two sections, separated into configuring digital modulation and lists for digital modulation.

The following section contains the commands for generating the digital modulation signal.

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
SOURce2 = path B

The keyword SOURce is optional in the case of commands for path A and can be omitted. For path B the command must contain the keyword with suffix 2.

DM General Remote-Control Commands

Command	Parameter	Default unit	Note
[SOURce<[1]|2>:]BB:DM:ASK:DEPTh	0 ... 100	PCT	
[SOURce<[1]|2>:]BB:DM:CLOCk			Query only
[SOURce<[1]|2>:]BB:DM:CLOCk:MODE	SYMBol | BIT | MSYMbol		
[SOURce<[1]|2>:]BB:DM:CLOCk:MULTiplier	1 ... 64		
[SOURce<[1]|2>:]BB:DM:CLOCk:SOURce	COUPled | INTernal | EXTernal		
[SOURce<[1]|2>:]BB:DM:CODing	OFF| APCO25 | APCO25FSK | CDMA2000 | DIFF| DPHS| DGRay | EDGE | GRAY| GSM| ICO| NADC| PDC| PHS| TETRa | PWT| TFTS| INMarsat | VDL | WCDMa		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:APCO25	0.15 ... 2.5		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:COSine	0.05 ... 0.99		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:GAUSs	0.15 ... 2.5		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:PGAus	0.15 ... 2.5		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:RCOSine	0.05 ... 0.99		
[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:SPHase	0.15 ... 2.5		
[SOURce<[1]|2>:]BB:DM:FILTer:TYPE	RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | PGAuss		
[SOURce<[1]|2>:]BB:DM:FLISt:SELect	<file name>		
[SOURce<[1]|2>:]BB:DM:FORMat	ASK | BPSK | P2DBpsk |		

Command	Parameter	Default unit	Note
	QPSK | QPSK45 | OQPSk | P4QPsk | P4DQpsk | PSK8 | P8D8psk | P8EDge | QAM16 | QAM32 | QAM64 | QAM256 | QAM1024 | MSK | FSK2 | FSK4 | FSKVar		
[SOURce<[1]|2>:]BB:DM:FSK:DEViation	0.1 x Symbol Rate ... 1.5 x Symbol Rate	Hz	
[SOURce<[1]|2>:]BB:DM:FSK:VARiable:TYPE	4FSK | 8FSK | 16 FSK		
[SOURce<[1]|2>:]BB:DM:FSK:VARiable:SYMBol<0...15>:DEViation	-1.5 x Symbol Rate ... 1.5 x Symbol Rate (max 10 MHz)	Hz	
[SOURce<[1]|2>:]BB:DM:MDELay?			Query only
[SOURce<[1]|2>:]BB:DM:PATTern	#B0 ... #B111...1, 1...64		
[SOURce<[1]|2>:]BB:DM:PRAMp:ATTenuation	0.0 ... 50	dB	
[SOURce<[1]|2>:]BB:DM:PRAMp:BBONly[:STATe]	ON | OFF		
[SOURce<[1]|2>:]BB:DM:PRAMp:FDELay	-4.0 ... +4.0 symbols		
[SOURce<[1]|2>:]BB:DM:PRAMp:RDELay	-4.0 ... +4.0 symbols		
[SOURce<[1]|2>:]BB:DM:PRAMp:SHAPe	LINear | COSine		
[SOURce<[1]|2>:]BB:DM:PRAMp:SOURce	INTernal | EXTernal		
[SOURce<[1]|2>:]BB:DM:PRAMp[:STATe]	ON | OFF		
[SOURce<[1]|2>:]BB:DM:PRAMp:TIME	0.25 ... 32 symbols		
[SOURce<[1]|2>:]BB:DM:PRBS[:LENGth]	9 | 11 | 15 | 16 | 20 | 21 | 23		
[SOURce<[1]|2>:]BB:DM:PRESet			
[SOURce<[1]|2>:]BB:DM:SEQuence	AUTO | RETRigger | AAUTo | ARETrigger | SINGle		
[SOURce<[1]|2>:]BB:DM:SOURce	ZERO | ONE | PRBS | PATTern | DLISt | SERial | PARallel | LAN | USB		
[SOURce<[1]|2>:]BB:DM:SRATe	400 Hz ... 15 MHz (FSK) / 27 MHz	Hz	
[SOURce<[1]|2>:]BB:DM:STANdard	USER | BLUetooth | CFORward | CREVerse | DECT | ETC | GSM | GSMEdge | NADC | PDC | PHS | TDSCdma | TETRa | TFTS | W3GPp | WORLdspace		
[SOURce<[1]|2>:]BB:DM:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:DM:SWITching:SOURce	INTernal | EXTernal		
[SOURce<[1]|2>:]BB:DM:SWITching:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:DM:TRIGger:ARM:EXECute	-		No query
[SOURce<[1]|2>:]BB:DM:TRIGger:EXECute	-		No query
[SOURce<[1]|2>:]BB:DM:TRIGger[:EXTernal<[1]|2>]:DELay	0 ... 2^16 - 1 Symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger[:EXTernal<[1]|2>]:INHibit	0 ... 2^26 -1 Symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:OBASeband:DELay	0 ... 2^16 - 1 Symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:OBASeband:INHibit	0 ... 2^26 -1 Symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay	0 ... 2^20 -1 Symbols		

Command	Parameter	Default unit	Note
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut:DELay:FIXed	ON | OFF	Hz	
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay:MAX?			Query only
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay:MIN?			Query only
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:MODE	CLISt | PULSe | PATTern | RATio		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:OFFTime	1 ... (2^20 - 1) symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:ONTime	1 ... (2^20 - 1) symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PATTern	#B0, 1 ... #B111...1,32		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PULSe:DIVider	2 ... 2^10		
[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PULSe:FREQ?			Query only
[SOURce<[1]|2>:]BB:DM:TRIGger:RMODe			Query only
[SOURce<[1]|2>:]BB:DM:TRIGger:SLENgth	1 ...2^32-1 symbols		
[SOURce<[1]|2>:]BB:DM:TRIGger:SOURce	INTernal | EXTernal | BEXTernal | OBASeband		

[SOURce<[1]|2>:]BB:DM:ASK:DEPTh 0 ... 100 PCT

The command sets the ASK modulation depth when modulation type ASK is selected.

Example: `"BB:DM:FORM ASK"`
'selects the ASK modulation type.

`"BB:DM:ASK:DEPT 50 PCT"`
'sets a modulation depth of 50 percent.

*RST value	Resolution	Options	SCPI
100 PCT	0.1 PCT	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLOCk:MODE SYMBol | BIT | MSYMbol

The command enters the type of externally supplied clock (`:BB:DM:CLOCk:SOURce EXTernal`). The bit clock and the symbol clock differ only in the case of modulations that have more than two states, i.e. that require more than one bit for encoding each state. When `MSYMbol` is used, a multiple of the symbol clock is supplied via the CLOCK connector and the symbol clock is derived internally from this. The multiplier is entered with the command `:BB:DM:CLOCk:MULTiplier`.

With this command the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Example: `"BB:DM:CLOC:MODE SYMB"`
'selects clock type **Symbols**, i.e. the supplied clock is a symbol clock.

*RST value	Resolution	Options	Dependencies	SCPI
SYMBol	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	It is not possible to select `BIT` and `MSYMbol` in the case of an external serial or external parallel data source (not available) (`SOUR:BB:DM:SOUR SER` and `PAR`).	Device-specific

[SOURce<[1]|2>:]BB:DM:CLOCk:MULTiplier 1 ... 64

The command specifies the multiplier for clock type **Multiple Symbols** (`:BB:DM:CLOCk:MODE MSYM`) in the case of an external clock source.

With this command the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Example: `"BB:DM:CLOC:SOUR EXT"`
'selects the external clock source. The clock is supplied via the CLOCK connector.

`"BB:DM:CLOC:MODE MSYM"`
'selects clock type **Multiple Symbols**, i.e. the supplied clock has a rate which is a multiple of the symbol rate.

`"BB:DM:CLOC:MULT 12"`
'the multiplier for the external clock rate is 12.

*RST value	Resolution	Options	SCPI
4	1	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLOCk:SOURce COUPled | INTernal | EXTernal

The command selects the source for the digital modulation clock.

Selecting COUPLed and EXTernal is only possible for path A, since the external clock source is permanently allocated to path A.

Parameter: **IINTernal**

The internal clock reference is used.

EXTernal

The external clock reference is supplied to the CLOCK connector.

COUPled

The clock reference (internal or external) is selected automatically according to the selected data source.

Example: `"BB:DM:CLOC:SOUR INT"`

'selects the internal clock reference.

*RST value	Resolution	Options	Dependencies	SCPI
INTernal	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	When `COUPled` is selected and the data source is changed (`:BB:DM:DATA:SOUR`) the clock source is automatically changed correspondingly as well	Device-specific

[SOURce<[1]|2>:]BB:DM:CODing OFF| APCO25 | APCO25FSK | CDMA2000 | DIFF| DPHS| DGRay | EDGE | GRAY| GSM| ICO| NADC| PDC| PHS| TETRa | PWT| TFTS| INMarsat | VDL | WCDMa

The command selects the modulation coding.

Parameter: **DPHS**

Phase Difference

DGRay

Difference + Gray

...

Example: `"BB:DM:COD GRAY"`

'selects GRAY coding. This coding is valid for all modulation typesexcept the user-defined modulation type USER.

*RST value	Resolution	Options	Dependencies	SCPI
INTernal	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	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.	Instrum-ent-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:APCO25 0.05 ... 0.99

The command sets the roll-off factor for filter type APCO25.

Example: `"BB:DM:FILT:PAR:APCO25 0.2"`
'sets the roll-off factor to 0.2 for filter type APCO25.

*RST value	Resolution	Options	Dependencies	SCPI
0.20	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting filter APCO25, the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:COSine 0.05 ... 0.99

The command sets the roll-off factor for the Cosine filter type.

Example: `"BB:DM:FILT:PAR:COS 0.35"`
'sets the roll-off factor to 0.35 for filter type Cosine.

*RST value	Resolution	Options	Dependencies	SCPI
0.35	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting the Cosine filter , the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:GAUSs 0.15 ... 2.5

The command sets the roll-off factor for the Gauss filter type.

Example: `"BB:DM:FILT:PAR:GAUS 0.5"`
'sets B x T to 0.5 for the Gauss filter type.

*RST value	Resolution	Options	Dependencies	SCPI
0.3	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting the GAUSS filter or a standard (`:BB:DM:STAN`) which uses the GAUSS filter, the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:PGAuss 0.15 ... 2.5

The command sets the roll-off factor for the Pure Gauss filter type.

Example: `"BB:DM:FILT:PAR:PGA 0.5"`
'sets B x T to 0.5 for the Pure Gauss filter type.

*RST value	Resolution	Options	Dependencies	SCPI
0.5	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting the Pure GAUSS filter the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:RCOSine 0.05 ... 0.99

The command sets the roll-off factor for the Root Cosine filter type.

Example: `"BB:DM:FILT:PAR:RCOS 0.22"`
'sets the roll-off factor to 0. 22 for filter type Root Cosine.

*RST value	Resolution	Options	Dependencies	SCPI
0.35	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting the Root Cosine filter or a standard (`:BB:DM:STAN`) which uses the Root Cosine filter, the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:PARameter:SPHase 0.15 ... 2.5

The command sets B x T for the Split Phase filter type.

Example: `"BB:DM:FILT:PAR:SPH 0.5"`
'sets B x T to 0.5 for the Split Phase filter type.

*RST value	Resolution	Options	Dependencies	SCPI
0.35	0.01	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	On selecting the Split Phase filter or a standard (`:BB:DM:STAN`) which uses the Split Phase filter, the filter parameter is set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FILTer:TYPE RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | PGAuss | USER

The command selects the filter type.

Example: `"BB:DM:FILT:TYPE COS"`
'selects the Cosine filter type.

*RST value	Resolution	Options	Dependencies	SCPI
GAUSs	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	When a standard is selected (`:BB:DM:STAN`), the filter type and filter parameter are set to the default value.	Device-specific

[SOURce<[1]|2>:]BB:DM:FLISt:SELect <file name>

The command selects the user-defined filter (*.vaf).

The directory applicable to the following command is defined with the command `MMEMory:CDIR`. To access the files in this directory, only the file name is required, without the path and the file extension.

Example: "`MMEM:CDIR` 'D:\Filter_List'"
'selects the directory for the user-defined filters.

"`BB:DM:FLIS:SEL user_filter3`"
'selects the user-defined filter.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:FORMat ASK | BPSK | QPSK | QPSK45 | OQPSk | P4QPsk | P2DBpsk | P4DQpsk | P8D8psk | PSK8 | P8EDge | QAM16 | QAM32 | QAM64 | QAM256 | QAM1024 | MSK | FSK2 | FSK4 | FSKVar

The command selects the modulation type.

Example: "`BB:DM:FORM QPSK`"
'selects modulation type QPSK.

*RST value	Resolution	Options	Dependencies	SCPI
MSK	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	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.	Device-specific

[SOURce<[1]|2>:]BB:DM:FSK:DEViation <numeric_value>

The command 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.

Example: "`BB:DM:FORM FSK`"
'selects FSK modulation.

"`BB:DM:FSK:DEV 10 MHz`"
'sets the frequency deviation to 10 MHz.

*RST value	Resolution	Options	Dependencies	SCPI
Symbol rate/2	0.5 Hz	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	If the symbol rate that is set exceeds the maximum possible value for the chosen frequency deviation, it is suitably adapted (`:BB:DM:SRAT`).	Device-specific

[SOURce<[1]|2>:]BB:DM:FSK:VARiable:SYMBol<0...15>:DEViation <numeric_value>

The command sets the deviation of the selected symbol for variable FSK modulation mode. The number of symbols (and therefore the suffix range) depends on the selected FSK modulation type. The range of values depends on the symbol rate that is set (see data sheet) and the maximum deviation is 10 MHz.

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.

*RST value	Resolution	Options	SCPI
-	0.5 Hz	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:FSK:VARiable:TYPE FSK4 | FSK8 | FSK16

The command selects the modulation type for Variable FSK.

Example: `"BB:DM:FORM FSKV"`
'selects Variable FSK modulation.

`"BB:DM:FSK:VAR:TYPE FSK16"`
'selects 16FSK modulation.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:MDELay?

The command queries the digital modulation delay from the data input to the I/Q output in the case of external modulation.

This command is a query and therefore has no *RST value.

Example: `"BB:DM:MDEL?"`
'queries the delay in the case of external modulation.

Response: '`0.4 ms`'
'the delay is 0.4 ms.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PATTern #B0 ... #B111...1, 1...64

The command selects the data pattern for the internal data when PATTern is selected as the data source. The maximum length is 64 bits.

Example: `"BB:DM:SOUR PATT"`
'selects Pattern as the data source for digital modulation.

`"BB:DM:PATT #B01110111010101010,17"`
'generates the user-defined sequence of 0/1 data.

*RST value	Resolution	Options	SCPI
#B0,1	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:ATTenuation 0.0 ... 70 dB

The command sets the level attenuation for signal ranges that are flagged with level attribute **attenuated** by the LEV_ATT control signal.

Example: `"BB:DM:PRAM:ATT 15 dB"`
'sets a level attenuation of 15 dB.

*RST value	Resolution	Options	SCPI
15 dB	0.01 dB	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:BBONly[:STATe] ON | OFF

This command selects power ramping in the baseband only or mixed power ramping in the baseband and the RF section. The **ON** setting is mandatory if, with power ramping active, only the baseband signal is output (I/Q outputs), or if a baseband signal is applied to two RF paths (RF A and RF B).

Only then can a signal with a defined, predictable level be output.

Example: `"BB:DM:PRAM:BBON ON"`
'selects power ramping in the baseband only.

*RST value	Resolution	Options	SCPI
OFF		B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:FDELay - 4.0 ... + 4.0 Symbols

The command sets the delay in the falling edge. A positive value gives rise to a delay and a negative value causes an advance. The setting is expressed in symbols.

Example: `"BB:DM:PRAM:FDEL 1"`
'the falling edge starts 1 symbol later.

*RST value	Resolution	Options	SCPI
0 symbols	0.1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:RDELay - 4.0 ... + 4.0 Symbols

The command sets the delay in the rising edge. A positive value gives rise to a delay and a negative value causes an advance. The setting is expressed in symbols.

Example: `"BB:DM:PRAM:RDEL 1"`
'the rising edge starts 1 symbol later.

*RST value	Resolution	Options	SCPI
0 symbols	0.1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:SHAPe LINear | COSine

The command sets the edge shape of the ramp envelope.

Example: `"BB:DM:PRAM:SHAP COS"`
'selects a cosine-shaped rise and fall for the transmitted power edge.

*RST value	Resolution	Options	SCPI
COSine	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:SOURce INTernal | EXTernal

The command sets the source for the power ramp control signals.

Parameter: **INTernal**
'the internal control signals LEV_ATT and BURST are used. Control signals are stored in dedicated lists. When remote control is in use, the list to be used is defined, selected and enabled with the aid of `SOURce:BB:DM:CLISt:...` commands.

EXTernal
'the digital control signals LEV_ATT and BURST are supplied via the control signal inputs on the AUX I/O connector.

Example: `"BB:DM:PRAM:SOUR EXT"`
'enables the use of external control signals for power ramp control. The signals must be supplied via the AUX I/O interface.

*RST value	Resolution	Options	SCPI
INTernal	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp[:STATe] ON | OFF

The command enables or disables power ramping.

Example: `"BB:DM:PRAM:STAT ON"`
'switches power ramping on.

*RST value	Resolution	Options	SCPI
OFF		B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRAMp:TIME 0.25 ... 16 Symbols

The command sets the power ramping rise time and fall time for a burst.

Example: `"BB:DM:PRAM:TIME 2"`
'sets a time of 2 symbols for the edges to rise and fall.

*RST value	Resolution	Options	SCPI
1 symbol	0.1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRBS[:LENGth] 9 | 11 | 15 | 16 | 20 | 21 | 23

The command defines the length of the pseudo-random sequence in accordance with the following equation:

Length = (2^LENGth) - 1

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.

*RST value	Resolution	Options	SCPI
9	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:PRESet

The command calls the default settings for digital modulation.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:PRES"`
'calls the default settings for DM.

*RST value	Options	Dependencies	SCPI
-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	:BB:DM:CLOC:DEL 0 :BB:DM:CLOC:MODE SYMB :BB:DM:CLOC:SOUR INT :BB:DM:CLOC:COD GSM :BB:DM:FILT:PAR:APC 0.2 :BB:DM:FILT:PAR:COS 0.35 :BB:DM:FILT:PAR:GAUS 0.5 :BB:DM:FILT:PAR:RCOS 0.22 :BB:DM:FILT:PAR:SPH 0.1 :BB:DM:FILT:TYPE RCOS :BB:DM:FORM MSK :BB:DM:FSK:DEV 135.417kHz :BB:DM:PATT #H0,1 :BB:DM:PRAM:ATT 15 dB :BB:DM:PRAM:ROFF 0 :BB:DM:PRAM:FOFF 0 :BB:DM:PRAM:SHAP COS :BB:DM:PRAM:SOUR INT :BB:DM:PRAM OFF :BB:DM:PRAM:TIME 1 Symb :BB:DM:PRBS 9 :BB:DM:SEQ AUTO :BB:DM:SOUR PRBS :BB:DM:SRAT 270.833 kHz :BB:DM:STAN GSM :BB:DM:TRIG:DEL 0 :BB:DM:TRIG:INH 0 :BB:DM:TRIG:OUTP:DEL 0 :BB:DM:TRIG:OUTP:MODE FRAM :BB:DM:TRIG:OUTP:PER 1 :BB:DM:TRIG:SOUR INT	Device-specific

[SOURce<[1]|2>:]BB:DM:SEQuence AUTO | RETRigger | AAUTo | ARETrigger | SINGle

The command selects the trigger mode.

Parameter:

AUTO

The modulation signal is generated continuously.

RETRigger

The modulation signal is generated continuously. A trigger event (internal or external) causes a restart.

AAUTo

The modulation signal is generated only when a trigger event occurs. After the trigger event the signal is generated continuously. Signal generation is stopped with command `SOUR:BB:DM:TRIG:ARM:EXEC` and started again when a trigger event occurs.

ARETrigger

The modulation signal is generated only when a trigger event occurs. The device automatically toggles to RETRIG mode. Every subsequent trigger event causes a restart. Signal generation is stopped with command `SOUR:BB:DM:TRIG:ARM:EXEC` and started again when a trigger event occurs.

SINGle

The modulation signal is generated only when a trigger event occurs. After the trigger event the signal is generated once to the set sequence length (`SOUR:BB:DM:TRIG:SLEN`). Every subsequent trigger event causes a restart.

Example: `"BB:DM:SEQ AAUT"`

'sets the **Armed_auto** trigger mode; the device waits for the first trigger (e.g. with `*TRG`) and then generates the signal continuously.

*RST value	Resolution	Options	SCPI
AUTO	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SOURce ZERO | ONE | PRBS | PATTern | DLISt | SERial | PARallel

The command selects the data source.

Parameter:

ZERO
An internally generated 0 data sequence is used.

ONE
An internally generated 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 aid of command `SOURce:BB:DM:PRBS`.

PATTern
Internally generated data with a fixed pattern is used. The data pattern is defined using command `SOURce:BB:DM:PATTern`.

DLISt
Data from the selected data list is used.

SERial
External data from the serial interface is used (path A).

PARallel
External data from the parallel interface is used (path A).

Example: `"BB:DM:SOUR DLIS"`
'the internal data generator is used.

`"BB:DM:DLIS:SEL 'test'"`
'the data list 'test.dm_iqd' is used.

*RST value	Resolution	Options	SCPI
PRBS	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SRATe 400 Hz ... 15 MHz (FSK) / 25 MHz

The command 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.

Example: `"BB:DM:SRAT 10 MHz"`
'sets a symbol rate of 10 MHz.

*RST value	Resolution	Options	Dependencies	SCPI
270.833 kHz	0.001 Hz	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	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.	Device-specific

[SOURce<[1]|2>:]BB:DM:STANdard USER | BLUetooth | CFORward | CREVerse | DECT | ETC | GSM | GSMEdge | NADC | PDC | PHS | TDSCdma | TETRa | TFTS | W3GPp | WORLdspace

The command selects the standard. After selection, modulation parameters **Modulation Type**, **Symbol Rate**, **Filter** and **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:...`

Example: `"BB:DM:STAN DECT"`
'selects digital modulation according to the DECT standard.

*RST value	Resolution	Options	Dependency	SCPI

GSM	-	B9/B10/B11 and B13
		SOURce2 only with second option B9/B10/B11
			Each selection sets the parameters
			`:BB:DM:FORMat`
			`:BB:DM:SRATe`
			`:BB:DM:FILTer:TYPE`
			`:BB:DM:FILTer:PARameter:...`
			`:BB:DM:CODing` and if necessary
			`:BB:DM:FSK:DEV`
			to the appropriate default values.
				Device-specific

[SOURce<[1]|2>:]BB:DM:STATe ON | OFF

The command enables or disables digital modulation. Switching on digital modulation turns off all the other digital standards on the same path (SOURce1 or SOURce2).

Example: `"BB:DM:STAT ON"`
'switches digital modulation on.

*RST value	Resolution	Options	Dependency	SCPI
OFF	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	`:BB:DM:STAT ON` turns off all the other standards on the same path".	Device-specific

[SOURce<[1]|2>:]BB:DM:SWITching:SOURce INTernal | EXTernal

The command selects the source of the CW control signal for switching between a modulated and an unmodulated RF signal.

Parameter:

INTernal
The CW signal in the control list is used for the control. The internal signal can be output on one of the user interfaces.

EXTernal
The control signal on the CW pin of the AUX I/Q connector is used (path A and B).

Example: `"BB:DM:SWIT INT"`
'the CW signal in the control list is used for the control.

*RST value	Resolution	Options	SCPI
INTernal	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SWITching:STATe ON | OFF

The command enables switching between a modulated and an unmodulated RF signal.

Example: `"BB:DM:SWIT:STAT INT"`
'CW switching is active.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:ARM:EXECute

The command stops signal generation for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart signal generation.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:TRIG:SOUR INT"`
'sets internal triggering.

`"BB:DM:TRIG:SEQ ARET"`
'sets Armed_Retrigger mode, i.e. every trigger event causes signal generation to restart.

`"BB:DM:TRIG:EXEC"`
'executes a trigger, signal generation is started.

`"BB:DM:TRIG:ARM:EXEC"`
'signal generation is stopped.

`"BB:DM:TRIG:EXEC"`
'executes a trigger, signal generation is started again.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:EXECute

The command executes a trigger. The internal trigger source must be selected using the command `:BB:DM:TRIG:SOUR INT` and a trigger mode other than `AUTO` must be selected using the command `:BB:DM:TRIG:SEQ`.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:TRIG:SOUR INT"`
'sets internal triggering.

`"BB:DM:TRIG:SEQ RETR"`
'sets Retrigger mode, i.e. every trigger event causes signal generation to restart.

`"BB:DM:TRIG:EXEC"`
'executes a trigger.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger[:EXTernal<[1]|2>]:DELay 0 ... 2^16-1 Symbols

The command specifies the trigger delay (expressed as a number of symbols) for external triggering. The numeric suffix to EXTernal distinguishes between the external trigger via the TRIGGER 1 (suffix 1) and TRIGGER 2 (suffix 2) connector.

Example: `"BB:DM:TRIG:SOUR EXT"`
'selects an external trigger via the TRIGGER 1 connector.

`"BB:DM:TRIG:DEL 50"`
'sets a delay of 50 symbols for the trigger.

*RST value	Resolution	Options	SCPI
0 symbols	1 symbol for `:BB:DM:CLOC:SOUR EXT` 0.01 symbols for `:BB:DM:CLOC:SOUR INT`	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger[:EXTernal<[1]|2>]:INHibit 0 ... 2^26-1 Symbols

The command specifies the number of symbols by which a restart is to be inhibited following a trigger event. This command applies only in the case of external triggering. The numeric suffix to EXTernal distinguishes between the external trigger via the TRIGGER 1 (suffix 1) and TRIGGER 2 (suffix 2) connector.

Example: `"BB:DM:TRIG:SOUR EXT"`
'selects an external trigger via the TRIGGER 1 connector.

`"BB:DM:TRIG:INH 200"`
'sets a restart inhibit for 200 symbols following a trigger event.

*RST value	Resolution	Options	SCPI
0 symbols	1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OBASeband:DELay 0 ... 2^16-1 Symbols

The command specifies the trigger delay (expressed as a number of symbols) for triggering by the trigger signal from the second path (two-path instruments only).

Example: `"BB:DM:TRIG:SOUR OBAS"`
'sets for path A the internal trigger executed by the trigger signal from the second path (path B).

`"BB:DM:TRIG:OBAS:DEL 50"`
sets a delay of 50 symbols for the trigger.

*RST value	Resolution	Options	SCPI
0 symbols	1 symbol for `:BB:DM:CLOC:SOUR EXT` 0.01 symbols for `:BB:DM:CLOC:SOUR INT`	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OBASeband:INHibit 0 ... 2^26-1 Symbols

The command specifies the number of symbols by which a restart is to be inhibited following a trigger event. This command applies only for triggering by the second path (two-path instruments only).

Example: `"BB:DM:TRIG:SOUR OBAS"`
'sets for path A the internal trigger executed by the trigger signal from the second path (path B).

`"BB:DM:TRIG:INH 200"`
'sets a restart inhibit for 200 symbols following a trigger event.

*RST value	Resolution	Options	SCPI
0 symbols	1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay 0 ... 100 000 Symbols

The command defines the delay between the signal on the marker outputs and the start of the signal, expressed in terms of symbols. Command `:BB:DM:TRIGger:OUTPut:DELay:FIXed` can be used to restrict the range of values to the dynamic range, i.e. the range within which a delay of the marker signals can be set without restarting the marker and signal.

Example: `"BB:DM:TRIG:OUTP2:DEL 16"`
'sets a delay of 16 symbols for the signal on connector MARKER 2.

*RST value	Resolution	Options	SCPI
0 symbols	1 symbol	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut:DELay:FIXed ON | OFF

The command restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal. If a delay is entered in setting ON but is outside this range, the maximum possible delay is set and an error message is generated.

The numeric suffix in `OUTPut` has no significance for this command, since the setting always affects every marker.

Example: `"BB:DM:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay:MAXimum

The command queries the maximum marker delay for setting `:BB:DM:TRIG:OUTP:DEL:FIX ON`.

The command is a query only and therefore has no *RST value.

Example: `"BB:DM:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

`"BB:DM:TRIG:OUTP:DEL:MAX"`
'queries the maximum of the dynamic range.

Response: `"2000"`
'the maximum for the marker delay setting is 2000 symbols.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:DELay:MINimum

The command queries the minimum marker delay for setting `:BB:DM:TRIGger:OUTPut:DELay:FIXed ON`.

The command is a query only and therefore has no *RST value.

Example: `"BB:DM:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

`"BB:DM:TRIG:OUTP:DEL:MIN"`
'queries the minimum of the dynamic range.

Response: `"0"`
'the minimum for the marker delay setting is 0 symbols.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:MODE CLISt | PULSe | PATTern | RATio

The command defines the signal for the selected marker output.

Parameter:

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.

Example: `"BB:DM:TRIG:OUTP2:MODE PULS"`

'selects the pulsed marker signal on output MARKER 2.

*RST value	Resolution	Options	SCPI
RATio	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:OFFTime 1 ... 2^20 -1 symbol

The command 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.

Example: `"BB:DM:TRIG:OUTP2:OFFT 20"`

'sets an OFF time of 20 symbols for marker signal 2 on path A.

*RST value	Resolution	Options	SCPI
1	1	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:ONTime 1 ... 2^20 -1 symbol

The command 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.

Example: `"BB:DM:TRIG:OUTP2:ONT 20"`
'sets an ON time of 20 symbols for marker 2 on path A.

*RST value	Resolution	Options	SCPI
1	1	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PATTern #B0,1 ... #B111...1, 2

The command defines the bit pattern used to generate the marker signal in the setting `SOURce:BB:DM:TRIGger:OUTPut:MODE PATTern`. 0 is marker off, 1 is marker on.

Example: `"BB:DM:TRIG:OUTP2:PATT #B000000011111111,15"`
'sets a bit pattern.

`"BB:DM:TRIG:OUTP2:MODE PATT"`
'activates the marker signal according to a bit pattern on output MARKER 2.

*RST value	Resolution	Options	SCPI
#B,1	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PULSe:DIVider 2 ... 2^10

The command 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.

Example: `"BB:DM:TRIG:OUTP2:PULS:DIV 2"`
'sets the divider to 2 for the path A 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.

*RST value	Resolution	Options	SCPI
2	1	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:OUTPut<[1]...4>:PULSe:FREQuency?

The command 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.

The command is a query command and therefore has no *RST value.

Example: `"BB:DM:TRIG:OUTP2:PULS:DIV 2"`
'sets the divider for the path A 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 33 kHz.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:RMODe

The command displays the status of signal generation for all trigger modes with digital modulation on.

The command is a query command and therefore has no *RST value.

Parameter:

RUN
the signal is generated. A trigger event occurred in the triggered mode.

STOP
the signal is not generated. A trigger event did not occur in the triggered modes, or signal generation was stopped by the command `:BB:DM:TRIG:ARM:EXECute` (armed trigger modes only).

Example: `"SOUR2:BB:DM:TRIG:SOUR EXT"`
'sets external triggering via the TRIGGER 1 connector for path B of a two-path instrument.

`"SOUR2:BB:DM:TRIG:MODE ARET"`
'selects the Armed_Retrigger mode

`"SOUR2:BB:DM:TRIG:RMOD?"`
'queries the current status of signal generation.

Response: `"RUN"`
'the signal is generated, an external trigger was executed.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:SLENgth 1 … (2^32-1) Symbols

The command defines the length of the signal sequence to be output in the **Single** trigger mode.

Example: `"SOUR2:BB:DM:SEQ SING"`
'sets trigger mode Single.

`"SOUR2:BB:DM:TRIG:SLEN 200"`
'sets a sequence length of 200 symbols. 200 symbols will be output after the next trigger event.

*RST value	Resolution	Options	SCPI
1000 Symbols	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:TRIGger:SOURce INTernal | EXTernal | BEXTernal | OBASeband

The command selects the trigger source.

Parameter:

INTernal
Triggering is executed by means of the Trigger command `SOURce<[1]|2>:BB:DM:TRIGger:EXECute`, `TRIGger:BB:DM:IMMediate` or `*TRG` in the case of remote control and by means of **Execute Trigger** in the case of manual operation.

EXTernal
Triggering is executed by means of the signal on the TRIGGER 1 connector.

BEXTernal
Triggering is executed by means of the signal on the TRIGGER 2 connector.

OBASeband
Triggering is executed by means of the trigger signal from the second path (two-path instruments only).

Example: `"SOUR2:BB:DM:TRIG:SOUR EXT"`
'sets external triggering via the TRIGGER 1 connector for path B of a two-path instrument.

*RST value	Resolution	Options	SCPI
INTernal	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

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). The directory which applies to the commands that follow is defined using the command `MMEMory:CDIR`. Files in this directory can be accessed by quoting the file name. The path and extension are not needed.

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

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.

Command	Parameter	Default unit	Note
[SOURce<[1]|2>:]BB:DM:CLISt:CATalog?			Query only
[SOURce<[1]|2>:]BB:DM:CLISt:COPY	<new_control_list_name>		No query
[SOURce<[1]|2>:]BB:DM:CLISt:DATA	0 | 1, {0 | 1} | block data		No query
[SOURce<[1]|2>:]BB:DM:CLISt:DELete	<control_list_name>		No query
[SOURce<[1]|2>:]BB:DM:CLISt:POINts			Query only
[SOURce<[1]|2>:]BB:DM:CLISt:SELect	<control_list_name>		Query only
[SOURce<[1]|2>:]BB:DM:CLISt:TAG?	<control_list_name>, <tag_name>		Query only
[SOURce<[1]|2>:]BB:DM:DLISt:CATalog?			Query only
[SOURce<[1]|2>:]BB:DM:DLISt:COPY	<new_data_list_name>		No query
[SOURce<[1]|2>:]BB:DM:DLISt:DATA	0 | 1, {0 | 1} | block data		
[SOURce<[1]|2>:]BB:DM:DLISt:DATA:APPend	0 | 1, {0 | 1} | block data		
[SOURce<[1]|2>:]BB:DM:DLISt:DELete	<data_list_name>		No query
[SOURce<[1]|2>:]BB:DM:DLISt:POINts			
[SOURce<[1]|2>:]BB:DM:DLISt:SELect	<data_list_name>		
[SOURce<[1]|2>:]BB:DM:DLISt:TAG?	<data_list_name>, <tag_name>		Query only
[SOURce<[1]|2>:]BB:DM:MLISt:SELect	<user_mapping_list_name>		
[SOURce<[1]|2>:]BB:DM:SETTing:CATalog?			Query only
[SOURce<[1]|2>:]BB:DM:SETTing:DELete	"setting_file"		No query
[SOURce<[1]|2>:]BB:DM:SETTingt:LOAD	"setting_file"		No query
[SOURce<[1]|2>:]BB:DMSETTing:STORe	"setting_file"		No query
[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:CATalog?			Query only
[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:DELete	"user_list"		No query
[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:LOAD	"user_list"		No query
[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:STORe	"user_list"		No query

[SOURce<[1]|2>:]BB:DM:CLISt:CATalog?

The command queries the control lists present 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 read. When the names of the lists are returned they are separated by commas. The command only reads out files with the ***.dm_iqc** extension.

The control lists contain the control signals for digital modulation.

The command is a query command and therefore has no *RST value.

Example: `"BB:DM:CLIS:CAT?"`
'queries which control lists are present in the default directory.

Response: `"c_list1","c_list2","c_list3"`
'control lists `c_list1`, `c_list2`, and `c_list3` are present.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:COPY <list name>

The command copies the selected control list into the control list specified by <list_name>. If a control list with the specified name 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.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:CLIS:SEL 'c_list1'"`
'selects control list c_list1.

`"BB:DM:CLIS:COPY 'c_list4'"`
'copies the content of control list c_list1 into control list c_list4. If this list already exists, its content is overwritten. If the list does not yet exist, it is created.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:DATA 0...255 | block data

The command 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 a 8-bit value as follows:

Signal	Order	Decimal value of bits
Marker 1	LSBit	1
Marker 2		2
Marker 3		4
Marker 4		8
Burst =		16
LevAtt1		32
CWMod		64
Hop	MSBit	128

The data can also be sent as a binary block, each binary block being a 2-byte value in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSByte first). When binary data transmission is in use, command `:SYSTem:COMMunicate:GPIB:LTERminator EOI` should be used to set the termination character mode to 'EOI control data message only' so that a random LF in the data sequence is not interpreted as End, thereby prematurely terminating the data transmission. The command `...LTER STANdard` resets the mode.

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-

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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:DELete <list name>

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.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:CLIS:DEL 'c_list3'"`
'deletes control list c_list3.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:POINts?

The command queries the number of lines (2 bytes) in the currently selected list.

The command is a query command and therefore has no *RST value.

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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:TAG? <control_list_name>, <tag_name>

The command queries the content of the specified tag in the selected file.

The command is a query command and therefore has no *RST value.

Example: `"BB:DM:CLIS:TAG 'c_list1','date"`
'queries the Date tag in control list c_list1.

Response: "10.10.2003"
'the control list was created on 10.10.2003.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:CLISt:SELect <list name>

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.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:CLIS:SEL 'c_list1'"`
'selects control list c_list1.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:CATalog?

The command queries the data lists present 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 read. When the names of the lists are returned they are separated by commas. The command only reads out files with the ***.dm_iqd** extension.

The data lists contain the modulation data for digital modulation.

The command is a query command and therefore has no *RST value. The numeric suffix on SOURce<[1]|2> is ignored in this command.

Example: `"BB:DM:DLIS:CAT?"`
'queries which data lists are present.

Response: `"d_list1","d_list2","d_list3"`
'data lists d_list1, d_list2, d_list3 are present.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:COPY <list name>

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.

The command triggers an action and therefore has no *RST value and no query form.

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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:DATA 0 | 1 {,0 | 1 }.| block data

[SOURce<[1]|2>:]BB:DM:DLISt:DATA? [<start>[,<length>]]

The setting command sends the bit data to the data list selected with the aid of `: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 data can also be sent as block data in binary or PACKed format (see section Parameters, block data), each byte being interpreted as 8 data bits. In this case, command `:SYSTem:COMMunicate:GPIB:LTERminator EOI` should be used to set the termination character mode to ‘EOI control data message only’ so that a random LF in the data sequence is not interpreted as End, thereby prematurely terminating the data transmission. The command `...LTER STAN` resets the mode.

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.

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).

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.

*RST has no effect on data lists.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:DATA:APPend 0 | 1 {,0 | 1 }.| block data

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.

Example 1: `"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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:DELete <list name>

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.

The command triggers an action and therefore has no *RST value and no query form. The numeric suffix on SOURce<[1]|2> is ignored in this command.

Example: `"BB:DM:DLIS:DEL ' d_list2'"`
'deletes data list d_list2.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:POINTs <n>

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.

The command triggers an action and therefore has no *RST value and no query form.

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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:SELect <list name>

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"`.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:DLIS:SEL ' d_list2'"`
'selects data list d_list2.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:DLISt:TAG? <control_list_name>, <tag_name>

The command queries the content of the specified tag in the selected file.

The command is a query command and therefore has no *RST value.

Example: `"BB:DM:DLIS:TAG 'D_list1','date"`
'queries the Date tag in control list D_list1.

Response: `"10.10.2003"`
'the data list was created on 10.10.2003.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:MLISt:SELect <mapping_list_name>

The command 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.

The command triggers an action and therefore has no *RST value and no query form.

Example: `"BB:DM:MLIS:SEL 'c_list1'`
'selects the user mapping list c_list1.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SETTing:CATalog?

This command reads out the files with Custom Digital Modulation settings 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 read. Only files with the file extension ***.dm** will be listed.

The command is a query command and therefore has no *RST value.

Example: `"MMEM:CDIR 'D:\user\dig_mod"`
'sets the default directory to D:\user\dig_mod.

`"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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SETTing:DELete <file_name>

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.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:DEL 'DM_1'"`
'deletes file 'DM_1'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SETTing:LOAD <file_name>

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.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:LOAD 'DM_1'"`
'loads file 'DM_1'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:SETTing:STORe <file_name>

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**.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:STOR 'DM_QAM'"`
'stores the current Custom Digital Modulation settings into file '`DM_QAM`'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:CATalog?

This command reads out the files with Digital Standard settings 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 read. Only files with the file extension ***.dm_stu** will be listed.

The command is a query command and therefore has no *RST value.

Example: `"MMEM:CDIR 'D:\user\dig_mod"`
'sets the default directory to D:\user\dig_mod.

`"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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:DELete <file_name>

This command 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.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:DEL 'DM_QAM'"`
'deletes file 'DM_QAM'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:LOAD <file_name>

This command 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.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:LOAD 'DM_QAM'"`
'loads file 'DM_QAM'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:DM:STANdard:ULISt:STORe <file_name>

This command 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**.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:DM:STAN:ULIS:STOR 'DM_QAM'"`
'stores the current Digital Standard settings into file '`DM_QAM`'.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 SOURce2 only with second option B9/B10/B11	Device-specific

SOURce-BB-IMPairment Subsystem

This subsystem contains the commands for the digital I/Q impairments. Included in this section is also the description of command `SOURce:BB:IQOutput:SOURce` that determined the source for the I/Q output connectors.

Digital I/Q impairments can be activated in the case of two-path instruments with a second R&S AMU-B13 option (Baseband Main Module) and one of the options R&S AMU-B9/B10/B11 (Baseband Generator), R&S AMU-B17 (External Baseband Input) or R&S AMU-K62 (Noise Generator).

SOURce[1] = Path A

SOURce2 = Path B

Command	**Parameters**	**Default unit**	**Remark**
[SOURce<[1]|2>:]BB:IMPairment:IQRatio	-1 dB ... +1 dB	dB	
[SOURce<[1]|2>:]BB:IMPairment:LEAKage:I	0 ... 50.0 PCT	PCT	
[SOURce<[1]|2>:]BB:IMPairment:LEAKage:Q	0 ... 50.0 PCT	PCT	
[SOURce<[1]|2>:]BB:IMPairment:OPTimization:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:IMPairment:QUADrature[:ANGLe]	-10.0...10.0 DEG	DEG	
[SOURce<[1]|2>:]BB:IMPairment:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:IQGain	AUTO | DBM3 | DB0 | DB3 | DB6		
[SOURce:]BB:IQOutput:SOURce	A | B		

[SOURce<[1]|2>:]BB:IMPairment:IQRatio -1 dB ... +1 dB

This command sets the ratio of I modulation to Q modulation (amplification “imbalance”). The input may be either in dB or %. The resolution is 0.001 dB, an input in percent is rounded to the closest valid value in dB. A query returns the value in dB.

Examples: `"BB:IMP:IQR 3 PCT"`
'sets the imbalance to 3 percent.

`"BB:IMP:IQR?"`
'queries the imbalance

Response: `"0.259000"`
'the value is returned in dB

`"BB:IMP:IQR 1"`
'sets the imbalance to 1 dB.

***RST value**	**Resolution**	**Options**	**SCPI**
0 dB	0.001 dB	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IMPairment:LEAKage:I 0 ... 50 PCT

This command sets the carrier leakage amplitude for the I-signal component.

Example: `"BB:IMP:LEAK:I 3 PCT"`
'sets the leakage for the I-component to 3 percent'.

*RST value	Resolution	Options	SCPI
0 PCT	0.05 PCT	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IMPairment:LEAKage:Q 0 ... 50 PCT

This command sets the carrier leakage amplitude for the Q-signal component.

Example: `"BB:IMP:LEAK:Q 3 PCT"`
'sets the leakage for the Q-component to 3 percent'.

*RST value	Resolution	Options	SCPI
0 PCT	0.05 PCT	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IMPairment:OPTimization:STATe ON | OFF

This command activates and deactivates internal compensation of signal distortions by the I/Q modulator.

Example: `"BB:IMP:OPT:STAT ON"`
'activates internal compensation of signal distortions for Path A'.

*RST value	Resolution	Options	SCPI
OFF	-	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IMPairment:QUADrature[:ANGLe] -10.0 ... 10.0 DEG

This command sets the quadrature offset for the digital I/Q signal.

Example: `"BB:IMP:QUAD:ANGL -5DEG"`
'sets the quadrature offset to -5 degrees.

*RST value	Resolution	Options	SCPI
0 DEG	0.02 DEG	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IMPairment:STATe ON | OFF

The command activates (ON) and deactivates (OFF) the three impairment or correction values LEAKage, QUADrature and IQRatio for the digital baseband signal prior to input into the I/Q modulator

Example: `"BB:IMP:STAT OFF"`
'deactivates digital impairment.

*RST value	Resolution	Options	SCPI
OFF	-	B13 SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce<[1]|2>:]BB:IQGain AUTO | DBM3 | DB0 | DB3 | DB6

This command specifies the baseband gain for the internal or external baseband signal.

Thus, the modulation of the I/Q modulator can be optimized for any measurement requirement. The gain settings for an external analog wideband signal (**Analog Wideband I/Q In**) are performed with command `:SOURce:IQ:GAIN`

Parameters:

AUTO
Activates automatic setting. The modulation is automatically optimized for the internally set baseband signal.

DBM3
Activates -3 dB gain. With this setting, signal distortions are minimized.

DB0
Activates 0 dB gain (standard settings).

DB3
Activates 3 dB gain. This setting is recommended for high 3GPP ACLR.

DB6
Activates 6 dB gain. With this setting, signal noise is minimized.

Example: `"IQ:SOUR BAS"`
'selects the internal baseband signal as the input signal of the I/Q modulator.

`"BB:IQG DB6"`
'sets gain 6dB (best for low noise).

*RST value	Resolution	Options	SCPI
Auto	0.01 dB	SOURce2 only with second B13 option and at least one of options B9/B10/B11, B17 or K62.	Device-specific

[SOURce:]BB:IQOutput:SOURce A | B

This command selects the output signal at the I/Q OUT connectors for a two-path instrument.

Example: `"BB:IQO:SOUR A"`
'the I/Q components of path A baseband signal are output at the I/Q OUT connectors.

*RST value	Resolution	Options	SCPI
A		Two B13 options and at least one of options B9/B10/B11, B17 or K62.	Device-specific

SOURce:BB:MCCW Subsystem

Introduction - MCCW Remote-Control Commands

This subsystem contains the commands for setting the Multicarrier CW signals.

The numeric suffix to SOURce distinguishes between multicarrier generation for path A and path B in the case of two-path instruments:

SOURce<1> = path A

SOURce2 = path B

The keyword SOURce is optional in the case of commands for path A and can be omitted. For path B the command must contain the keyword with suffix 2.

Command	Parameter	Default unit	Note
[SOURce<[1]|2>:]BB:MCCW:CARRier:COUNt	1 ... 8192	-	
[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:PHASe	0° ... 360°, 0° ... 360°, ...	RAD	
[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:POWer	-80 ... 0 dB , -80 ... 0 dB, ...	dB	
[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:STATe	ON | OFF, ON | OFF, ...		
[SOURce<[1]|2>:]BB:MCCW:CARRier:PHASe	<index>, 0 ... 360DEG	RAD	
[SOURce<[1]|2>:]BB:MCCW:CARRier:POWer	<index>, -80 ... 0 dB	dB	
[SOURce<[1]|2>:]BB:MCCW:CARRier:SPACing	0 Hz ... 50 MHz	Hz	
[SOURce<[1]|2>:]BB:MCCW:CARRier:STATe	<index>, ON | OFF		
[SOURce<[1]|2>:]BB:MCCW:CFACtor	0 ... 100 dB	dB	
[SOURce<[1]|2>:]BB:MCCW:CFACtor:MODE	OFF | CHIRp | SLOW		
[SOURce<[1]|2>:]BB:MCCW:CLOCk			Query only
[SOURce<[1]|2>:]BB:MCCW:CLOCk:MODE	SAMPle | MSAMple		
[SOURce<[1]|2>:]BB:MCCW:CLOCk:MULTiplier	1 ... 64		
[SOURce<[1]|2>:]BB:MCCW:CLOCk:SOURce	INTernal | EXTernal		
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:EXECute			No query
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:PHASe[:STARt]	0 ... 360DEG	RAD	
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:PHASe:STEP	-360 ... 360DEG	RAD	
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:POWer[:STARt]	-80 ... 0 dB	dB	
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:POWer:STEP	-80 ... 80 dB	dB	
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STARt	<carrier_index>		
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STOP	<carrier_index>		
[SOURce<[1]|2>:]BB:MCCW:PRESet	-		
[SOURce<[1]|2>:]BB:MCCW:SEQuence	AUTO / RETRigger / AAUTO / ARETrigger / SINGle		
[SOURce<[1]|2>:]BB:MCCW:STATe	ON | OFF		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:ARM:EXECute			No query

[SOURce<[1]|2>:]BB:MCCW:TRIGger:EXECute			No query
[SOURce<[1]|2>:]BB:MCCW:TRIGger[:EXTernal<[1]|2>]:DELay	0 ... 2^32-1 Samples	-	
[SOURce<[1]|2>:]BB:MCCW:TRIGger[:EXTernal<[1]|2>]:INHibit	0 ... 2^32-1 Samples	-	
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OBASeband:DELay	0 ... 2^32-1 Samples	-	
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OBASeband:INHibit	0 ... 2^32-1 Samples	-	
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay	0 ... 2^20-1 Samples		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut:DELay:FIXed	ON | OFF		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay:MAX?			Query only
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay:MIN?			Query only
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:MODE	RESTart | PULSe | PATTern | RATio		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:OFFTime	1 ... max. wavelength - 1 sample		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:ONTime	1 ... max. wavelength - 1 sample		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PATTern	#B0,1 ... #B111 ... 1,32		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PULSe:DIVider	2 ... 2^10		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PULSe:FREQ			Query only
[SOURce<[1]|2>:]BB:MCCW:TRIGger:RMODe			Query only
[SOURce<[1]|2>:]BB:MCCW:TRIGger:SLENgth	1 … 2^32-1 Samples		
[SOURce<[1]|2>:]BB:MCCW:TRIGger:SOURce	INTernal | EXTernal | BEXTernal | OBASeband		

[SOURce<[1]|2>:]BB:MCCW:CARRier:COUNt 1 ... 8192

The command sets the number of carriers in the Multicarrier CW signal. The total bandwidth *(Number of carriers - 1) * Carrier spacing* is 80 MHz. The number of carriers entered therefore defines the maximum carrier spacing (`:BB:MCCW:CARRier:SPACing`).

Example: `"BB:MCCW:CARR:COUN 10"`
'sets 10 CW carriers for the multicarrier signal.

*RST value	Resolution	Options	Dependencies	SCPI
64	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	The carrier spacing (`:BB:MCCW:CARRier:SPACing`) is reduced if the total bandwidth of 80 MHz is not respected when entering the number of carriers.	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:PHASe 0 ... 360 DEG[, 0 ... 360 DEG].

The command 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 multicarriers. 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.

If the query is expanded by using the two parameters <start> and <count>, the value list is read out in smaller sections. Start is expressed in position of bit, count in number of values. Without the parameters all values are always read out starting from the first value.

Example: `"BB:MCCW:CARR:LIST:PHAS 90 DEG, 90 DEG, 90 DEG, 80 DEG"`
'sets a start phase for carriers 0, 1, 2 and 3.

`"BB:MCCW:CARR:LIST:PHAS 2,3"`
'queries the phase of carrier 1, 2 and 3.

Response: "90,90,80"

*RST value	Resolution	Options	SCPI
0 DEG	0.01 DEG	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:POWer - 80 dB ... 0 dB[, - 80 dB ... 0 dB]

The command 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 multicarriers. 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.

If the query is expanded by using the two parameters <start> and <count>, the value list is read out in smaller sections. Start is expressed in position of bit, count in number of values. Without the parameters all values are always read out starting from the first value.

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 2,2"`
'queries the power of carrier 1 and 2.

Response: `"-30,-50"`

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:LIST:STATe ON | OFF, ON | OFF, ...

The command 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 multicarriers. 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.

If the query is expanded by using the two parameters <start> and <count>, the value list is read out in smaller sections. Start is expressed in position of bit, count in number of values. Without the parameters all values are always read out starting from the first value.

Example: `"BB:MCCW:CARR:LIST:STAT ON, OFF, ON,...."`
'switches carrier 0 on, carrier 1 off, etc.

`"BB:MCCW:CARR:LIST:POW 2,2"`
'queries the states of carrier 1 and 2.

Response: `"0,1"`

*RST value	Resolution	Options	SCPI
ON	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:PHASe <carrier_index>, 0 ... 360 DEG.

The command sets the start phase of the selected carrier. The carrier is selected by the numerical parameter <carrier_index>.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:MCCW:CFACtor:MODE OFF`).

Example: `"BB:MCCW:CARR:PHAS 15, 90 DEG"`
'sets a start phase of 90° for carrier 15.

*RST value	Resolution	Options	SCPI
0 DEG	0.01 DEG	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:POWer <carrier_index>, 80 dB ... 0 dB

The command sets the power of the selected carrier. The carrier is selected by the numerical parameter <carrier_index>.

Example: `"BB:MCCW:CARR:POW 15, -50 dB"`
'sets the power of carrier 15 to -50 dB.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:SPACing 0 Hz ... 50 MHz

The command sets the carrier spacing. The carriers are generated symmetrically around the RF carrier. The total bandwidth *(Number of carriers - 1) * Carrier spacing* is 80 MHz. The maximum carrier spacing that can be set is dependent on the chosen number of carriers

Example: `"BB:MCCW:CARR:SPAC 10 MHz"`
'sets a carrier spacing of 10 MHz.

*RST value	Resolution	Options	Dependencies	SCPI
10 kHz	0.01 Hz	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	The maximum carrier spacing is automatically reduced so that the maximum total bandwidth of 80 MHz is not exceeded on entering the number of carriers (`:BB:MCCW:CARRier:COUNt`).	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CARRier:STATe <carrier_index>, ON | OFF

The command switches the selected carrier on or off. The carrier is selected by the numerical parameter <carrier_index>. 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.

Example: `"BB:MCCW:CARR:STAT 15, ON"`
'switches carrier 16 on.

*RST value	Resolution	Options	SCPI
ON	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CFACtor 0 ... 100 dB

The command sets the desired crest factor for the multicarrier signal on selection of the command `SOURce:BB:MCCW:CFACtor:MODE SLOW`.

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.

*RST value	Resolution	Options	SCPI
3 dB	0.01 dB	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CFACtor:MODE OFF | CHIRp | SLOW

The command sets the mode by which automatic settings will minimize the crest factor or hold it at a chosen value.

Parameter:

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 multicarrier 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 `SOURce:BB: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.

Example: `"BB:MCCW:CFAC:MODE OFF"`
'switches off automatic crest factor optimization. The setting `SOUR:BB:MCCW:CARR:PHAS` has an effect.

*RST value	Resolution	Options	SCPI
FAST	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CLOCk?

The command queries the output clock rate. The output clock rate depends on the number of carriers an the selected carrier spacing.

The command is a query only and therefore has no *RST value.

Example: `"BB:MCCW:CLOC?"`
'queries the output clock rate.

Response: `"256 000 000"`
'the output clock rate is 256 MHz.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CLOCk:MODE SAMPle | MSAMple

The command enters the type of externally supplied clock (`:BB:MCCW:CLOCk:SOURce EXTernal)`.. When `MSAMple` is used, a multiple of the sample clock is supplied via the CLOCK connector and the sample clock is derived internally from this. The multiplier is entered with the command `BB:MCCW:CLOCk:MULTiplier`.

With this command the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Example: `"BB:MCCW:CLOC:MODE SAMP"`
'selects clock type **Sample**, i.e. the supplied clock is a sample clock.

*RST value	Resolution	Options	SCPI
SAMPle	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CLOCk:MULTiplier 1 ... 64

The command specifies the multiplier for clock type **Multiple Samples** (`:BB:MCCW:CLOCk:MODE MSAM)` in the case of an external clock source.

With this command the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Example: `"BB:MCCW:CLOC:SOUR EXT"`
'selects the external clock source. The clock is supplied via the CLOCK connector.

`"BB:MCCW:CLOC:MODE MSAM"`
'selects clock type **Multiple Samples**, , i.e. the supplied clock has a rate which is a multiple of the sample rate.

`"BB:MCCW:CLOC:MULT 12"`
'the multiplier for the external clock rate is 12.

*RST value	Resolution	Options	SCPI
4	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:CLOCk:SOURce INTernal | EXTernal

The command selects the source for the digital modulation clock.

Selecting EXTernal is only possible for path A, since the external clock source is permanently allocated to path A.

Parameter: **INTernal**
The internal clock reference is used.

EXTernal
The external clock reference is supplied to the CLOCK connector.

Example: `"BB:MCCW:CLOC:SOUR EXT"`
'selects an external clock reference for path A. The clock is supplied via the CLOCK connector.

*RST value	Resolution	Options	SCPI
INTernal		B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:EXECute

The command 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 multicarrier signal. Carriers 4 to 400 are in the ON state.

*RST value	Resolution	Options	SCPI
		B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:PHASe[:STARt] 0 ... 360 DEG.

The command 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`).

Example: `"BB:MCCW:EDIT:CARR:PHAS 90 DEG"`
'sets a start phase of 90° for the carriers in the carrier range.

*RST value	Resolution	Options	SCPI
0 DEG	0.01 DEG	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:PHASe:STEP 0 ... 360 DEG.

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:MCCW:CFACtor:MODE OFF`).

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.

*RST value	Resolution	Options	SCPI
0 DEG	0.01 DEG	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:POWer[:STARt] 80 dB ... 0 dB

The command 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.

Example: `"BB:MCCW:EDIT:CARR:POW -50 dB"`
'sets the power of the carrier to -50 dB.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:POWer:STEP -80 dB ... +80 dB.

The command sets the step width by which the starting power of the carriers in the defined carrier range will be incremented.

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 1dB for each carrier, i.e. the first carrier has -80dB, the second -79dB, etc.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STARt <carrier_index>

The command selects the first carrier in the carrier range to which the settings with the `:BB:MCCW:EDIT:CARR:..` commands shall apply.

Example: `"BB:MCCW:EDIT:CARR:STAR 4"`
'the carrier range starts at carrier 4.

*RST value	Resolution	Options	SCPI
0		B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STATe ON | OFF

The command switches all the carriers in the selected carrier range on or off.

Example: `"BB:MCCW:EDIT:CARR:STAT ON"`
'sets all the carriers in the carrier range to ON.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:EDIT:CARRier:STOP <carrier_index>

The command selects the last carrier in the carrier range to which the settings with the `:BB:MCCW:EDIT:CARR:..` commands shall apply.

Example: `"BB:MCCW:EDIT:CARR:STOP 40"`
'the carrier range stops at carrier 40.

*RST value	Resolution	Options	SCPI
0		B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:PRESet

The command sets all multicarrier signal parameters to their default values

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:MCCW:PRESet"`
'resets the Multicarrier settings to default values.

*RST value	Options	Dependencies	SCPI

-	B9/B10/B11 and B13
	K61
	SOURce2 only with second option B9/B10/B11
		`:BB:MCCW:CARR:COUN 64`
		`:BB:MCCW:CARR:PHAS 0`
		`:BB:MCCW:CARR:POW 0`
		`:BB:MCCW:CARR:SPAC 10 kHz`
		`:BB:MCCW:CARR:STAT ON`
		`:BB:MCCW:CLOC:SOUR INT`
		`:BB:MCCW:CFAC 3 dB`
		`:BB:MCCW:CFAC:MODE FAST`
		`:BB:MCCW:STAT OFF`
		`:BB:MCCW:TRIG:EXT:DEL 0`
		`:BB:MCCW:TRIG:EXT:INH 0`
		`:BB:MCCW:TRIG:OBAS:DEL 0`
		`:BB:MCCW:TRIG:OBAS:INH 0`
		`:BB:MCCW:TRIG:OUTP<[1]|2|3|4>:MODE REST`
		`:BB:MCCW:TRIG:OUTP<[1]|2|3|4>:PFR 1MHz`
		`:BB:MCCW:TRIG:OUTP<[1]|2|3|4>:PATT #H0,1`
		`:BB:MCCW:TRIG:OUTP<[1]|2|3|4>:OFFT 0`
		`:BB:MCCW:TRIG:OUTP<[1]|2|3|4>:ONT 0`
		`:BB:MCCW:TRIG:SEQ AUTO`
		`:BB:MCCW:TRIG:SOUR INT`
			Device-specific

[SOURce<[1]|2>:]BB:MCCW:SEQuence AUTO | RETRigger | AAUTo | ARETrigger | SINGle

The command selects the trigger mode.

Parameter:

AUTO
The multicarrier signal is generated continuously.

RETRigger
The multicarrier signal is generated continuously. A trigger event (internal or external) causes a restart.

AAUTo
The multicarrier signal is generated only when a trigger event occurs. After the trigger event the signal is generated continuously. Signal generation is stopped with command `SOUR:BB:MCCW:TRIG:ARM:EXEC` and started again when a trigger event occurs.

ARETrigger
The multicarrier signal is generated only when a trigger event occurs. The device automatically toggles to RETRIG mode. Every subsequent trigger event causes a restart. Signal generation is stopped with command `SOUR:BB:MCCW:TRIG:ARM:EXEC` and started again when a trigger event occurs.

SINGle
The multicarrier signal is output only when a trigger event occurs. After the trigger event the signal is output once to the set sequence length (`SOUR:BB:MCCW:TRIG:SLEN`). Every subsequent trigger event causes a restart.

Example: `"BB:MCCW:SEQ AAUT"`
'sets the **Armed_auto** trigger mode; the device waits for the first trigger (e.g. with `*TRG`) and then generates the signal continuously.

*RST value	Resolution	Options	SCPI
RETRigger	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:STATe ON | OFF

The command turns on the Multicarrier CW signal. Any other digital standards or digital modulation that may be in the ON state will be automatically turned OFF.

Example: `"BB:MCCW:STAT ON"`
'switches on generation of the Multicarrier CW signal.

*RST value	Resolution	Options	Dependencies	SCPI
OFF	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	`:BB:MCCW:STAT ON` switches off all the digital standards and digital modulationon the same path.	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:ARM:EXECute

The command stops signal generation for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart signal generation.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:MCCW:TRIG:SOUR INT"`
'sets internal triggering.

`"BB:MCCW:TRIG:SEQ ARET"`
'sets Armed_Retrigger mode, i.e. every trigger event causes signal generation to restart.

`"BB:MCCW:TRIG:EXEC"`
'executes a trigger, signal generation is started.

`"BB:MCCW:TRIG:ARM:EXEC"`
'signal generation is stopped.

`"BB:MCCW:TRIG:EXEC"`
'executes a trigger, signal generation is started again.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:EXECute

The command executes a trigger. The internal trigger source must be selected using the command `MCCW:TRIGger:SOURce INTernal` and a trigger mode other than `AUTO` must be selected using the command `:BB:MCCW:TRIGger:MODE`.

This command triggers an event and therefore has no *RST value and no query form.

Example: `"BB:MCCW:TRIG:SOUR INT"`
'sets internal triggering.

`"BB:MCCW:TRIG:SEQ RETR"`
'sets Retrigger mode, i.e. every trigger event causes signal generation to restart.

`"BB:MCCW:TRIG:EXEC"`
'executes a trigger.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger[:EXTernal<[1]|2>]:DELay 0 ... 2^32-1 samples

The command specifies the trigger delay (expressed as a number of samples)for external triggering. The numeric suffix to EXTernal distinguishes between the external trigger via the TRIGGER 1 (suffix 1) and TRIGGER 2 (suffix 2) connector.

Example: "BB:MCCW:TRIG:SOUR EXT"
'selects an external trigger via the TRIGGER 1 connector

"BB:MCCW:TRIG:DEL 200"
'sets a delay of 200 samples for the trigger.

*RST value	Resolution	Options	SCPI
0	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger[:EXTernal<[1]|2>]:INHibit 0 ... 2^26-1 samples

The command specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only in the case of external triggering. The numeric suffix to EXTernal distinguishes between the external trigger via the TRIGGER 1 (suffix 1) and TRIGGER 2 (suffix 2) connector.

Example: "BB:MCCW:TRIG:SOUR EXT"
'selects an external trigger via the TRIGGER 1 connector

"BB:MCCW:TRIG:INH 200"
'sets a restart inhibit for 200 samples following a trigger event.

*RST value	Resolution	Options	SCPI
0	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OBASeband:DELay 0 ... 2^32-1 samples

The command specifies the trigger delay (expressed as a number of samples) for triggering by the signal from the second path (two-path instruments only).

Example: "BB:MCCW:TRIG:SOUR OBAS"
'sets for path A the internal trigger executed by the signal from the second path (path B).

"BB:MCCW:TRIG:DEL 200"
'sets a delay of 200 samples for the trigger.

*RST value	Resolution	Options	SCPI
0	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OBASeband:INHibit 0 ... 2^32-1 samples

The command specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only for triggering by the second path (two-path instruments only).

Example: `"BB:MCCW:TRIG:SOUR OBAS"`
'sets for path A the internal trigger executed by the signal from the second path (path B).

`"BB:MCCW:TRIG:INH 200"`
'sets a restart inhibit for 200 samples following a trigger event.

*RST value	Resolution	Options	SCPI
0	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay 0 ... 2^20-1 Symbols

The command defines the delay between the signal on the marker outputs and the start of the signals, expressed in terms of samples. Command `:BB:MCCW:TRIGger:OUTPut:DELay:FIXed ON` can be used to restrict the range of values to the dynamic range, i.e. the range within which a delay of the marker signals can be set without restarting the marker and signal.

Example: `"BB:MCCW:TRIG:OUTP2:DEL 16"`
'sets a delay of 16 samples for the signal on connector MARKER 2.

*RST value	Resolution	Options	SCPI
0 Symbols	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut:DELay:FIXed ON | OFF

The command restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal. If a delay is entered in setting ON but is outside this range, the maximum possible delay is set and an error message is generated.

The numeric suffix in `OUTPut` has no significance for this command, since the setting always affects every marker.

Example: `"BB:MCCW:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay:MAXimum

The command queries the maximum marker delay for setting `:BB:MCCW:TRIGger:OUTPut:DELay:FIXed ON`.

The command is a query only and therefore has no *RST value.

Example: `"BB:MCCW:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

`"BB:MCCW:TRIG:OUTP:DEL:MAX"`
'queries the maximum of the dynamic range.

Response: `"2000"`
'the maximum for the marker delay setting is 2000 samples.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:DELay:MINimum

The command queries the minimum marker delay for setting `:BB:MCCW:TRIGger:OUTPut:DELay:FIXed ON`.

The command is a query only and therefore has no *RST value.

Example: `"BB:MCCW:TRIG:OUTP:DEL:FIX ON"`
'restricts the marker signal delay setting range to the dynamic range.

`"BB:MCCW:TRIG:OUTP:DEL:MIN"`
'queries the minimum of the dynamic range.

Response: `"0"`
'the minimum for the marker delay setting is 0 samples.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:MODE RESTart | PULSe | PATTern | RATio

The command defines the signal for the selected marker output.

Parameter:

RESTart

A marker signal is generated at every signal start.

PULSe

A pulsed marker signal is generated. The pulse frequency (= symbol rate/divider) is defined with the `SOUR:BB:MCCW:TRIG:OUTP:PULS:DIVider` command and can be queried with the `SOUR:BB:MCCW:TRIG:OUTP:PULS:FREQ?` command.

PATTern

A marker signal is generated with the aid of a user-definable bit pattern. The bit pattern is entered with the aid of command `SOURce:BB:MCCW:TRIGger: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:OFFT` and `SOURce:BB:MCCW:TRIGger:ONT` is generated.

Example: `"BB:MCCW:TRIG:OUTP2:MODE PULS"`
'selects the pulsed marker signal on output MARKER 2.

*RST value	Resolution	Options	SCPI
RESTart	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:OFFTime 1 ... max. wave length -1 sample

The command 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 OFF.

Example: `"BB:MCCW:TRIG:OUTP2:OFFT 20"`
'sets an OFF time of 20 samples for marker signal 2 on path A.

*RST value	Resolution	Options	SCPI
1 Sample	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:ONTime 1 ... max. wavelength -1 sample

The command 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.

Example: `"BB:MCCW:TRIG:OUTP2:ONT 20"`
'sets an ON time of 20 samples for marker 2 on path A.

*RST value	Resolution	Options	SCPI
1 Sample	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PATTern #B0,1 ... #B111...1,32

The command defines the bit pattern used to generate the marker signal in the setting `SOURce:BB:MCCW:TRIGger:OUTPut:MODE PATTern` 0 is marker off, 1 is marker on.

Example: `"BB:MCCW:TRIG:OUTP2:PATT #HE0F52,20"`
'sets a bit pattern.

`"BB:MCCW:TRIG:OUTP2:MODE PATT"`
'activates the marker signal according to a bit pattern on output MARKER 2.

*RST value	Resolution	Options	SCPI
0		B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PULSe:DIVider 2 ... 2^10

The command 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.

Example: `"BB:MCCW:TRIG:OUTP2:PULS:DIV 2"`
'sets the divider for the path A 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.

*RST value	Resolution	Options	SCPI
2	1	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:OUTPut<[1]...4>:PULSe:FREQuency?

The command 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`.

The command is a query only and therefore has no *RST value.

Example: `"BB:MCCW:TRIG:OUTP2:PULS:DIV 4"`
'sets the divider for the path A 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.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:RMODe

The command queries the current status of signal generation for all trigger modes with Multicarrier CW on.

The command is a query command and therefore has no *RST value.

Parameter:

RUN
the signal is generated. A trigger event occurred in the triggered mode.

STOP
the signal is not generated. A trigger event did not occur in the triggered modes, or signal generation was stopped by the command `:BB:MCCW:TRIG:ARM:EXECute` (armed trigger modes only).

Example: `"SOUR2:BB:MCCW:TRIG:SOUR EXT"`
'sets external triggering via the TRIGGER 1 connector for path B of a two-path instrument.

`"SOUR2:BB:MCCW:TRIG:MODE ARET"`
'selects the Armed_Retrigger mode.

`"SOUR2:BB:MCCW:TRIG:RMOD?"`
'queries the current status of signal generation.

Response: `"RUN"`
'the signal is generated, an external trigger was executed.

*RST value	Resolution	Options	SCPI
-	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:SLENgth 1 … (2^32-1) Samples

The command defines the length of the signal sequence to be output in the **Single** trigger mode. The input is to be expressed in samples. It is then possible to output deliberately just part of the waveform, an exact sequence of the waveform, or a defined number of repetitions of the waveform.

Example: `"SOUR2:BB:MCCW:SEQ SING"`
'sets trigger mode Single.

`"SOUR2:BB:MCCW:TRIG:SLEN 200"`
'sets a sequence length of 200 samples. The first 200 samples of the current waveform will be output after the next trigger event.

*RST value	Resolution	Options	SCPI
1 Waveform length	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

[SOURce<[1]|2>:]BB:MCCW:TRIGger:SOURce INTernal | EXTernal | BEXTernal | OBASeband

The command selects the trigger source.

Parameter:

INTernal
Triggering is executed by means of the Trigger command `:BB:MCCW:TRIG:EXECute` in the case of remote control, and by means of **Execute Trigger** in the case of manual operation.

EXTernal
Triggering is executed by means of the signal on the TRIGGER 1 connector.

BEXTernal
Triggering is executed by means of the signal on the TRIGGER 2 connector.

OBASeband
Triggering is executed by means of the signal from the second path (two-path instruments only).

Example: `"BB:MCCW:TRIG:SOUR INT"`
'sets internal triggering.

*RST value	Resolution	Options	SCPI
INTernal	-	B9/B10/B11 and B13 K61 SOURce2 only with second option B9/B10/B11	Device-specific

SOURce-BB-POWer Subsystem

This subsystem contains the commands for retrieving the level values of the digital baseband signal.

The numeric suffix to SOURce distinguishes between the signal for path A and path B in the case of two-path instruments:

SOURce[1] = path A

SOURce2 = path B

The keyword SOURce is optional in the case of commands for path A and can be omitted. For path B the command must contain the keyword with suffix 2.

The keyword SOURce is optional and can be omitted.

Command	Parameters	Default unit	Remark
[SOURce<[1]|2>:]BB:CFACtor		dB	Query only
[SOURce<[1]|2>:]BB:POWer:PEAK		dBfs	Query only
[SOURce<[1]|2>:]BB:POWer:RMS		dBfs	Query only

[SOURce<[1]|2>:]BB:CFACtor?

This command queries the crest factor of the baseband signal .

The command is a query command and therefore has no *RST value.

Example: `"BB:CFAC?"`
'queries the crest factor of the baseband signal.

*RST value	Resolution	Options	SCPI
-	-	B13 and B9/B10/B11 SOURce2 only with second B13 option	Device-specific

[SOURce<[1]|2>:]BB:POWer:PEAK?

This command queries the peak level of the baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

The command is a query command and therefore has no *RST value.

Example: `"BB:POW:PEAK?"`
'queries the peak level of the baseband signal.

*RST value	Resolution	Options	SCPI
-	-	B13 and B9/B10/B11 SOURce2 only with second B13 option	Device-specific

[SOURce<[1]|2>:]BB:POWer:RMS?

This command queries the rms level of the baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

The command is a query command and therefore has no *RST value.

Example: `"BB:POW:RMS?"`
'queries the rms level of the baseband signal.

*RST value	Resolution	Options	SCPI
-	-	B13 and B9/B10/B11 SOURce2 only with second B13 option	Device-specific

SOURce:BBIN Subsystem

SOURce-BBIN Subsystem - External Baseband Input

The SOURce:BBIN subsystem contains the commands for setting the external digital and analog baseband signals.

The external baseband signal A can be routed to path A, path B, or both paths. External baseband signal B can be routed to path B only.

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]BBIN:ALEVel:EXECute			No query
[SOURce<[1]|2>:]BBIN:CFACtor	0 ... 100 dB	dB	
[SOURce<[1]|2>:]BBIN:FOFFSet	-40 MHz ... +40 MHz	Hz	
[SOURce<[1]|2>:]BBIN:GIMBalance	-3.0 dB ... +3.0 dB	0 dB	
[SOURce<[1]|2>:]BBIN:IQSWap[:STATe]	ON | OFF		
[SOURce<[1]|2>:]BBIN:MODE	ANALog | DIGital | EBOX		
[SOURce<[1]|2>:]BBIN:MPER	1 s ... +32 s	s	
[SOURce<[1]|2>:]BBIN:OFFSet:I	-10.0 ... +10.0 %FS	%FS	
[SOURce<[1]|2>:]BBIN:OFFSet:Q	-10.0 ... +10.0 %FS	%FS	
[SOURce<[1]|2>:]BBIN:OLOad:STATe			Query only
[SOURce<[1]|2>:]BBIN:PGAin	-50 dB ... +50 dB	dB	
[SOURce<[1]|2>:]BBIN:POWer:PEAK	-10 .. 0	dBfs	
[SOURce<[1]|2>:]BBIN:POWer:RMS			Query only
[SOURce<[1]|2>:]BBIN:ROUTe	A | B | AB		
[SOURce<[1]|2>:]BBIN:SKEW	-1 ns ... +1 ns	s	
[SOURce<[1]|2>:]BBIN:SRATe[:ACTual]	400 Hz ... 100 MHz		Query only
[SOURce<[1]|2>:]BBIN:SRATe:SOURce	USER		Query only
[SOURce<[1]|2>:]BBIN:STATe	ON | OFF		

[SOURce<[1]|2>:]BBIN:ALEVel:EXECute

This command starts measuring the input signal. The measurement estimates the crest factor and the peak power.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"BBIN:ALEV:EXEC"`
'starts measuring the input signal.

*RST value	Resolution	Options	SCPI
		B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:CFACtor 0 ... 100 dB

This command enters the crest factor of the external baseband signal.

Example: `"BBIN:CFAC 10"`
'enters a crest factor of 10 dB for the external baseband signal.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:FOFFset -40 MHz ... +40 MHz

This command enters the frequency offset for the external baseband signal. The offset affects the signal on the output of the **Baseband** block.

The complex I/Q bandwidth of the shifted useful signal must not exceed 80 MHz in total. The following applies:

$$f_{offset} - {f_{use}}/{2} \geq -{80}/{2}\,MHz \quad \text{and} \quad f_{offset} + {f_{use}}/{2} \leq +{80}/{2}\,MHz$$

f_{use} = the complex useful bandwidth of the I/Q signal before the offset.
f_{offset} = frequency offset.

Example: `"BBIN:FOFF 2 MHz"`
'sets a frequency offset of 2 MHz.

*RST value	Resolution	Options	SCPI
0 Hz	0.01 Hz	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:GIMBalance -3.0 dB ... +3.0 dB

This command enters a gain to the Q component of the external baseband signal.

Example: `"SOUR:BBIN:GIMB -1.0dB"`
'amplifies the Q component of the external input signal with -1.0 dB.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:IQSWap[:STATe] ON | OFF

This command swaps the I and Q channel if set to ON.

Example: `"BBIN:IQSW ON"`
'swaps the I and Q channel of the external baseband signal.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:MODE ANALog | DIGital | EBOX

This command selects the external input signal mode for the **Baseband In** block.

Parameters: **ANALog**
The external analog baseband signal is supplied via the inputs **I** and **Q**.

DIGital
The external digital baseband signal is fed into the signal path via the **Digital Input** connector. The internal signal processing is based on a sample rate of 100 MHz. Input signals with a sample rate less than 100 MHz are upsampled. The sample rate can be estimated or defined by the user in the appropriate entry fields.

EBOX
This mode is reserved for future extensions.

Example: `"BBIN:SOUR ANAL"`
'selects an external analog signal as the input signal. The signal must be applied at the inputs **I** and **Q**.

*RST value	Resolution	Options	Dependencies	SCPI
ANALog	-	B9/B10/B11 and B13 B17	-	Device-specific

[SOURce<[1]|2>:]BBIN:MPERiod 1 s ... 32 s

Sets the recording duration for measuring the baseband input signal by Auto Level Set.

Example: `"BBIN:MPER 4s"`
'sets the recording duration for Auto Level Set to 4 seconds.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:OFFSet:I -10.0 ... +10.0 %FS

This command enters a DC offset to the I component of the external baseband signal.

Example: `"SOUR:BBIN:OFFS:I +2.5PCT"`
'sets +2.5 %FS DC offset to the I component of the external input signal.

*RST value	Resolution	Options	SCPI
0.0 %FS	0.001 %FS	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:OFFSet:Q -10.0 ... +10.0 %FS

This command enters a DC offset to the Q component of the external baseband signal.

Example: `"SOUR:BBIN:OFFS:Q -0.1PCT"`
'sets -0.1 %FS DC offset to the Q component of the external input signal.

*RST value	Resolution	Options	SCPI
0.0 %FS	0.001 %FS	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:OLOAd:STATe?

This command queries the overload state of the A/D converter.

The command is a query command and therefore does not have an *RST value.

Example: `"BBIN:OLO:STAT?"`
'queries the overload state.

Response: `"0"`
'the AC/DC converter is not overloaded.

*RST value	Resolution	Options	SCPI
		B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:PGAin -50 dB ... +50 dB.

This command enters the relative gain for the external baseband signal compared with the signals of the other baseband sources. The actual gain of the different baseband signals depends not only on the path gain setting but also on the signal characteristics such as the crest factor and on the number of used sources. The gain affects the signal on the **Baseband In** block output**.**

Example: `"SOUR:BBIN:PGA 3dB"`
'sets the relative gain of 3 dB for the external baseband signal.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:POWer:PEAK -10 ... 0 dBfs

This command enters the peak level of the external baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Example: `"BBIN:POW:PEAK -2"`
'enters the peak level of -2 dBfs.

*RST value	Resolution	Options	SCPI
0	0.01 dBfs	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:POWer:RMS

This command queries the rms level of the external digital baseband signal.

The command is a query command and therefore does not have an *RST value.

Example: `"BBIN:POW:RMS?"`
'queries the estimated rms level.

*RST value	Resolution	Options	SCPI
		B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:ROUTe A | B | AB

This command selects the signal route for the external baseband signal of a two-path instrument.

Parameter:

A
The external baseband signal is introduced into path A. The signals are summed if necessary.

B
The external baseband signal is introduced into path B. The signals are summed if necessary.

AB
The external baseband signal is introduced into path A and path B. The signals are summed if necessary.

Example: `"BBIN:ROUT A"`
'the external baseband signal is introduced into path A.

*RST value	Resolution	Options	SCPI
A	-	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:SKEW -1 ns ... +1 ns

This command determines the delay between Q and I channel. Positive values represent a delay for Q versus I.

Example: `"BBIN:SKEW -23PS"`
'enters a delay between Q and I channel of 23 picoseconds.

*RST value	Resolution	Options	SCPI
0	1 ps	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:SRATe[:ACTual]ACTual]

This command queries the sample rate of the external digital baseband signal.

Note:
Currently, only the sample rate of 100 MHz is available. For future upgrades the allowed value range for the sample rate will amount 400 Hz to 100 MHz.

The command is a query command and therefore does not have an *RST value.

Example: `"BBIN:SRAT?"`
'queries the sample rate value of the external digital baseband signal.

*RST value	Resolution	Options	SCPI
	-	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:SRATe:SOURce USER | DINSOURce]

This command queries the source for estimating the sample rate of the digital input signal or defining it by the user.

Note:
*Currently, only the sample rate source **User Defined** is available. For future upgrades the sample rate can be automatically estimated by selecting the source **Digital I/Q In**.*

The command is a query command and therefore does not have an *RST value.

Example: `"BBIN:SRAT:SOUR?"`
'queries the sample rate mode of the external digital baseband signal.

*RST value	Resolution	Options	SCPI
USER	-	B9/B10/B11 and B13 B17	Device-specific

[SOURce<[1]|2>:]BBIN:STATe ON | OFF

This command switches the feeding of an external analog signal into the signal path on/off.

Example: `"BBIN:SOUR ANAL"`
'selects an external analog signal as the input signal. The signal must be applied at the inputs **I** and **Q**.

`"BBIN:STAT ON"`
'switches on the Baseband In block. The external analog signal is A/D-converted and fed into the digital signal.

*RST value	Resolution	Options	SCPI
OFF	-	B9/B10/B11 and B13 B17	Device-specific

SOURce:FSIMulator-Subsystem

SOURce - FSIMulator Subsystem

This subsystem contains the commands needed to configure the fading simulator.

Dual-channel fading is possible when the instrument is fitted with the options B14 (Fading Simulator) and B15 (Path Extension). Unlike the SOURce subsystem SOURce2, it is the second fader which responds here and not the second baseband path in dual-path instruments.

SOURce<1> = Fader A

SOURce2 = Fader B

The dynamic fading configurations Birth Death and Moving Propagation and the Fine Delay configurations are available with option K71.

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:GRID	0 ... <10 µs	s	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:MAXimum		s	Query only
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:MINimum	0 ... < 40 µs	s	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:FDOPpler			Query only
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:FRATio	-1.0 ... +1.0		
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:HOPPing:DWELl	1ms ... (2^32-1) ns	s	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:PATH<[1]|2>:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:PATH<[1]|2>:PROFile	PDOPpler		
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:POSition	3 ... 11		
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:SOFFset	1ms .. (2^32-1) us	s	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:SPEed	0 ... 479.67 m/s	Km/h	
[SOURce<[1]|2>:]FSIMulator:BIRThdeath:STATe	ON | OFF		
[SOURce]:FSIMulator:CATalog?			Query only
[SOURce<[1]|2>:]FSIMulator:COPY:DESTination	1 ...4 / 1... 8		
[SOURce<[1]|2>:]FSIMulator:COPY:EXECute			No query
[SOURce<[1]|2>:]FSIMulator:COPY:SOURce	1 ...4 / 1... 8		
[SOURce<[1]|2>:]FSIMulator:COUPle:LOGNormal:CSTD	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:COUPle:LOGNormal:LCONstant	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:COUPle:SPEed	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:CSPeed	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:ADELay	0.0 ... 40.0E-6 s		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:BDELay	0.0 ... 2.56E-3 s	s	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:CORRelation:COEFficient	0.0 ... 100.0 PCT	PCT	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:CORRelation:PHASe	0.0 ... 359.9 DEG	RAD	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:CORRelation:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3 >:CPHase	0.0 ... 359.9 DEG	RAD	

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:FDOPpler	0.0 ... 1000.0 Hz	Hz	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:FRATio	-1.0 ... +1.0		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:CSTD	0.0 ... 12.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:LCONstant	0.0 ... 200.0 m	Meter	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:PRATio	-30.0 ... +30.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:PROFile	PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe		
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:RDELay			Query only
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:SPEed	0.0 ... 27778.0 m/s	M/s	
[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL30:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:ADELay	0.0 ... 40.0E-6 s		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:BDELay	0.0 ... 2.56E-3 s		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:COEFficient	0.0 ... 100.0 PCT	PCT	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:PHASe	0.0 ... 359.9 DEG	RAD	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CPHase	0.0 ... 359.9 DEG	RAD	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:FDOPpler	0.0 ... 1000.0 Hz	Hz	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:FRATio	-1.0 ... +1.0		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:CSTD	0 ... 12 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:LCONstant	0.0 ... 200.0 m	Meter	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:PRATio	-30.0 ... +30.0	dB	

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:PROFile	PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:RDELay			Query only
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:SPEed	0.0 ... 27778.0 m/s		
[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DEL50:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:ADELay	0.0 ... 40.0E-6 s		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:BDELay	0.0 ... 2.56E-3 s		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:COEFficient	0.0 ... 100.0 PCT	PCT	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:PHASe	0.0 ... 359.9 DEG	RAD	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CPHase	0.0 ... 359.9 DEG	DEG	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:FDOPpler	0.0 ... 1000.0 Hz	Hz	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:FRATio	-1.0 ... +1.0		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:CSTD	0.0 ... 12.0 m/s		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:LCONstant	0.0 ... 200.0 m	Meter	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:PRATio	-30.0 ... +30.0	dB	
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:PROFile	PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:RDELay			Query only
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:SPEed	0.0 ... 27778.0 m/s		
[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DELay:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:DELETE	<file name>		No query
[SOURce]:FSIMulator:EXTension	A1 | A1EXT | B1EXT		
[SOURce<[1]|2>:]FSIMulator:FREQuency	100.0E3 ... 6.0E9		
[SOURce<[1]|2>:]FSIMulator:ILOSs:CSAMples			Query only

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:ILOSs:MODE	NORMal | LACP | USER		
[SOURce<[1]|2>:]FSIMulator:ILOSs[:LOSS]	0.0 ... 10.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:LOAD	<file name>		No query
[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:DELay:MEAN	1.5 µs ... 1688 µs	s	
[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:DELay:VARiation	0.3 ... 100 µs	s	
[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:VPERiod	10 ... 500 s	s	
[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:DELay	0.0 ... 1638 µs	s	
[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:LOSS	0.0 ... 50.0 dB	dB	
[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:MDELay:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:PRESet			No query
[SOURce<[1]|2>:]FSIMulator:RESTart			No query
[SOURce<[1]|2>:]FSIMulator:RESTart:MODE	AUTO | MANual | INTernal | EXT1 | EXT2		
[SOURce]:FSIMulator:ROUTe	FAA | FAAFBA | FAAFBB | FABFBB | FAABFBAB | FAMAXA | FAMAXAB | FBMAXB | FBMAXAB		
[SOURce<[1]|2>:]FSIMulator:SPEed:UNIT	MPS | KMH | MPH		

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:STANdard	USER | CDMA8 | CDMA30 | C1DMA30 | CDMA100 | CDMA0 | CDMA3 | G6TU3 | GTU3 | G6TU50 | GTU50 | G6HT100 | GHT100 | GRA250 | GET50 | GET100 | HL2A | HL2B | HL2C | HL2D | HL2C | NADC8 | NADC50 | NADC100 | P6TU1 | PTU1 | P6TU50 | PTU50 | P6HT100 | PHT100 | PRA130 | PET50 | PET100 | TTU | TBU | THT | T4ET | TDU | TDR | G3C1 | G3C2 | G3C3 | G3C4 | G3UEC1 | G3UEC2 | G3UEC3 | G3UEC4 | G3UEC5 | G3UEC6 | G3UEC7SE | G3UEC7BE | G3UEC8CQ | G3UEPA3 | G3UEPB3 | G3UEVA30 | G3UEVA120 | G3TU3 | G3TU50 | G3TU120 | G3HT120 | G3RA120 | G3RA250 | BD1 | MP1 | DABRA04 | DABRA06 | DABTU12 | DABTU06 | DABSFN | WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75 | WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75 | WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75 | WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75 | WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50 | WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 | WMITUOIPA | WMITUOIPB | WMITIVA		
[SOURce<[1]|2>:]FSIMulator:STANdard:REFerence	<string>		
[SOURce<[1]|2>:]FSIMulator:STORe	<file name>		No query
[SOURce<[1]|2>:]FSIMulator[:STATe]	ON | OFF		

Command	Parameter	Default unit	Comment
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:DELay:MINimum	0 ... 1638 µs	µs	
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:DELay:MAXimum	0 ... 1638 µs	µs	Query only
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | FDOPpler			Query only
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:FRATio	-1.0 ... +1.0		
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:LOSS	0 dB...50 dB	dB	
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:PROFile	SPATh | PDOPpler | RAYLeigh		
[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:STATe	ON | OFF		
[SOURce<[1]|2>:]FSIMulator:TCInterferer:SPEed	0.0 ... 479,67 m/s		
[SOURce<[1]|2>:]FSIMulator:TCInterferer:MMODe	SLIDing | HOPPing		
[SOURce<[1]|2>:]FSIMulator:TCInterferer:PERiod	0.1 s...1000 s		

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:GRID 0 ... 10 µs

This command sets the delay grid for both paths with birth death propagation fading. The selected delay grid defines the resolution of the possible hopping positions for the two fading paths in the delay range. The delay range is defined by the minimum delay (`FSIM:BIRThdeath:DELay:MIN`), the delay grid (`FSIM:BIRThdeath:DELay:GRID`) and the number of possible hop positions (`FSIM:BIRThdeath:POSitions`).

Example: "`FSIM:BIRT:DEL:GRID 0.00001`"
'sets a delay grid of 10 µs.

*RST value	Resolution	Options	SCPI
1 µs	1 ns	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:MAXimum?

This command queries the maximum delay for both paths with birth death propagation fading. The maximum delay is defined by the minimum delay (`FSIM:BIRThdeath:DELay:MIN`), the delay grid (`FSIM:BIRThdeath:DELay:GRID`), and the number of possible hop positions (`FSIM:BIRThdeath:POSitions`).

The command represents a query and thus has no *RST value.

Example: "FSIM:BIRT:DEL:MIN 0.000012"
'sets a minimum delay of 12 µs.

"FSIM:BIRT:DEL:GRID 0.000002"
'sets a delay grid of 2 µs.

"FSIM:BIRT:POS 9"
'sets 9 possible hop positions.

"FSIM:BIRT:DEL:MAX?"
'queries the maximum delay.

Response: "0.000028"
'the maximum delay is 28 µs. The delay range lies between +12 and +28 µs. There are 9 hop positions on a 2 µs grid available.

*RST value	Resolution	Options	SCPI
-	-	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:DELay:MINimum 0 ... < 40 µs

This command sets the minimum delay for both paths with birth death propagation fading. The minimum delay corresponds to the start value of the delay range.

Example: "FSIM:BIRT:DEL:MIN 0.000008"
'sets a 8 µs minimum delay.

*RST value	Resolution	Options	SCPI
0 µs	1 ns	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:POSitions 3 ... 11

This command sets the number of possible hop positions in the delay range. The delay range is defined by the minimum delay (`FSIM:BIRThdeath:DELay:MIN`), the delay grid (`FSIM:BIRThdeath:DELay:GRID`) and the number of possible hop positions (`FSIM:BIRThdeath:POSitions`).

0 µs < (`...:BIRT:POS` – 1) x `...:DEL:GRID` + `...:DEL:MIN` < 40 µs

Example: `"FSIM:BIRT:POS 11"`
'sets 11 possible delay positions.

*RST value	Resolution	Options	SCPI
11	1	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:FDOPpler?

This command queries the Doppler frequency with birth death propagation. The Doppler frequency is determined by the entered speed (command `SOURce:FSIM:BIRT:SPEed`) and by the entered ratio of the actual Doppler frequency to the set Doppler frequency (command `SOURce:FSIM:BIRT:FRATio`).

The command is a query and thus has no *RST value.

Example: `"FSIM:BIRT:FDOP?"`
'queries the resulting Doppler frequency.

Response: "55"
'the resulting Doppler frequency is 55 Hz.

*RST value	Resolution	Options	SCPI
		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:FRATio -1.0 ... +1.0

This command sets the ratio of the actual Doppler frequency to the set Doppler frequency with birth death propagation fading.

Example: `"FSIM:BIRT:FRAT 0.5"`
'sets a frequency ratio of 0.5 for both fading paths.

*RST value	Resolution	Options	SCPI
1	0.05	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:HOPPing:DWELl 1ms.. (2^32-1) ns

This command enters the time until the next change in the delay of a path (birth death event).

Example: `"FSIM:BIRT:HOPP:DWEL 210 ms"`
'sets a dwell time of 210 ms until the next change in the delay of a fading path.

*RST value	Resolution	Options	SCPI
191 ms	10 ns	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:PATH<[1]|2>:LOSS 0.0 ... 50.0 dB

This command sets the loss of the paths with birth death propagation.

Example: `"FSIM:BIRT:PATH2:LOSS 4 dB"`
'sets a loss of 4 dB for the second fading path.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:PATH<[1]|2>:PROFile PDOPpler

This command queries the fading profile. In birth death propagation, the pure Doppler profile is used.

The command represents a query and thus has no *RST value.

Parameter: **PDOPpler**

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by two parameters: Speed (`SOURce:FSIM:BIRThdeath:SPEed`) and Frequency Ratio (`SOURce:FSIM:BIRThdeath:FRATio`).

Example: `"FSIM:BIRT:PATH2:PROF?"`
'queries the profile of the second fading path.

*RST value	Resolution	Options	SCPI
PDOPpler	-	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:SOFFset 1ms .. (2^32-1) us

This command sets the time until the start of the next birth death event. With dual-channel fading, this allows the user to intentionally displace the birth death events of the two faders with respect to one another.

Example: `"FSIM:BIRT:SOFF 21E-6"`
'sets a start offset of 21 us.

*RST value	Resolution	Options	SCPI
0 s	10 ns	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:SPEed 0 m/s ... 479.67 m/s

This command sets the speed **v** of the moving receiver for birth death propagation. Based on the speed **v** and the virtual RF frequency f_{RF}, the Doppler frequency f_D is computed.

$$c = 2.998 \cdot 10^8 \, m/s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

If the speed is changed, the resulting Doppler shift is automatically modified. The resulting Doppler shift is a function of the speed **v** and the entered ratio of the actual Doppler shift to the set Doppler shift (Frequency Ratio - `SOURce:FSIM:BIRT:FRATio)` and can be queried with the command `SOURce:FSIM:BIRT:FDOPpler`.

Available speed units are km/h, m/s and mph. The unit is selected with the command `:SOURce:FSIMulator:SPEed:UNIT`.

Example: `"FSIM:SPE:UNIT MPS"`
'sets the unit for entering the speed to m/s.

`"FSIM:BIRT:SPE 2"`
'sets a speed of 2 m/s on both fading paths.

*RST value	Resolution	Options	SCPI
0 m/s	0.1 m/s	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:BIRThdeath:STATe ON | OFF

This command selects the birth death propagation fading configuration and switches the fading simulation on and off.

Example: `"SOUR2:FSIM:BIRT:STAT ON"`
'selects birth death propagation for fader B and switches on fading in path B.

*RST value	Resolution	Options	SCPI
OFF	-	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce]:FSIMulator:CATalog?

This command reads out the files with fading settings in the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified in command `:SOUR:CORR:CSET:CAT?`, in which case the files in the specified directory are read. Only files with the file ending ***.fad** are read out.

The command represents a query and thus has no *RST value.

Example: "`MMEM:CDIR 'D:\user\fading`"
'sets the default directory to D:\user\fading.

"`FSIM:CAT? `"
'reads all files from the default directory with fading settings.

Response: "`Birthdeath_3gpp`"
'the file `'Birthdeath_3GPP'` is available.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10	Device-specific

[SOURce<[1]|2>:]FSIMulator:COPY:DESTination 1 ...4 / 1... 8

This command determines the destination for the copy operation for a fading path group. It is available only for the fading configurations **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** (`SOURce:FSIM:DELay:STATe ON` or `SOURce:FSIM:DEL30|50:STATe ON`).

Example: "`FSIM:DEL:STAT ON`"
'activates the **Standard Delay** fading configuration.

"`FSIM:COPY:DEST 4`"
'sets fading group 4 as the destination for the copy operation.

"`FSIM:COPY:SOUR 1`"
'sets fading group 1 as the source for the copy operation.

"`FSIM:COPY:EXEC`"
'copies the settings from group 1 to group 4.

*RST value	Resolution	Options	SCPI
2		Option B14 Options B13 and B10 SOURce2 only with option B15 Range of values 5 to 8 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:COPY:EXECute

This command causes the copy operation to execute for a fading path group. The source group settings are copied to the destination group. This command is available only for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations (`SOURce:FSIM:DELay:STATe ON` or `SOURce:FSIM:DEL30|50:STATe ON`).

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:COPY:DEST 4"`
'sets fading group 4 as the destination for the copy operation.

`"FSIM:COPY:SOUR 1"`
'sets fading group 1 as the source for the copy operation.

`"FSIM:COPY:EXEC"`
'copies the settings from group 1 to group 4.

*RST value	Resolution	Options	SCPI
-		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:COPY:SOURce 1 ...4 / 1... 8

This command determines the source for the copy operation for a fading path group. It is available only for the fading configurations **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** (`SOURce:FSIM:DELay:STATe ON` or `SOURce:FSIM:DEL30|50:STATe ON`).

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:COPY:DEST 4"`
'sets fading group 4 as the destination for the copy operation.

`"FSIM:COPY:SOUR 1"`
'sets fading group 1 as the source for the copy operation.

`"FSIM:COPY:EXEC"`
'copies the settings from group 1 to group 4.

*RST value	Resolution	Options	SCPI
1		Option B14 Options B13 and B10 SOURce2 only with option B15 Range of values 5 to 8 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:COUPle:LOGNormal:CSTD ON | OFF

This command couples the setting for the lognormal standard deviation for the paths of both faders. A change in the standard deviation in one fader leads to a corresponding change in the other path.

Example: `"FSIM:ROUT FAAFBB"`
'the fading signal from fader A is output on path A and the fading signal from fader B is output on path B.

`"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader A.

`"SOUR2:FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader B.

`"FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'activates lognormal fading for fading path 2 of fader A.

`"SOUR2:FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'activates lognormal fading for fading path 2 of fader B.

`"FSIM:COUP:LOGN:CSTD ON"`
'activates coupling of the standard deviation of the two paths. The settings in fader A are transferred to fader B.

*RST value	Resolution	Options	Dependencies	SCPI
Off	-	Options B14 and B15 Options B13 and B10	Activation of coupling sets the standard deviation setting (`SOURce:FSIM:...:GROup:PATH:LOGN:CSTD`) of the second fader to that of the first fader for which coupling was activated. After activation, any change in one of the two faders is automatically made in the other fader as well.	Device-specific

[SOURce<[1]|2>:]FSIMulator:COUPle:LOGNormal:LCONstant ON | OFF

With lognormal fading, this command couples the setting of the **Local Constant** for the paths of both faders. A change in the local constant in one fader leads to a corresponding change in the second fader.

Example: `"FSIM:ROUT FAAFBB"`
‘the fading signal from fader A is output on path A and the fading signal from fader B is output on path B.

`"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader A.

`"SOUR2:FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader B.

`"FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'activates lognormal fading for fading path 2 of fader A.

`"SOUR2:FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'activates lognormal fading for fading path 2 of fader B.

`"SOUR2:FSIM:COUP:LOGN:LCON ON"`
'activates coupling of the local constants in both faders. The settings in fader B are transferred to fader A.

*RST value	Resolution	Options	Dependencies	SCPI
Off	-	Options B14 and B15 Options B13 and B10	Activation of coupling sets the local constant setting (`SOURce:FSIM:...:GROup:PATH:LOGN:LCON`) of the second fader to that of the first fader for which coupling was activated. After activation, any change in one of the two faders is automatically made in the other fader as well.	Device-specific

[SOURce<[1]|2>:]FSIMulator:COUPle:SPEed ON | OFF

This command couples the setting for the speed for the paths of both faders. A change in the speed in one fader leads to a corresponding change in the second fader. The **Common Speed for all Paths** setting is also coupled (`SOURce:FSIM:CSPeed`).

Example: `"FSIM:ROUT FAAFBB"`
'the fading signal from fader A is output on path A and the fading signal from fader B is output on path B.

`"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader A.

`"SOUR2:FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader B.

`"FSIM:COUP:SPE ON"`
'activates coupling of the speed for the paths of both faders. The settings in fader A are transferred to fader B.

*RST value	Resolution	Options	Dependencies	SCPI
Off	-	Options B14 and B15 Options B13 and B10	Activation of coupling sets the speed settings (`SOURce:FSIM:...:GROup:PATH:SPEed` and `SOURce:FSIM:CSPeed`) of the second fader to that of the first fader for which coupling was activated. After activation, any change in one of the two faders is automatically made in the other fader as well.	Device-specific

[SOURce<[1]|2>:]FSIMulator:CSPeed ON | OFF

This command determines whether or not the same speed is set for all of the activated fading paths. When set to On, a change in the speed for one path automatically leads in a change in the speed for all other paths.

This command is available only in the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations (`SOURce:FSIM:DELay:STATe ON` or `SOURce:FSIM:DEL30|50:STATe ON`).

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:CSP ON"`
'activates coupling of the speed for all active fading paths.

*RST value	Resolution	Options	Dependencies	SCPI
ON	-	Option B14 Options B13 and B10 SOURce2 only with option B15	If coupling of the speed is activated in instruments with two faders (`SOURce:FSIM:COUPled:SPEed ON`), this parameter is also coupled. When coupling is activated, the settings of the path for which coupling is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:ADELay 0.0 ... 40.0E-6 s

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:ADELay 0.0 ... 40.0E-6 s

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:ADELay 0.0 ... 40.0E-6 s

These commands determine the path-specific delay (**Additional Delay)** of the selected path for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay. No **Additional Delay** can be entered for path 1 of group 1.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:ADEL 10E-6"`
'sets an Additional Delay of 10 µs for fading path 2.

*RST value	Resolution	Options	SCPI
0	Standard Delay: 10 ns Fine Delay : 10 ps	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:BDELay 0.0 ... 2.56E-3 s

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:BDELay 0.0 ... 2.56E-3 s

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:BDELay 0.0 ... 2.56E-3 s

These commands determine the group delay (**Basic Delay)** for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. Within a group, all of the paths are jointly delayed by this value. The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay. The Basic Delay of group 1 is always equal to 0.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:BDEL 1E-3"`
'sets a delay of 1 ms for fading group 2. This value applies to all of the paths in the group.

*RST value	Resolution	Options	SCPI
0.0 ns	10 ns	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:CORRelation:COEFficient 0.0 ... 100.0 PCT

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:COEFficient 0.0 ... 100.0 PCT

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:COEFficient 0.0 ... 100.0 PCT

These commands determine the magnitude of the complex correlation coefficient for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations (`SOURce:FSIM:...:GROup:PATH:CORR:STATe ON`). The higher the entered percentage, the greater the correlation of the statistical fading processes for the two paths. Highly correlated ambient conditions for the signal are simulated in this manner.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:CORR:STAT ON"`
'switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

`"FSIM:DEL:GRO2:PATH:CORR:COEF 95"`
'specifies a correlation coefficient of 95% for the two paths.

*RST value	Resolution	Options	Dependencies	SCPI
100 PCT	5 PCT	Option B14 and option B15 Options B13 and B10 Fine Delay configurations only with option K71	Sets the correlation coefficient of the correlated path of the second fader also to the entered value.	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:CORRelation:PHASe 0.0... 359.9 DEG

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:PHASe 0.0... 359.9 DEG

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:PHASe 0.0... 359.9 DEG

These commands determine the phase of the complex correlation coefficient for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:CORR:STAT ON"`
'switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

`"FSIM:DEL:GRO2:PATH:CORR:PHAS 5"`
'specifies a phase of the correlation coefficient equal to 5 DEG for the two paths.

*RST value	Resolution	Options	Dependencies	SCPI
0	0.1 DEG	Option B14 and option B15 Options B13 and B10 Fine Delay configurations only with option K71	Sets the phase of the correlation coefficient of the correlated path of the second fader also to the entered value.	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:CORRelation:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CORRelation:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CORRelation:STATe ON | OFF

These commands switch on correlation of the paths of the first fader to the corresponding paths of the second fader for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. This command is available only if dual-channel mode is selected for the faders (`FSIM:ROUT FAAFBB`). The suffix in `SOURce` defines the fader on which path settings the correlation is based.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:CORR:STAT ON"`
'switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

*RST value	Resolution	Options	Dependencies	SCPI

0	0.1 DEG	Options B14 and B15
		Options B13 and B10
		Fine Delay configurations only with option K71
			When correlation is activated, the settings of the correlation parameters, the profile, the speed and the lognormal parameters are the same for both paths (`SOUR:FSIM:...:GROup:PATH:CORR:STAT`
			`SOUR:FSIM:...:GROup:PATH:CORR:COEF`
			`SOUR:FSIM:...:GROup:PATH:CORR:PHAS`
			`SOUR:FSIM:...:GROup:PATH:PROFile`
			`SOUR:FSIM:...:GROup:PATH:SPEed`
			`SOUR:FSIM:...:GROup:PATH:FRATio`
			`SOUR:FSIM:...:GROup:PATH:LOGN:STATe`
			`SOUR:FSIM:...:GROup:PATH:LOGN:LCON`
			`SOUR:FSIM:...:GROup:PATH:LOGN:CSTD`).
			When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).
				Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:CPHase 0.0 ... 359.9 DEG

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:CPHase 0.0 ... 359.9 DEG

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:CPHase 0.0 ... 359.9 DEG

These commands determine the phase for constant phase and pure Doppler fading for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations (`:SOURce:FSIMulator:DELay|DEL30|DEL50:GROup:PATH:PROFile CPHase|PDOPler`).

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:PROF CPH"`
'selects the **Constant Phase** fading profile for fading path 1 of group 2.

`"FSIM:DEL:GRO2:PATH:CPH 5DEG"`
'sets a phase of 5 DEG for fading path 1 of group 2. The path is multiplied by this phase.

*RST value	Resolution	Options	SCPI
0 DEG	0.1 DEG	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:FDOPpler?

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:FDOPpler?

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:FDOPpler?

This command queries the Doppler frequency for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. The Doppler frequency is determined by the entered speed (command `SOURce:FSIM:DELay|DEL30|DEL50:GROup:PATH:SPEed`). For the **Pure Doppler** and **Rice Fading** profiles, the actual Doppler shift is a function of the entered ratio of the actual Doppler shift to the set Doppler frequency (**Frequency Ratio**, command `SOURce:FSIM:DELay|DEL30|DEL50:GROup:PATH:FRATio`).

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

The command represents a query and thus has no *RST value.

Example: `"FSIM:DEL:GRO:PATH:FDOP?"`
'queries the resulting Doppler frequency of path 1 of group 1.

Response: `"556"`
'the resulting Doppler frequency is 556 Hz.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:FRATio -1.0 ... +1.0

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:FRATio -1.0 ... +1.0

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:FRATio -1.0 ... +1.0

These commands enter the ratio of the actual Doppler frequency to the set Doppler frequency for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations for Rice and pure Doppler fading. The Frequency Ratio serves as a measure of the angle of incidence between the transmitter and receiver.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

The command represents a query and thus has no *RST value.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:PROF RICE"`
'sets the Rice fading profile for the second fading path of group 1.

`"FSIM:DEL:GRO:PATH2:FRAT -0.71"`
'sets a frequency ratio of -0.71 for the second fading path of group 1. This corresponds to an angle of incidence of about 45° with respect to a receiver that is going away from the transmitter.

*RST value	Resolution	Options	Dependencies	SCPI
1	0.05	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`), the frequency ratio of both paths is set to the same value. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:CSTD 0.0 ... 12.0 dB

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:CSTD 0.0 ... 12.0 dB

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:CSTD 0.0 ... 12.0 dB

These commands enter the standard deviation for lognormal fading for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'selects lognormal fading for fading path 2 of group 1.

`"FSIM:DEL:GRO:PATH2:LOGN:CSTD 2"`
'sets a standard deviation of 2 dB for fading path 2 of group 1.

*RST value	Resolution	Options	Dependencies	SCPI
0 dB	1dB	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`) or two faders are coupled (`SOUR:FSIM:COUPling:CSTD ON`), the lognormal parameters of both paths/all paths are set to the same values. When correlation/coupling is activated, the settings of the path/fader for which correlation/coupling is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths/faders (no matter in which path/fader it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:LCONstant 0.0 ... 200.0 m

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:LCONstant 0.0 ... 200.0 m

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:LCONstant 0.0 ... 200.0 m

These commands enter the Local Constant for lognormal fading for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

The lower setting limit is a function of the virtual RF frequency $\mathbf{f_{RF}}$.

The following holds: $L_{min} = \dfrac{12 \cdot 10^9 m/s}{f_{RF}}$

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'selects lognormal fading for fading path 2 of group 1.

`"FSIM:DEL:GRO:PATH2:LOGN:LCON 100"`
'sets a Local Constant of 100 m for the second fading path of group 1.

*RST value	Resolution	Options	Dependencies	SCPI
100 m	0.1 m	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`) or two faders are coupled (`SOUR:FSIM:COUPling:LCONstant ON`), the lognormal parameters of both paths/all paths are set to the same values. When correlation/coupling is activated, the settings of the path/fader for which correlation/coupling is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths/faders (no matter in which path/fader it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOGNormal:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOGNormal:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOGNormal:STATe ON | OFF

These commands switch lognormal fading on or off for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:LOGN:STAT ON"`
'activates lognormal fading for fading path 2 of group 1.

*RST value	Resolution	Options	Dependencies	SCPI
OFF		Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`), the lognormal parameters of both paths are set to the same values. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:LOSS 0.0 ... 50.0 dB

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:LOSS 0.0 ... 50.0 dB

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:LOSS 0.0 ... 50.0 dB

These commands set the loss of the paths for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:LOSS 2 dB"`
'sets a loss of 2 dB for fading path 2 of group 1.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:PRATio -30.0 ... + 30.0 dB

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:PRATio -30.0 ... + 30.0 dB

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:PRATio -30.0 ... + 30.0 dB

These commands set the power ratio of the discrete and distributed components for Rice fading (`:SOURce:FSIMulator:DELay:GROup:PATH2:PROFile RICE"`) for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:PROF RICE"`
'sets the Rice fading profile for fading path 2 of group 1.

`"FSIM:DEL:GRO:PATH2:PRAT -15"`
'sets a power ratio of –15 dB. The distributed (Rayleigh) component prevails. The total power of the two components remains constant.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:PROFile PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:PROFile PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:PROFile PDOPpler | SPATh | RAYLeigh | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe

These commands select the fading profile for the paths for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Parameter:

SPAT

A static transmission path is simulated which can only undergo attenuation (loss) or delay.

PDOPpler

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by two parameters: **Speed** (`SOURce:FSIM:DELay|DEL30|DEL50:GROup:PATH:SPEed`) and **Frequency Ratio** (`SOURce:FSIM:DEL|DEL30|DEL50:GROup:PATH:FRATio`).

RAYLeigh

A radio hop is simulated in which many highly scattered subwaves arrive at a moving receiver. The resulting received amplitude varies over time. The probability density function of the magnitude of the received amplitude is characterized by a Rayleigh distribution. The fading spectrum is a classic Doppler spectrum.

RICE

A radio hop is simulated in which a strong direct wave (discrete component) arrives at a moving receiver in addition to many highly scattered subwaves. The probability density of the magnitude of the received amplitude is characterized by a Rice distribution. The fading spectrum of an unmodulated signal involves the superimposition of the classic Doppler spectrum with a discrete spectral line.

CPHase

A radio hop is simulated without any direct waves or randomly occurring waves (no discrete and no static component). The path is multiplied by a constant pointer corresponding to the path-specific parameter.

OGAUs

GAUS1 is the sum of two Gaussian functions and is used for excess delay times in the range of 0,5 μs to 2 μs (0,5 μs ≤ τi ≤ 2 μs).

(GAUS1) $S(\tau_i,f) = G\,(A, -0{,}8f_d, 0{,}05f_d) + G\,(A_1, +0{,}4f_d, 0{,}1f_d)$

where A1 is 10 dB below A.

TGAUs

GAUS2 is also the sum of two Gaussian functions and is used for paths with delays in excess of 2 μs (τi ≥ 2 μs).

(GAUS2) $S(\tau_i,f) = G\,(B, +0{,}7f_d, 0{,}1f_d) + G\,(B_1, -0{,}4f_d, 0{,}15f_d)$

where B1 is 15 dB below B.

DGAUs

GAUSDAB is composed of a Gaussian function and is used for special DAB profiles.

(GAUSDAB) $S(\tau_i, f) = G\,(A, \pm 0{,}7f_d, 0{,}1f_d)$

WDOPpler

Selects the WM Doppler fading profile.

WRICe

Selects the WM Rice fading profile.

Example: `"FSIM:DEL:STAT ON"`

'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:PROF RICE"`

'sets the Rice fading profile for fading path 2 of group 1.

*RST value	Resolution	Options	Dependencies	SCPI
RAYLeigh		Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`), the same profile is set on both paths. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:RDELay?

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:RDELay?

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:RDELay?

These commands query the Resulting Delay of the paths for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. The Resulting Delay is the sum of the Basic Delay (`SOURce:FSIM:DELay|DELay30|DELay50:BDELay`) and the Additional Delay (`SOURce:FSIM:DELay|DELay30|DELay50:ADELay`).

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

The command represents a query and thus has no *RST value.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO2:PATH:BDEL 2E-4"`
'sets a Delay Offset of 200 µs for group 2.

`"FSIM:DEL:GRO2:PATH2:ADEL 1E-5"`
'sets an Additional Delay of 10 µs for fading path 2 of group 2.

`"FSIM:DEL:GRO2:PATH2:RDEL?"`
'queries the Resulting Delay for fading path 2 of group 2.

Response: "`0.00021`"
'the Resulting Delay is 210 µs.

*RST value	Resolution	Options	SCPI
-	-	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:SPEed 0.0 ... 27778.0 m/s

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:SPEed 0.0 ... 27778.0 m/s

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:SPEed 0.0 ... 27778.0 m/s

These commands set the speed **v** of the moving receiver for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. Based on the speed **v** and the virtual RF frequency f_{RF}, the Doppler frequency f_D is computed.

$$c = 2.998 \cdot 10^8 \, m/s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

The resulting Doppler shift for Rice and pure Doppler fading is a function of the speed **v** and the entered ratio of the actual Doppler shift to the set Doppler shift f_D (Frequency Ratio `SOUR:FSIM:DEL|DEL30|DEL50:GROup:PATH:FRATio)` and can be queried with the commands `SOUR:FSIM:DELay|DEL30|DEL50:GROup:PATH:FDOPpler`. The resulting Doppler frequency may not exceed the maximum Doppler frequency of 1600 Hz. If the speed is changed, the resulting Doppler shift is automatically modified.

The unit of speed is selected with the command `:SOURce:FSIMulator:SPEed:UNIT`. Available speed units are km/h, m/s, and mph.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:SPE:UNIT MPS"`
'sets the unit for entering the speed to m/s.

`"FSIM:DEL:GRO:PATH2:SPE 2"`
'sets a speed of 2 m/s for the moving receiver for fading path 2 of group 1.

*RST value	Resolution	Options	Dependencies	SCPI
0 m/s	0.1 m/s	Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	When two paths are correlated (`SOUR:FSIM:...:GRO:PATH:CORR:STAT ON`) and when two faders are coupled (`SOUR:FSIM:COUP:SPEed ON`), the same speed is set on both / all paths. When correlation/coupling is activated, the setting of the path/fader for which correlation/coupling is switched on is accepted for both paths/faders. Afterwards, the most recent modification applies to both paths/faders (no matter in which path/fader it was made).	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:GROup<[1]|2...8>:PATH<[1]|2|3>:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DEL50:GROup<[1]|2...8>:PATH<[1]|2>:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DELay:GROup<[1]|2...8>:PATH<[1]|2...5>:STATe ON | OFF

These commands activate the selected path for the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations.

`GROup<5...8>` is only available for the signal routings `SOURce:FSIMulator:ROUTe FBMAXB|FAMAXA|FAMAXAB |FBMAXAB`.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration.

`"FSIM:DEL:GRO:PATH2:STAT ON"`
'activates fading path 2 in group 1.

*RST value	Resolution	Options	SCPI
OFF		Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 and GROup<5...8> only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:DEL30:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DEL50:STATe ON | OFF

[SOURce<[1]|2>:]FSIMulator:DELay:STATe ON | OFF

These commands activate the **Standard Delay** and **Fine Delay 30 MHz** / **50 MHz** fading configurations. These three configurations differ in terms of the maximum number of paths (20 / 12 / 8 or 40 / 24 / 16), the resolution of the Additional Delay (10 ns / 5 ns /10 ps), and the available RF bandwidth (limited to 30 MHz for Fine Delay 30 MHz).

At the same time the fading simulator is switched on or off.

Important:
Changing the configuration will cause an interruption in the fading process, followed by a restart after about one second. If the instrument is fitted with two faders (options B14 and B15), this applies to both faders since the FPGAs in the instrument are rebooted and loaded with the modified configuration.

Example: `"FSIM:DEL:STAT ON"`
'activates the **Standard Delay** fading configuration for fader A and switches on fading for path A.

*RST value	Resolution	Options	SCPI
OFF		Option B14 Options B13 and B10 Fine Delay configurations only with option K71 SOURce2 only with option B15	Device-specific

[SOURce]:FSIMulator:DELETE <file name>

This command deletes the specified file containing a fading setting from the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. Only files with the file ending ***.fad** are deleted.

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"MMEM:CDIR 'D:\user\fading'"`
'sets the default directory to D:\user\fading.

`"FSIM:CAT?"`
'reads all files from the default directory with fading settings.

Response: `"Birth_3gpp"`
'the file `'Birthdeath_3GPP'` is available.

`"FSIM:DELETE 'Birth_3gpp'"`
'deletes the file `'Birthdeath_3GPP'`.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:FREQuency 100.0E3 ... 6.0E9

This command sets the virtual RF frequency. The entered value is used as the basis for computing the Doppler shift.

Example: `"FSIM:FREQ 2GHz"`
'sets the virtual frequency to 2 GHz.

*RST value	Resolution	Options	SCPI
1 GHz	0.01 Hz	Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:ILOSs:CSAMples

This command queries the share of samples which were clipped due to the insertion loss setting.

The command represents a query and thus has no *RST value.

Example: `"FSIM:ILOS:CSAM?"`
'queries the share of samples which were clipped.

Response: `"11"`
'11% of the samples were clipped.

*RST value	Resolution	Options	SCPI
-		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:ILOSs:MODE NORMal | LACP | USER

This command sets the insertion loss of the fading simulator.

Parameter: **NORMal**

The minimum insertion loss for a path of the fading simulator is set to a fixed value of 18 dB. The value is chosen so that even when lognormal fading is switched on, overdrive will occur only very rarely in the fading simulator. This setting is recommended for BERTs.

LACP

The minimum insertion loss is between 6 and 12 dB. This value is dependent upon the **Path Loss** setting of the fading paths which are switched on. **Low ACP** mode is only recommended for fading paths with Raleigh profile. Only in this case statistical distribution of level fluctuation is ensured. For other fading profiles, non-statistical level fluctuations occur which lead to an enormous increase of clipping. However, monitoring the percentage of clipped samples is recommended for Raleigh paths also.

USER

Any value for the minimum insertion loss in the range from 0 dB to 18 dB can be selected. Enter the value using the `[SOURce]:FSIMulator:ILOSs[:LOSS]` command.

Example: `"FSIM:ILOS:MODE USER"`
'chooses the user-defined setting for the insertion loss.

`"FSIM:ILOS 4 dB"`
'sets the minimum insertion loss to 4 dB.

*RST value	Resolution	Options	SCPI
NORMal	-	Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:ILOSs[:LOSS] 0.0 ... 10.0 dB

This command sets the user-defined insertion loss of the fading simulator when **User** is selected.

In the **Normal** and **Low ACP** modes, the current setting of the value can be queried.

Example: `"FSIM:ILOS:MODE USER"`
'chooses the user-defined setting for the insertion loss.

`"FSIM:ILOS 4 dB"`
'sets the minimum insertion loss to 4 dB.

*RST value	Resolution	Options	SCPI
0.0 dB	0.1 dB	Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:LOAD <file name>

This command loads the specified file containing a fading setting from the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. Only files with the file ending ***.fad** are loaded.

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"MMEM:CDIR 'D:\user\fading"`
'sets the default directory to D:\user\fading.

`"FSIM:CAT? "`
'reads all files from the default directory with fading settings.

Response: `"Birth_3gpp"`
'the file `'Birthdeath_3GPP'` is available.

`"FSIM:LOAD 'Birth_3gpp'"`
'loads the fading settings from the file `'Birthdeath_3GPP'`.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:DELay:MEAN <numeric_value>

This command sets the mean delay of the moving fading path for moving propagation.

Example: `"FSIM:MDEL:STAT ON"`
'sets moving propagation.

`"FSIM:MDEL:MOV:DEL:VAR  1E-5"`
'sets the range 10 µs (+/- 5 µs) for the variation of the delay of the moving fading path.

`"FSIM:MDEL:MOV:DEL:MEAN  9E-6"`
'sets the mean delay of the moving path to 9 µs.

`"FSIM:MDEL:MOV:VPER 105"`
'sets a period of 105 s for the sinusoidal variation of the delay of the moving path. The delay of the moving path now varies once sinusoidally in 105 s between 4 µs and 14 µs.

*RST value	Resolution	Options	SCPI
3.5 µs	0.1 µs	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:DELay:VARiation 0.3 ... 100 µs

This command enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidally within this range.

Example: `"FSIM:MDEL:MOV:DEL:VAR 1E-5"`
'sets the range 10 µs for the delay of the moving fading path.

*RST value	Resolution	Options	SCPI
5 µs	0.1 ìs	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:LOSS 0.0 ... 50.0 dB

This command enters the insertion loss of the moving path for moving propagation.

Example: `"FSIM:MDEL:MOV:LOSS 12 dB"`
'sets the loss for the moving fading path.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:STATe ON | OFF

This command activates the moving fading path for moving propagation.

Example: `"FSIM:MDEL:STAT ON"`
'sets moving propagation.

`"FSIM:MDEL:MOV:STAT ON"`
'activates the moving path for moving propagation.

*RST value	Resolution	Options	SCPI
ON		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:MOVing:VPERiod 10 ... 500 s

This command sets the speed of the delay variation of the moving fading path for moving propagation. A complete cycle comprises one pass through this **Variation Period**.

Example: `"FSIM:MDEL:MOV:VPER 100 s"`
'sets the period for the delay variation to 100 s.

*RST value	Resolution	Options	SCPI
157 s	0.01 s	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:DELay 0.0 ... 1638 µs

This command enters the delay of the reference path for moving propagation.

Example: `"FSIM:MDEL:REF:DEL  1E-5"`
'sets the range to 10 µs for the delay of the reference path.

*RST value	Resolution	Options	SCPI
1 µs	0.01 µs	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:LOSS 0.0 ... 50.0 dB

This command enters the loss of the reference path for moving propagation.

Example: `"FSIM:MDEL:REF:LOSS  12 dB"`
'sets the insertion loss for the reference path.

*RST value	Resolution	Options	SCPI
0 dB	0.1 dB	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:REFerence:STATe ON | OFF

This command activates the reference path for moving propagation.

Example: `"FSIM:MDEL:STAT ON"`
'sets moving propagation.

`"FSIM:MDEL:REF:STAT ON"`
'activates the reference path for moving propagation.

*RST value	Resolution	Options	SCPI
ON		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:MDELay:STATe ON | OFF

This command activates the moving propagation fading configuration. The paths and the fading simulator must be switched on separately (`SOURce:FSIMulator:MDELay:MOVing|REFerence:STATe ON` and `SOURce:FSIMulator ON`).

Example: `"FSIM:MDEL:STAT ON"`
'sets moving propagation for fader A.

*RST value	Resolution	Options	SCPI
OFF		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:PRESet

This command sets the default settings (preset) for fading simulation.

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"FSIM:PRES"`
'resets fading simulation to the default values.

*RST value	Resolution	Options	Dependencies	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	:FSIM:STAN CDMA8 :FSIM:DEL:STAT ON :FSIM:SPE:UNIT KMH :FSIM:REST:MODE AUTO :FSIM:COUP:... OFF :FSIM:ILOS:MODE NORM :FSIM:DEL:GRO1:PATH1:STAT ON :FSIM:DEL:GRO1:PATH1:PROF RAYL :FSIM:DEL:GRO<n>:PATH<n>:STAT OFF	Device-specific

[SOURce<[1]|2>:]FSIMulator:RESTart

This command triggers a restart of fading simulation if manual restart is chosen (`FSIMulator:RESTart:MODE MANual`). For two-channel fading, a restart is triggered for both faders if manual restart is chosen for both faders.

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"FSIM:REST:MODE MAN"`
'selects manual mode for triggering a restart.

`"FSIM:REST"`
'triggers a restart of fading simulation. The fading process begins at a defined start point.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:RESTart:MODE AUTO | MANual | INTernal | EXT1 | EXT2

This command selects how a restart of fading simulation is triggered.

Parameter:

AUTO
The modulation signal is continually faded.

MANual
A restart is triggered by the command `[SOURce]:FSIMulator:RESTart`.

INTernal
A restart is triggered by the trigger which is selected for the associated baseband.

EXT1|2
A restart is triggered by an external trigger on the jack TRIGGER 1 or TRIGGER 2.

Example:

`"FSIM:REST:MODE MAN"`
'selects manual mode for triggering a restart.

`"FSIM:REST"`
'triggers a restart of fading simulation.

*RST value	Resolution	Options	SCPI
AUTO		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce]:FSIMulator:ROUTe FAA | FAAFBB | FAAFBA | FABFBB | FAABFBAB | FAMAXA | FBMAXB | FAMAXAB | FBMAXAB

This command selects on which baseband path the faded signal is output (dual-path instruments only). The input signal of the fader is selected with command `SOURce:BB:ROUTe`.

For one-path instruments this command is query only. It returns value `FAA` (Fader A always outputs the signal on baseband A).

Parameter:

FAA
The faded modulation signal of fader A is placed on baseband path A. If the instrument is equipment with option B15, 40 fading paths are available for fader A.

FAAFBB
The faded modulation signal of fader A is placed on baseband path A and the faded modulation signal of fader B is placed on baseband path B. 20 fading paths are available for each fader (requires option B15).

FAAFBA
The faded modulation signal of fader A and B is placed on baseband path A. 20 fading paths are available for each fader (requires option B15).

FABFBB
The faded modulation signal of fader A and B is placed on baseband path B. 20 fading paths are available for each fader (requires option B15).

FAABFBAB
The faded modulation signal of fader A and B is placed on baseband paths A and B. 20 fading paths are available for each fader (requires option B15).

FAMAXA
The faded modulation signal of fader A is placed on baseband path A. 40 fading paths are available for fader A. Fader B is switched off (requires option B15).

FBMAXB
The faded modulation signal of fader B is placed on baseband path B. 40 fading paths are available for fader B. Fader A is switched off (requires option B15).

FAMAXAB
The faded modulation signal of fader A is placed on baseband paths A and B. If the instrument is equipment with option B15, 40 fading paths are available for fader A and the signal from fader B is not output, the signal flow of baseband B is interrupted.

FBMAXAB
The faded modulation signal of fader B is placed on baseband paths A and B. 40 fading paths are available for fader B. The signal from fader A is not output, the signal flow of baseband A is interrupted (requires option B15).

Example: `"FSIM:ROUT FAMAXA"`
'places the faded baseband signal of fader A on baseband path A. 40 fading paths are available and fader B is switched off.

*RST value	Resolution	Options	SCPI
1 fader: FAA		Options B14	Device-specific

2 faders: FAAFBB		Options B13 and B10 FAAFBA | FAAFBB | FABFBB | FAMAXA | FBMAXB | FBMAXAB: option B15 and second option B10 FAMAXAB: second option B10	

[SOURce<[1]|2>:]FSIMulator:SPEed:UNIT MPS | KMH | MPH

This command chooses the default unit for the speed (commands `...:SPEed`).

Example: `"FSIM:SPE:UNIT MPS"`
'sets meters per second as the default unit for the speed.

*RST value	Resolution	Options	SCPI
MPS		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:STANdard USER | CDMA8 | CDMA30 | C1DMA30 | CDMA100 | CDMA0 | CDMA3 | G6TU3 | GTU3 | G6TU50 | GTU50 | G6HT100 | GHT100 | GRA250 | GET50 | GET100 | HL2A | HL2B | HL2C | HL2D | HL2C | NADC8 | NADC50 | NADC100 | P6TU1 | PTU1 | P6TU50 | PTU50 | P6HT100 | PHT100 | PRA130 | PET50 | PET100 | TTU | TBU | THT | T4ET | TDU | TDR | G3C1 | G3C2 | G3C3 | G3C4 | G3UEC1 | G3UEC2 | G3UEC3 | G3UEC4 | G3UEC5 | G3UEC6 | G3UEC7SE | G3UEC7BE | G3UEC8CQ | G3UEPA3 | G3UEPB3 | G3UEVA30 | G3UEVA120 | G3TU3 | G3TU50 | G3TU120 | G3HT120 | G3RA120 | G3RA250 | BD1 | MP1 | DABRA04 | DABRA06 | DABTU12 | DABTU06 | DABSFN | WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75 | WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75 | WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75 | WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75 | WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50 | WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 | WMITUOIPA | WMITUOIPB | WMITIVA

This command selects a predefined fading simulator setting which complies with the test specifications found in the common mobile radio standards. For a detailed summary of all of the default settings, see description of the **Standard / Test Case** selection parameter.

Parameter: **USER**

USER parameter cannot be set. A query returns this value if a user-defined Fading setting was loaded or if one of the associated settings was changed subsequent to the selection of a standard

CDMA0 | CDMA3 | CDMA8 | CDMA30 | C1DMA30 | CDMA100

CDMA 1, 2 and 3 path

NADC8 | NADC50 | NADC100

NADC 2 path

G6TU3 | GTU3 | G6TU50 | GTU50

GSM Typical Urban 6 and 12 path

v

G6HT100 | GHT100

GSM Hilly Terrain 6 and 12 path

GRA250

GSM Rural Area 6 path

GET50 | GET100

GSM Equal Test 6 path

P6TU1 | PTU1 | P6TU50 | PTU50

DCS1800/PCS1900 Typical Urban 6 and 12 path

P6HT100 | PHT100

DCS1800/PCS1900 Hilly Terrain 6 and 12 path

PRA130

DCS1800/PCS1900 Rural Area 6 path.

PET50 | PET100
DCS1800/PCS1900 Equal Test 6 path

TTU
Tetra Typical Urban 2 path

TBU
Tetra 2 path

THT
Tetra Hilly Terrain 2 path

TET | T4ET
Tetra Equal Test 3 and 4 path

TDU
Tetra Mode Direct Mode Rural Propagation Model 1 path

TDR
Tetra Mode Urban Propagation Mode 1 path

G3C1 | G3C2 | G3C3 | G3C4
3GPP FDD Test Case x (BS)

G3UEC1 | G3UEC2 | G3UEC3 | G3UEC4 | G3UEC5 | G3UEC6
3GPP FDD UE Test Case x (UE)

G3UEC7SE
3GPP FDD UE Sector (UE)

G3UEC7BE
3GPP FDD Beam (UE)

G3UEC8CQ
3GPP FDD CQI (UE)

G3UEPA3
3GPP FDD Pedestrian A 4 path (UE)

G3UEPB3
3GPP FDD Pedestrian B 6 path (UE)

G3UEVA30 | G3UEVA120
3GPP FDD Vehicular A 6 path (UE)

G3TU3 | G3TU50 | G3TU120
3GPP FDD Typical Urban 20 path

G3HT120
3GPP FDD Hilly Terrain 20 path

G3RA120 | G3RA250
3GPP FDD Rural Area 10 path

HL2A | HL2B | HL2C | HL2D | HL2E
WLAN HyperLan 18 path

DABRA04 | DABRA06
DAB Rural Area 4 and 6 path

BD1
3GPP Bith Death 2 path

MD1
3GPP Moving Propagation 2path

DABTU12 | DABTU06
DAB Typical Urban 12 and 6 path

DABSFN
DAB Single Frequency Network (in the VHF range) 7 path

WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75
Modified Stanford University Interim Channel Model, Terrain Type C (Flat/light tree density) 3 path

WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75
Modified Stanford University Interim Channel Model, Terrain Type C (Flat/light tree density) 3 path

WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75
Modified Stanford University Interim Channel Model, Terrain Type B (Hilly, light tree density or flat/moderate-to-heavy tree density) 3 path

WMSUI4A360P90 | WMSUI4A360P75| WMSUI4A030P90 | WMSUI4A030P75
Modified Stanford University Interim Channel Model, Terrain Type B (Hilly, light tree density or flat/moderate-to-heavy tree density) 3 path

WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50
Modified Stanford University Interim Channel Model, Terrain Type A (Hilly, moderate-to-heavy tree density) 3 path

WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50

Modified Stanford University Interim Channel Model, Terrain Type A (Hilly, moderate-to-heavy tree density) 3 path

WMITUOIPA | WMITUOIPA | WMITUVA
Wimax ITU

Example: `"FSIM:STAN THT"`
'selects settings in conformity with Tetra Hilly Terrain 200 (with two fading paths).

*RST value	Resolution	Options	SCPI
USER		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:STANdard:REFerence <string>

This command queries the reference in the standard for the selected test case default.

Example: `"FSIM:STAN WC1BUP2"`
'selects settings in conformity with 3GPP FDD Test Case 1 (with two fading paths).

`"FSIM:STAN:REF?`
'queries the reference in the standard.

Response: `"3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2"`
'the test case is defined in the specified reference.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:STORe <file name>

This command saves the current fading simulator settings in the specified file in the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. The file ending ***.fad** is automatically used.

This command triggers an event and thus does not have a query format or an *RST value.

Example: `"MMEM:CDIR 'D:\user\fading"`
'sets the default directory to D:\user\fading.

`"FSIM:STOR 'delay_3gpp'"`
'saves the current fading simulator settings of fader A in the file `'delay_3gpp'`.

*RST value	Resolution	Options	SCPI
		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator[:STATe] ON | OFF

This command activates fading simulation.

Example: `"FSIM ON"`
'activates fading simulation in baseband path A with the current settings.

*RST value	Resolution	Options	SCPI
OFF		Option B14 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:DELay:MAXimum 0 ... 1638 µs

This command sets the maximum delay for the moving path.

Example: `"FSIM:TCI:DEL:MAX 0.000200"`
'sets a 200 µs maximum delay for the reference path.

*RST value	Resolution	Options	SCPI
110 µs (Reference Path)	1 ns	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:DELay:MINimum 0 ... 1638 µs

This command sets the minimum delay for either the reference path or the moving path.

Example: `"FSIM:TCI:REF:DEL:MIN 0.000008"`
'sets a 8 µs minimum delay for the reference path.

*RST value	Resolution	Options	SCPI
40 µs (Reference Path) 0 µs (Moving Path)	0.1 µs	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:FDOPpler?

This command queries the Doppler frequency with 2 channel interferer fading. The Doppler frequency is determined by the entered speed (command `SOURce:FSIM:TCI:SPEed`) and by the entered ratio of the actual Doppler frequency to the set Doppler frequency (command `SOURce:FSIM:TCI:FRATio`).

The command is a query and thus has no *RST value.

Example: `"FSIM:TCI:REF:FDOP?"`
'queries the resulting Doppler frequency for the reference path.

Response: "55"
'the resulting Doppler frequency is 55 Hz.

*RST value	Resolution	Options	SCPI
		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:FRATio -1.0 ... +1.0

This command sets the ratio of the actual Doppler frequency to the set Doppler frequency with 2 channel interferer fading.

Example: `"FSIM:TCI:FRAT 0.5"`
'sets a frequency ratio of 0.5 for both fading paths.

*RST value	Resolution	Options	SCPI
1	0.05	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:LOSS 0.0 dB...50.0 dB

This command sets the loss of the paths for 2 channel interferer fading.

Example: `"FSIM:TCI:REF:LOSS 10"`
'sets a loss of 10 db for the reference path for fader A.

*RST value	Resolution	Options	SCPI
0	0.1 dB	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:PROFile SPATh | PDOPpler | RAYLeigh

This command selects the fading profile to be used for 2 channel interferer fading.

Parameter: **SPATh**

A static transmission path is simulated which can only undergo attenuation (loss) or delay.

PDOPpler

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by two parameters: **Speed** (`SOURce:FSIM:TCI:SPEed`) and **Frequency Ratio** (`SOURce:FSIM:TCI:FRATio`).

RAYLeigh

A radio hop is simulated in which many highly scattered subwaves arrive at a moving receiver. The resulting received amplitude varies over time. The probability density function of the magnitude of the received amplitude is characterized by a Rayleigh distribution. The fading spectrum is a classic Doppler spectrum.

Example: `"FSIM:TCI:REF:PROF SPAT"`

'selects the static path profile for the reference path of the **2 Channel Interferer Fading** configuration for fader A.

*RST value	Resolution	Options	SCPI
SPATh		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:SPEed 0 m/s ... 479.67 m/s

This command sets the speed **v** of the moving receiver for 2 channel interferer fading. Based on the speed **v** and the virtual RF frequency $\mathbf{f_{RF}}$, the Doppler frequency $\mathbf{f_D}$ is computed.

$$c = 2.998 \cdot 10^8 \, m/s \qquad \frac{v}{c} = \frac{f_D}{f_{RF}}$$

If the speed is changed, the resulting Doppler shift is automatically modified. The resulting Doppler shift is a function of the speed **v** and the entered ratio of the actual Doppler shift to the set Doppler shift (Frequency Ratio - `SOURce:FSIM:TCI:FRATio`) and can be queried with the command `SOURce:FSIM:TCI:FDOPpler`.

Example: `"FSIM:TCI:SPE 2"`

'sets a speed of 2 m/s on both fading paths.

*RST value	Resolution	Options	SCPI
0.83 m/s	0.1 m/s	Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:REFerence | MOVing:STATe ON | OFF

This command activates the 2 channel interferer fading configuration. The paths and the fading simulator must be switched on separately (`SOURce:FSIMulator:TCInterferer:MOVing|REFerence:STATe ON` and `SOURce:FSIMulator ON`).

Example: `"FSIM:TCI:REF:STAT ON"`
'activates the reference path of the **2 Channel Interferer Fading** configuration for fader A.

*RST value	Resolution	Options	SCPI
OFF		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:MMODe SLIDing | HOPPing

This command selects the type of moving applied to the moving path.

Parameter:

SPATh
The reference path has a fix delay while the delay of the moving path varies slowly in a sinusoidal way.

HOPPing
The reference path has a fix delay while the delay of the moving path appears or disappears in alternation at arbitrary points.

Example: `"FSIM:TCI:MMOD SLID"`
'selects the **Sliding** mode for the moving path.

*RST value	Resolution	Options	Dependencies	SCPI
HOPPing		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	For `FSIM:TCI:MMOD SLID`, the command `FSIM:TCI:PER` sets the period for a complete cycle of the moving path. For `FSIM:TCI:MMOD HOPP`, the command `FSIM:TCI:PER` sets the dwell time of the moving path.	Device-specific

[SOURce<[1]|2>:]FSIMulator:TCInterferer:PERiod 0.1 s...1000 s

The command enters either the dwell time or the period for a complete cycle of the moving path.

The set time depends on the setting of the moving mode: `FSIM:TCI:MMOD SLID` selects the sliding mode for the moving path and therefore `FSIM:TCI:PER` sets the period for a complete cycle for the the moving path. `FSIM:TCI:MMOD HOPP` selects the hopping mode for the moving path and therefore `FSIM:TCI:PER` sets the dwell time for the moving path.

Example: `"FSIM:TCI:MMOD SLID"`
'selects the **Sliding** mode for the moving path.

`"FSIM:TCI:PER 50"`
'sets the time for a complete cycle of the moving path to 50 s.

*RST value	Resolution	Options	SCPI
2.9 s (for hopping mode) 160 s (for sliding mode)		Options B14 and K71 Options B13 and B10 SOURce2 only with option B15	Device-specific

SOURce-ROSCillator Subsystem

This subsystem contains the commands for setting the external and internal reference frequency.

In the case of two-path instruments, this setting is effective for all paths. No suffix should therefore be specified under SOURce.

Command	Parameters	Default unit	Remark
[SOURce:]ROSCillator:EXTernal:FREQuency	5 MHz | 10 MHz | 13 MHz	Hz	
[SOURce:]ROSCillator[:INTernal]:ADJust[:STATe]	ON | OFF		
[SOURce:]ROSCillator[:INTernal]:ADJust:VALue	0 ... 4095		
[SOURce:]ROSCillator:SOURce	INTernal | EXTernal		

[SOURce:]ROSCillator:EXTernal:FREQuency 5 MHz | 10 MHz | 13 MHz

The command informs the instrument of the frequency of the external reference. An external reference signal with a frequency of 5 MHz, 10 MHz or 13 MHz can be used.

Example: `"ROSC:SOUR EXT"`
'selects the external source. The reference must be input at the REF IN input.

`"ROSC:EXT:FREQ 5 MHz"`
'informs the instrument that the external reference frequency is 5 MHz.

*RST value	Resolution	Options	SCPI
10 MHz	-	-	Compliant

[SOURce:]ROSCillator[:INTernal]:ADJust:VALue 0 ... 4095

The command specifies the frequency correction value (adjustment value).

Example: `"ROSC:ADJ:VAL 500"`
'sets the adjustment value to 500.

*RST value	Resolution	Options	SCPI
1400	1		Device specific

[SOURce:]ROSCillator[:INTernal]:ADJust[:STATe] ON | OFF

The command determines whether the calibrated (OFF) or a user-defined (ON) adjustment value is used for fine adjustment of the frequency. With STATe ON, the instrument is no longer in the calibrated state.

Example: `"ROSC:SOUR INT"`
'selects the internal source.

`"ROSC:ADJ ON"`
'activates use of a user-defined adjustment value.

`"ROSC:ADJ:VAL 1400"`
'sets the adjustment value to 1400.

*RST value	Resolution	Options	SCPI
OFF	-	-	Device specific

[SOURce:]ROSCillator:SOURce INTernal | EXTernal

The command selects between internal and external reference frequency.

Parameters: **INTernal**
The internal reference oscillator is used.

EXTernal
An external reference signal is used. It must be input at the REF IN connector at the rear of the instrument. The instrument is informed of the frequency of the external reference signal by means of the command `SOURce:ROSCillator:EXTernal:FREQuency`.

Example: `"ROSC:SOUR EXT"`
'selects the external source.

`"ROSC:EXT:FREQ 5 MHz"`
'informs the instrument that the external reference has a frequency of 5 MHz.

*RST value	Resolution	Options	SCPI
INTernal	-	-	Device specific

SOURce-INPut Subsystem

The SOURce:INPut subsystem contains the commands for configuring the inputs for trigger, data and control signals.

A common trigger threshold and input impedance is effective for all trigger and control signal inputs (path A and path B). The settings influence the digital modulations, the generation of waveforms or multicarrier signals, and all digital standards. Irrespective of this, a common threshold and input impedance is effective for the serial and parallel data input (path A only). These data sources are available for digital modulation (**Custom Digital Modulation**).

Command	Parameters	Default unit	Remark
[SOURce:]INPut:DATA:IMPedance	G50 | G1K		
[SOURce:]INPut:DATA:THReshold	0 ... 2 V		
[SOURce:]INPut:TRIGger:BBANd:SLOPe	POSitive | NEGative		
[SOURce:]INPut:TRIGger:IMPedance	G50 | G1K		
[SOURce:]INPut:TRIGger:LEVel	0 ... 2 V ??		
[SOURce:]INPut:TRIGger:SLOPe	POSitive | NEGative		

[SOURce:]INPut:DATA:IMPedance G50 | G1K

The command sets the impedance of all data inputs.

The setting affects the serial data input DATA at the front of the instrument and the serial data inputs DATA at the AUX I/O interface at the rear of the instrument.

Example: `"INP:DATA:IMP G50"`
'all data inputs are set to 50 Ohm to ground.

*RST value	Resolution	Options	SCPI
G1K	-	B9/10/11 and B13	Device-specific

[SOURce:]INPut:DATA:THReshold 0 ... 2 V

The command sets the high/low threshold of the data inputs in the baseband section. In the case of positive polarity, this threshold determines the point as of which a signal is high (active) or low (inactive).

The setting affects the serial data input DATA at the front of the instrument and the serial data inputs DATA at the AUX I/O interface at the rear of the instrument.

Example: `"INP:DATA:THR 1 V"`
'a high/low threshold of 1 volt is set at all data inputs of the baseband section. The signal is high (active) for a signal voltage of 1 volt and higher.

*RST value	Resolution	Options	SCPI
1 V	-	B9/10/11 and B13	Device-specific

[SOURce:]INPut:TRIGger:BBANd:SLOPe POSitive | NEGative

The command sets the active slope of an externally applied trigger signal at the **TRIGGER** 1 | 2 connectors. The setting is effective for both connectors at the same time.

Example: `"INP:TRIG:BBAN:SLOP NEG"`
'the active slope of the external trigger signal at the TRIGGER 1 and 2 connector is the falling slope.

*RST value	Resolution	Options	SCPI
POSitive	-	B9/10/11 and B13	Device-specific

[SOURce:]INPut:TRIGger:IMPedance G1K | G50

The command sets the impedance of the trigger and control signal inputs.

The setting affects the TRIGGER 1 and 2, and CLOCK inputs (BNC connectors at the front of the instrument), and the CW, BURST, and LEV_ATT inputs (AUX I/O interface at the rear of the instrument).

Parameters: **G1K**
1 kOhm to ground.

G50
50 Ohm to ground.

Example: `"INP:TRIG:IMP G50"`
'all trigger and control signal inputs are set to 50 ohm to ground. This setting is recommended in the case of high clock rates.

*RST value	Resolution	Options	SCPI
G1K	-	B9/10/11 and B13	Device-specific

[SOURce:]INPut:TRIGger:LEVel 0 ... 2 V

The command sets the high/low threshold of the trigger and control signal inputs in the baseband section. In the case of positive polarity, this threshold determines the point as of which a signal is high (active) or low (inactive).

The setting affects the TRIGGER 1 and 2, and CLOCK inputs (BNC connectors at the front of the instrument), and the CW, BURST, and LEV_ATT inputs (AUX I/O interface at the rear of the instrument).

Example: `"INP:TRIG:LEV 1 V"`
'a high/low threshold of 1 volt is set at all trigger and control signal inputs of the baseband section. In the case of positive polarity, the signal is high (active) for a signal voltage of 1 volt and higher.

*RST value	Resolution	Options	SCPI
1 V	-	B9/10/11 and B13	Device-specific

[SOURce:]INPut:TRIGger:SLOPe POSitive | NEGative

The command sets the active slope of an externally applied trigger signal at the INST TRIG inputs (BNC connector at the rear of the instrument for path A, pin at the AUX I/O interface for path B). The setting is effective for both inputs at the same time.

Example: `"INP:TRIG:SLOP NEG"`
'the active slope of the external trigger signal at the INST TRIG inputs (BNC connector and AUX I/O interface) is the falling slope.

*RST value	Resolution	Options	SCPI
POSitive	-		Device-specific

SOURce-IQ-OUTPut Subsystem - I/Q Output

This subsystem contains the commands for switching on/off the I/Q output function blocks as well as for selecting level settings displayed in the status bar.

The digitally modulated signals can either be output directly or converted to analog I/Q baseband output signals. The analog signal can be output single-ended or differential. The differential output requires the option R&S AMU-B16, Differential I/Q Out. The digital output requires the option R&S AMU-B18, Digital I/Q Out. Two-path instruments require each a second option for the differential output and for the digital output.

The output function blocks can be activated separately and independently for the two I/Q outputs.

The suffix under SOURce distinguishes the outputs:
SOURce[1] = path A
SOURce2 = path B

The keyword SOURce is optional with commands for the I/Q output of path A and can be omitted. The commands of the I/Q output of path B must contain the keyword together with the suffix 2.

Command	**Parameters**	**Default unit**	**Remark**
OUTPut:IQ:ALL[:STATe]	ON | OFF		
[SOURce<[1]|2>:]IQ:OUTPut:DISPlay	ANALog | DIGital	ANALog	
[SOURce<[1]|2>:]IQ:OUTPut:POWer:VIA	PEP | LEVel	LEVel	
[SOURce<[1]|2>:]IQ:OUTPut:STATe	ON | OFF		
[SOURce<[1]|2>:]IQ:OUTPut:SWAP[:STATe]	ON | OFF		

OUTPut:IQ:ALL[:STATe] ON | OFF

Accordingly to the BASEBD ON/OFF key, the command switches the I/Q output signals on and off. In the two-path mode, the command `OUTP:IQ:ALL:STAT OFF` switches all outputs off. A subsequent command `OUTP:IQ:ALL:STAT ON` restores the status that was active before the last switch-off. **I/Q OUT OFF** is displayed in the status bar.

The setting is valid for both paths. If a suffix is specified, an error message is generated.

Example: `"OUTP:IQ:ALL ON"`
'the I/Q output signals, which have been active before the last switch off are activated again (path A and path B).

***RST value**	**Resolution**	**Options**	**SCPI**
OFF	-	B13 SOURce2 only with a second option B13 and second options B16 and B18.	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:DISPlay ANALog | DIGital

This command displays the selected I/Q output type in the status bar.

Parameter: **ANALog**
The I/Q-signal components are output analog.
Single ended or differential analog I/Q output is to be selected in the analog I/Q output settings menu.

DIGital
The I/Q-signal components are output digital.

Example: `"DISP:IQ:OUTP:TYP ANAL"`
'the I/Q-signal components of path A are output analog.

*RST value	Resolution	Options	SCPI
ANALog		B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:POWer:VIA PEP | LEVel

This command activates the selected I/Q output level entry fields of the currently selected signal path in the status bar.

Parameter: **PEP**
The entry field of the parameter PEP is activated for level entry in the status bar.

LEVel
The entry field of the parameter Level is activated for level entry in the status bar.

Example: `"IQ:OUTP:POW:VIA PEP"`
'the I/Q-signal level is set via PEP for the signal of path A.

*RST value	Resolution	Options	SCPI
LEVel			Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:STATe ON | OFF

The command activates (ON) and deactivates (OFF) the output signals at the selected I/Q OUT function block .

Example: `"IQ:OUTP:STAT ON"`
'the I/Q output components of the baseband signal path A are activated.

*RST value	Resolution	Options	SCPI
OFF	-	B13 SOURce2 only with a second option B13 and second options B16 and B18.	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:SWap[:STATe] ON | OFF

This command swaps the I and Q signal components if set to ON.

Example: `"IQ:OUTP:SWAP ON"`
'swaps the I and Q channel of the I/Q output signal.

*RST value	Resolution	Options	SCPI
OFF	-	B13 SOURce2 only with a second option B13 and second options B16 and B18	Device-specific

SOURce-IQ-OUTPut Subsystem - Digital I/Q Outputs

This subsystem contains the commands for configuring the digital I/Q output. The digital signal can be output with the aid of a standardized (LVDS) digital user interface. The digital output requires the option Digital I/Q Out (option R&S AMU-B18).

Two-path instruments require a second option for the digital output (option R&S AMU-B18, Digital I/Q Out). The output signals can be configured separately and independently for the two I/Q outputs.

The suffix under SOURce distinguishes the outputs:
SOURce[1] = path A
SOURce2 = path B

The keyword SOURce is optional with commands for the I/Q output of path A and can be omitted. The commands of the I/Q output of path B must contain the keyword together with the suffix 2.

Command	Parameters	Default unit	Remark
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:PON	OFF | UNCHanged		
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:LEVel	-90 .. 0 dBFS	dBFS	
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:PEP	-90 .. 0 dBFS	dBFS	
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:STEP[:INCRement]	0 .. 100 dB	dB	
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:STEP:MODE	DECimal | USER		
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:SRATe	400 Hz .. 100 MHz	MHz	
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:SRATe:SOUR	USER | DIN | DOUT		
[SOURce<[1]|2>:]IQ:OUTPut:DIGital:STATe	ON | OFF		

[SOURce<[1]|2>:]IQ:OUTPut:DIGital:PON OFF | UNCHanged

This command selects the state which the digital I/Q Output is to assume after the instrument is switched on.

For two-path instruments the power-on state can be set separately for each path.

Examples: `"IQ:OUTP:DIG:PON OFF"`
'deactivates the output when the instrument is switched on.

`"IQ:OUTP:DIG:PON UNCH"`
'sets the output to the status that was active before the last switch off.

*RST value	Resolution	Options	SCPI
OFF		B13 and B18	Device-specific

[SOURce:]IQ:OUTPut:DIGital:POWer:LEV -90 dBFS .. 0 dBFS

This command sets the rms level of the digital output signal. The level entry fields and the appropriate units (dBFS) are displayed in the status bar. The level display refers to both signal components ($\sqrt{(I^2+Q^2})$).

Value range: -90 dBFS .. 0 dBFS

Example: `"IQ:OUTP:DIG:POW:LEV -10"`
'sets the output signal level to -10 dBFS.

*RST value	Resolution	Options	SCPI
0 dB	0.0001 dB	B13 and B18	Device-specific

[SOURce:]IQ:OUTPut:DIGital:POWer:PEP -90 dBFS .. 0 dBFS

This command sets the peak envelope power of the digital output signal (PEP). The level entry fields and the appropriate units (dBFS) are displayed in the status bar. The level display refers to both signal components ($\sqrt{(I^2+Q^2})$).

Value range: -90 .. 0 dBFS

Example: `"IQ:OUTP:DIG:POW:PEP -10"`
'sets the signal output level to -10 dBFS.

*RST value	Resolution	Options	SCPI
0 dB	0.01 dB, 0.01e-5	B13 and B18	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:STEP:[INCRement] 0 dB .. 100 dB

The command sets the step width for the frequency setting if the frequency values `UP/DOWN` are used and variation mode `SOUR:IQ:OUTP:DIG:POW:STEP:MODE USER` is selected. The command is linked to **Variation Step** for manual operation, i.e. the command also sets the step width of the rotary knob for **Variation Active ON**..

For two-path instruments the step width can be set separately for each path.

Example: `"SOUR:IQ:OUTP:ANAL:POW:STEP:INCR 50 mV"`
'sets the step width for the level setting to 50 mV.

*RST value	Resolution	Options	SCPI
1 dB		B13 and B18	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:DIGital:POWer:STEP:MODE DECimal | USER

This command activates (`USER`) or deactivates (`DECimal`) the user-defined step width used when varying the level value with the level values `UP/DOWN`. The command is linked to setting **Variation Active** for manual operation, i.e. the command also activates/deactivates the user-defined step width used when varying the level value with the rotary knob.

For two-path instruments the step width can be set separately for each path.

Example: `"IQ:OUTP:DIG:POW:STEP:MODE USER"`
'actives the step width for level variation with the rotary knob (manual operation) and with level values `UP/DOWN` (remote control).

*RST value	Resolution	Options	SCPI
DECimal	-	B13 and B18	Device-specific

[SOURce:]IQ:OUTPut:DIGital:SRATe 400 Hz .. 100 MHz

Using the sample rate source User (Internal Clock Source only) the command sets the sample rate value of the output signal. This command is not active for external clock sources.
Value range: 400 Hz .. 100 MHz

Note:
*Currently the entry fields **Source** and **Value** are firmly set to **User defined** and **100 MHz** and in read-only mode. For future upgrades the sample rate is intended to be automatically estimated or defined by the user.*

Example: `"IQ:OUTP:DIG:SRAT:MODE USER"`
'with sample rate source User the internally generated clock reference signal is selected.

`"IQ:OUTP:DIG:SRAT 100 MHz"`
'the sample rate for the output signal is set to 100 MHz.

*RST value	Resolution	Options	SCPI
100 MHz	0.01 Hz	B13 and B18	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:DIGital:SRATe:SOURce USER | DIN | DOUT

This command selects the source for setting the sample rate of the digital I/Q output signal.

Note:
*Currently only the source **User defined** is available for using the internally generated clock reference signal. For future upgrades the sample rate is intended to be automatically estimated by using an externally clock reference signal that is fed in at the BBIN module (**DIN**) -*
*or the sample rate is to be defined by using an externally clock reference signal that is directly fed in at the BBOUT module (**DOUT)**.*

Example: `"IQ:OUTP:DIG:SRAT:SOUR USER"`
'the internally generated clock reference signal is selected.

*RST value	Resolution	Options	SCPI
USER	-	USER only with option B13 DIN only with option B17 DOUT only with option B18 SOURce2 only with second options B13, B17 and B18	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:DIGital:STATe ON | OFF

This command switches on and off the digital I/Q output signals.

Example: `"IQ:OUTP:DIG:STAT ON"`
'the digital I/Q output signals of path A are activated.

*RST value	Resolution	Options	SCPI
OFF	-	B13 and B18 SOURce2 only with second options B13 and B18	Device-specific

SOURce-IQ-OUTPut Subsystem - Analog I/Q Outputs

This subsystem contains the commands for configuring the analog I/Q output. The analog signal can be output single-ended or differential (non-inverted). The differential output requires the option R&S AMU-B16, Differential I/Q Out.

Two-path instruments require a second option for the differential output (option R&S AMU-B16, Differential I/Q Out). The output signals can be configured separately and independently for the two I/Q outputs.

The suffix under SOURce distinguishes the outputs:
SOURce[1] = path A
SOURce2 = path B

The keyword SOURce is optional with commands for the I/Q output of path A and can be omitted. The commands of the I/Q output of path B must contain the keyword together with the suffix 2.

Command	**Parameters**	**Default unit**	**Remark**
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe]	ON | OFF	OFF	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:BIAS:I	-3.6 .. 3.6 V	V	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:BIAS:Q	-3.6 .. 3.6 V	V	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:LOAD	EMF | L50Ohm (SING) EMF | L100Ohm (DIFF)	EMF	
[SOURce<[1]|2>]:IQ:OUTPut[:ANALog]:OFFSet:I	-0.3 … +0.3 V	V	
[SOURce<[1]|2>]:IQ:OUTPut[:ANALog]:OFFSet:Q	0 … 600 mV	V	
[SOURce<[1]|2>]:IQ:OUTPut[:ANALog]:PON	OFF | UNCHanged	OFF	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:POWer:LEVel	20 mV ... 2 V (SING) 40 mV ... 4 V (DIFF)	V	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:POWer:PEP	20 mV ... 2 V (SING) 40 mV ... 4 V (DIFF)	V	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:POWer:STEP [:INCRement]	20 mV - 4 V	V	
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:POWer:STEP:MODE	ON | OFF DECimal | USER	OFF	
[SOURce<[1]|2>:]IQ:OUTPut:ANALog:STATe	ON | OFF | 1 | 0		
[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:TYPE	SINGle | DIFFerential		

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]BIAS:COUPling[:STATe] ON | OFF

This command activates/deactivates the coupling of bias setting of the I-signal and Q-signal components. For activated coupling, the setting can be done for the I-signal component, it automatically applies to the Q-signal component as well.

For two-path instruments the bias coupling can be set separately for each path.

Example: `"IQ:OUTP:BIAS:COUP ON"`
'activates coupling of bias settings of the two components.

***RST value**	**Resolution**	**Options**	**Dependencies**	**SCPI**
ON		B13 and B16	If coupling is activated, settings made for the I-signal component (`SOUR:IQ:OUT:BIAS:I`) automatically applies to the Q-signal (`SOUR:IQ:OUT:BIAS:Q`)	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]BIAS:I -3.6 ... +3.6V

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]BIAS:Q -3.6 ... +3.6V

This command sets the amplifier bias. The bias refers to the load resistance. Changing the load type, the bias setting must be adjusted. The maximum overall voltage is 3.7 V. (`SOUR:IQ:OUTPut:POW:LEV + SOUR:IQ:OUTP:BIAS:I|Q + SOUR:IQ:OUTP:OFFS:I|Q`).

For two-path instruments the I/Q bias can be set separately for each path.

Example: `"IQ:OUTP:BIAS:I 0.1 V"`
'sets a bias of 100 mV for the I-signal.

*RST value	Resolution	Options	SCPI
0 V	2mV	B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut[:ANALog]:LOAD EMF | L50Ohm | L100Ohm LOAD

This command selects the load type of the analog output signal.

Parameter:

EMF
Load Type EMF (R_{LOAD} = infinitely).

50 Ohm
Load Type 50 Ohm (R_{LOAD} = 50 Ohm).

100 Ohm
Load Type 100 Ohm (R_{LOAD} = 100 Ohm).

Examples:

`"IQ:OUTP:TYP SING"`
'selects the analog output signal type Single Ended.

`"IQ:OUTP:LOAD EMF"`
'the load type to EMF is set to the output signal.

`"IQ:OUTP:TYP DIFF"`
'selects the analog output signal type Differential.

`"IQ:OUTP:LOAD 100"`
'100 Ohm R_{LOAD} are set to the output signal.

*RST value	Resolution	Options	SCPI
EMF		B13 and B16 for differential output	Device-specific

[SOURce:]IQ:OUTPut[:ANALog]:OFFSet:I -0.3 ... +0.3 V

[SOURce:]IQ:OUTPut[:ANALog]:OFFSet:Q -0.3 ... +0.3 V

This command sets an offset between the inverting and non-inverting output. The offset refers to the load resistance. Changing the load type, the offset setting must be adjusted.
Value range: -300 mV ... +300 mV EMF. The value range is dynamically adjusted in order to respect the following constrains:
The maximum overall output voltage is:
(0.5 · Level EMF + |Bias| + 0.5 · Offset) ≤ 3.7 V.

(`SOUR:IQ:OUTPut:POW:LEV + SOUR:IQ:OUTP:BIAS:I|Q + SOUR:IQ:OUTP:OFFS:I|Q`)
The commands are only valid for the I/Q Output Type Differential (`IQ:OUTP:TYPE DIFF`).

For two-path instruments the I/Q bias can be set separately for each path.

Example: `"IQ:OUTP:TYPE DIFF"`
'the I/Q-signal components are output differential.

`"IQ:OUTP:OFFS:I 0.05 V"`
'sets an offset of 50 mV for the I-signal.

*RST value	Resolution	Options	SCPI
0 V	0.2 mV	B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]PON OFF | UNCHanged

This command selects the state which the analog I/Q Output is to assume after the instrument is switched on.

For two-path instruments the power-on state can be set separately for each path.

Examples: `"IQ:OUTP:PON OFF"`
'deactivates the output when the instrument is switched on.

`"IQ:OUTP:PON UNCH"`
'sets the output to the status that was active before the last switch off.

*RST value	Resolution	Options	SCPI
OFF		B13 and B16	Device-specific

[SOURce:]IQ:OUTPut[:ANALog]:POWer:LEVel 20 mV ... 2 V (SING) | 40 mV ... 4 V (DIFF)

This command sets the output rms voltage for both signal components (I and Q). Level Vrms refers to the load resistance. When changing the load type, the level setting must be adjusted.

Single ended Output:

Value range: 20 mV ... 2 V EMF.

The maximum overall output voltage is:

(Level EMF + |Bias|) ≤ **3.7 V**

(for the load type 50 Ohm the limit is 1.85 V).

Differential Output:

Value range: 40 mV ... 4 V EMF.

The maximum overall output voltage is:

(0.5 · PEP EMF + |Bias| + 0.5 · Offset) ≤ **3.7 V**

(for the load type 100 Ohm the limit is 1.85 V).

`(SOUR:IQ:OUTPut:POW:LEV + SOUR:IQ:OUTP:BIAS:I|Q( + SOUR:IQ:OUTP:OFFS:I|Q))`

Example: `"IQ:OUTP:POW:LEV 0.25 V"`
'sets the output rms voltage Vrms to 0.25 V.

*RST value	Resolution	Options	SCPI
1 V	0.001 V	B13 and B16	Device-specific

[SOURce:]IQ:OUTPut[:ANALog]:POWer:PEP 20 mV ... 2 V (SING) | 40 mV ... 4 V (DIFF)

This command sets the output peak envelope voltage for both signal components (I and Q). PEP Vp refers to the load resistance. Setting EMF the entire value range is available. Using 50 Ohm or 100 Ohm, the value range decreases and the PEP setting must be adjusted to the load type. The range of values changes proportional to the load type.

Single ended Output:

Value range: 20 mV ... 2 V EMF.

The maximum overall output voltage is:

(PEP EMF + |Bias|) ≤ 3.7 V

(for the load type 50 Ohm the limit is 1.85 V).

Differential Output:

Value range: 40 mV ... 4 V EMF.

The maximum overall output voltage is:

(0.5 · PEP EMF + |Bias| + 0.5 · Offset) ≤ 3.7 V

(for the load type 100 Ohm the limit is 1.85 V).

(`SOUR:IQ:OUTPut:POW:PEP + SOUR:IQ:OUTP:BIAS:I|Q( + SOUR:IQ:OUTP:OFFS:I|Q)`).

Example: `"IQ:OUTP:POW:PEP 2 V"`
'sets the output peak envelope voltage Vp to 2 V.

*RST value	Resolution	Options	SCPI
1 V	0.001 V	B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]POWer:STEP:[INCRement] 20 mV - 4.0 V

The command sets the step width for the frequency setting if the frequency values `UP/DOWN` are used and variation mode `SOUR:IQ:OUTP:POW:STEP:MODE USER` is selected. The command is linked to **Variation Step** for manual operation, i.e. the command also sets the step width of the rotary knob for **Variation Active ON**.

For two-path instruments the step width can be set separately for each path.

Example: `"SOUR:IQ:OUTP:ANAL:POW:STEP:INCR 50 mV"`
'sets the step width for the level setting to 50 mV.

*RST value	Resolution	Options	SCPI
1.000 V		B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]POWer:STEP:MODE USER | DECimal

This command activates (`USER`) or deactivates (`DECimal`) the user-defined step width used when varying the level value with the level values `UP/DOWN`. The command is linked to setting **Variation Active** for manual operation, i.e. the command also activates/deactivates the user-defined step width used when varying the level value with the rotary knob.

For two-path instruments the step width can be set separately for each path.

Example: `"IQ:OUTP:POW:STEP:MODE USER"`
'actives the step width for level variation with the rotary knob (manual operation) and with level values `UP/DOWN` (remote control).

*RST value	Resolution	Options	SCPI
DECimal	-	B13 and B16	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:ANALog:STATe ON | OFF

This command switches the analog I/Q output signals on and off

Example: `"IQ:OUTP:ANAL:STAT ON"`
'the analog I/Q output signals of path A are activated.

*RST value	Resolution	Options	SCPI
OFF	-	B13 SOURce2 only with a second option B13 and second options B16 and B18.	Device-specific

[SOURce<[1]|2>:]IQ:OUTPut:[ANALog:]TYPE SINGle | DIFFerential

This command selects the analog output type.

Parameter: **DIFFerential**
The I/Q-signal components are output differential. Bias and offset can be defined.

Single Ended
The I/Q-signal components are output single-ended. A bias can be defined.

Example: `"IQ:OUTP:TYPE DIFF"`
'the I/Q-signal components are output differential.

*RST value	Resolution	Options	SCPI
SINGle		B13 and B16	Device-specific

STATus Subsystem

This system contains the commands for the status reporting system. *RST has no effect on the status registers.

Queries return the current value of the respective register, which permits a check of the device status. A decimal value between 0 and 32767 (=2^{15}-1) is returned.

The configuration commands set the respective register thus determining which status changes of the R&S AMU causes the status registers to be changed. A decimal value between 0 and 32767 (= 2^15-1) is set.

Command	Parameters	Default unit	Remark
STATus:OPERation:CONDition?			Query only
STATus:OPERation:ENABle	0 ... 32767		
STATus:OPERation[:EVENt]?			Query only
STATus:OPERation:NTRansition	0 ... 32767		
STATus:OPERation:PTRansition	0 ... 32767		
STATus:PRESet			No query
STATus:QUEStionable:CONDition?			Query only
STATus:QUEStionable:ENABle	0 ... 32767		
STATus:QUEStionable[:EVENt]?			Query only
STATus:QUEStionable:NTRansition	0 ... 32767		
STATus:QUEStionable:PTRansition	0 ... 32767		
STATus:QUEue[:NEXT]?			Query only

STATus:OPERation:CONDition?

The command queries 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 since it indicates the current hardware status.

Example: `"STAT:OPER:COND?"`
'queries the Status:Operation:Condition register.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:OPERation:ENABle

The command 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.

Example: `"STAT:OPER:ENAB 32767"`
'all events are forwarded to the sum bit of the status byte.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:OPERation:EVENt?

The command 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.

Example: `"STAT:OPER:EVEN?"`
'queries the STATus:OPERation:EVENt register.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:OPERation:PTRansition

The command 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, e.g. the start of an adjustment.

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.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:OPERation:NTRansition

The command 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, e.g. the end of an adjustment.

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.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:PRESet

The command 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.

The command triggers an event and therefore has no query form and no *RST value.

Example: `"STAT:PRES"`
'resets the status registers.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEStionable:EVENt?

The command 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.

Example: `"STAT:OPER:EVEN?"`
'queries the Status:Questionable:Event register.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEStionable:CONDition?

The command 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.

Example: `"STAT:OPER:COND?"`
'queries the Status:Questionable:Condition register.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEStionable:PTRansition

The command sets the bits of the PTRansition part of the STATus:QUEStionable 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.

Example: `"STAT:OPER: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.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEStionable:NTRansition

The command 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.

Example: `"STAT:OPER: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.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEStionable:ENABle

The command sets the bits of the ENABle part of the STATus:QUEStionable register. This setting determines which events of the Status-Event part are enabled for the sum bit in the status byte. These events can be used for a service request.

Example: `"STAT:OPER:ENAB 1"`
'problems when performing an adjustment cause an entry to be made in the sum bit.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

STATus:QUEue[:NEXT]?

The command 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 (see chapter 9). If the error queue is empty, 0 ("No error") is returned. The command is identical to `SYSTem:ERRor?`.

Example: `"STAT:QUE?"`
'queries the oldest entry in the error queue.

Response: "0, 'no error'"
'no errors have occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem Subsystem

The SYSTem subsystem contains a series of commands for general functions which do not directly affect signal generation.

Command	Parameters	Default unit	Remark
SYSTem:BEEPer:STATe	ON | OFF		
SYSTem:COMMunicate:GPIB:LTERminator	EOI | STANdard		
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	0 ... 30		
SYSTem:COMMunicate:NET:RESource	‘string’		
SYSTem:DATE	<year>,<month>,<day>		
SYSTem:DISPlay:UPDate	ON | OFF		
SYSTem:ERRor:ALL			Query only
SYSTem:ERRor:CODE:ALL			Query only
SYSTem:ERRor:CODE[:NEXT]?			Query only
SYSTem:ERRor:COUNt?			Query only
SYSTem:ERRor[:NEXT]?			Query only
SYSTem:KLOCk	ON | OFF		
SYSTem:PRESet			No query
SYSTem:PROTect<n>[:STATe]	ON | OFF , password		
SYSTem:SECurity[:STATe]	ON | OFF		
SYSTem:SERRor?			Query only
SYSTem:TIME	<hour>,<minute>,<second>		
SYSTem:VERSion?			Query only

SYSTem:BEEPer:STATe ON | OFF

The command switches the key beep on or off.

Example: `"SYST:BEEP:STAT OFF"`
'no acoustic signal is output when a key on the front panel is pressed.

*RST value	Resolution	Options	SCPI
OFF	-	-	Compliant

SYSTem:COMMunicate:GPIB:LTERminator EOI | STANdard

The command sets the terminator recognition for remote control via the IEC/IEEE bus.

Parameters: **EOI**
The terminator must be sent together with the line message EOI (End of Line). This setting is recommended for binary block transmissions where a character could coincidentally have the value LF (Line Feed) but is not intended as the terminator. This setting must be selected for block data with undefined length.

STANdard
An LF (Line Feed) is recognized as the terminator regardless of whether it is sent with or without EOI.

Example: `"SYST:COMM:GPIB:LTER EOI"`
'only a character which is sent simultaneously with the line message EOI is accepted as the terminator.

***RST value**	**Resolution**	**Options**	**SCPI**
STANdard	-	-	Compliant

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 1 ... 30

The command sets the IEC/IEEE bus address.

Example: `"SYST:COMM:GPIB:ADDR 14"`
'sets IEC/IEEE bus address 14.

***RST value**	**Resolution**	**Options**	**SCPI**
28	-	-	Compliant

SYSTem:COMMunicate:NET:RESource?

The command queries the visa resource string. This string is used for remote control of the instrument.

The command is a query command and therefore has no *RST value.

Example: `SYST:COMM:NET:RES?`
'queries the VISA resource string.

Response:
`TCPIP::127.0.0.1::INSTR`

***RST value**	**Resolution**	**Options**	**SCPI**
-	-	-	Device-specific

SYSTem:DATE <year>,<month>,<day>

The command sets the date for the instrument-internal calendar.

Example: `"SYST:DATE 2003,05,01"`
'sets May 1, 2003.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:DISPlay:UPDate ON | OFF

The command switches the update of the display on/off. A switchover from remote control to manual operation always sets the status of the update of the display to ON.

Example: `"SYST:DISP:UPD OFF"`
'switches update of displayed parameter values off.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

SYSTem:ERRor:ALL?

The command queries all entries in the error queue and then deletes them. 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 a query command and therefore has no *RST value.

Example: `"SYST:ERR:ALL?"`
'queries all entries in the error queue.

Response: "0, 'no error'"
'no errors have occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:ERRor:CODE:ALL?

The command queries all entries in the error queue and then deletes them. Only the error numbers are returned and not the entire error text. Positive error numbers denote device-specific errors, and negative error numbers denote error messages defined by SCPI (see chapter 9, section "*Error Messages*"). If the error queue is empty, 0 ("No error") is returned.

The command is a query command and therefore has no *RST value.

Example: `"SYST:ERR:CODE:ALL?"`
'queries all entries in the error queue.

Response: "0"
'no errors have occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:ERRor:CODE[:NEXT]?

The command queries the oldest entry in the error queue and then deletes it. Only the error number is returned and not the entire error text. Positive error numbers denote device-specific errors, and negative error numbers denote error messages defined by SCPI (see chapter 9, section "*Error Messages*"). If the error queue is empty, 0 is returned.

The command is a query command and therefore has no *RST value.

Example: `"SYST:ERR:CODE?"`
'queries the oldest entry in the error queue.

Response: "0"
'no errors have occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:ERRor:COUNt?

The command queries the number of entries in the error queue. If the error queue is empty, '0' is returned.

The command is a query command and therefore has no *RST value.

Example: `"SYST:ERR:CODE?"`
'queries the oldest entry in the error queue.

Response: "1"
'one error has occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:ERRor[:NEXT]?

The command 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 (see chapter 9). If the error queue is empty, 0 ("No error") is returned. The command is identical to the command `STATus:QUEue:NEXT?`.

The command is a query command and therefore has no *RST value.

Example: `"SYST:ERR?"`
'queries the oldest entry in the error queue.

Response: "0, 'no error'"
'no errors have occurred since the error queue was last read out.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:KLOCk ON | OFF

The command (Keyboard LOCk) disables the front panel keyboard of the R&S ANU including the LOCAL key, or enables it again (OFF).

Example: `"SYST:KLOC ON"`
'activates the keyboard lock. The keyboard cannot be operated again until it has been enabled with `SYST:KLOC OFF`.

*RST value	Resolution	Options	SCPI
OFF	-	-	Compliant

SYSTem:PRESet

The command triggers an instrument reset. It has the same effect as the PRESET key on the front panel and the *RST command.

The command triggers an event and therefore has no *RST value and no query form.

Example: `"SYST:PRES"`
'all instrument settings (also those that are not currently active) are reset to their default values.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:PROTect<n>[:STATe] ON | OFF, password

The command activates and deactivates the specified protection level. There are several protection levels which disable specific service functions (authorized personnel of R&S Service Departments only). These levels are identified by the suffix under PROTect.

The respective functions are disabled when the protection level is activated. No password is required for activation. A password must be entered to deactivate the protection level. The password for the first level is 123456. This protection level can be used to lock-out internal adjustments.

The command triggers an event and therefore has no *RST value and no query form.

Example: `"SYST:PROT1 ON"`
'activates protection level 1. Internal adjustments are only possible after deactivating the lock-out.

`"SYST:PROT1 OFF, 123456"`
'deactivates protection level 1. Internal adjustments are enabled again.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:SERRor?

This command 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 operation.

The command is a query command and therefore has no *RST value.

Example: `"SYST:SERR?"`
'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 queried.

*RST value	Resolution	Options	SCPI
-	-	-	Device-specific

SYSTem:TIME 0 ... 23,0 ... 59,0 ... 59

The command sets the time for the instrument-internal clock.

Example: `"SYST:TIME 12,0,0"`
'sets the time to precisely 12 pm.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

SYSTem:VERSion?

The command queries the SCPI version with which the instrument complies.

The command is a query command and therefore has no *RST value.

Example: `"SYST:VERS?"`
'queries the SCPI version.

Response: 1996
'the instrument complies with the version from 1996.

*RST value	Resolution	Options	SCPI
-	-	-	Compliant

TEST Subsystem

The TEST system contains the commands for performing the routines as well as for direct manipulation of the hardware assemblies (`:TEST:DIRect`). The self tests return a "0" if the test is performed successfully, otherwise a value other than "0" is returned. None of the commands of this system have an *RST value.

In the case of two-path instruments, the numerical suffix under TEST distinguishes between path A and path B:

TEST[1] = path A

TEST2 = path B

CAUTION

Risk of damage to the assembly!

Improper use could destroy the assembly.

The respective hardware assembly responds to the command TEST:DIRect directly and safety mechanisms are bypassed. The command is used for servicing purposes and should not be applied by the user.

Command	Parameters	Default unit	Remark
TEST:CONNector:AUXio	-		Query only
TEST:CONNector:BNC	-		Query only
TEST<1|2>:DIRect	'BBIN' | 'BBOUT' | 'DACIF' | 'FADER' | 'UNICOD', subaddress, hex data string		

TEST:CONNector:AUXio?

The command triggers a test of the AUX IO interface (see Service Manual Instrument, chapter 1, "Performance Test"). This function is only available via remote control.

Example: "TEST:CONN:AUX?"

*RST value	Resolution	Options	SCPI
-	-	Z5	Device-specific

TEST:CONNector:BNC?

The command triggers a test of the BNC connectors of the instrument (see Service Manual Instrument, chapter 1, "Performance Test"). This function is only available via remote control.

Example: "TEST:CONN:BNC?"

*RST value	Resolution	Options	SCPI
-	-	Z5	Device-specific

TEST<1|2>:DIRect "'DACIF' | 'BBIN' | 'BBOUT' | 'FADER' | 'UNICOD', subaddress, hex data string

The respective hardware assembly responds directly to the command; any safety mechanisms are bypassed. This function is only available via remote control.

Example: "TEST:DIR 'BBINS',0,#H12345678"

"TEST:DIR? 'BBINS',0"

Response:
'#H12345678

*RST value	Resolution	Options	SCPI
-	-		Device-specific

UNIT Subsystem

The UNIT subsystem contains the commands specifying which units are valid if no unit is indicated in a command. These settings are valid for the entire instrument.

Command	Parameters	Default unit	Remark
UNIT:ANGLe	DEG | RAD		
UNIT:POWer	V | DBM		

UNIT:ANGle DEG | RAD

The command defines the default unit for angles. It is valid for all commands which determine angle values. It does not influence the manual operation parameter unit and the display.

Example: `"UNIT:ANGL DEG"`
'sets default unit DEG for all commands which determine angle values.

*RST value	Resolution	Options	SCPI
RAD	-		Compliant

UNIT:POWer V | DBM

The command defines the default unit for power. It is valid for all commands which determine power values. It does not influence the manual operation parameter unit and the display.

Example: `"UNIT:POW V"`
'sets default unit V for all commands which determine power values.

*RST value	Resolution	Options	SCPI
DBM	-		Compliant

Contents Chapter 8 - Maintenance and Interfaces

8 Maintenance and Remote Control Interfaces

Introduction - Maintenance and Interfaces

The following chapter contains information on the maintenance of the signal generator and a description of the remote control interfaces.

Please follow the instructions in the service manual when exchanging modules or ordering spares. The order no. for spare parts can be found in the service manual.

The address of our support center and a list of all Rohde & Schwarz service centers can be found at the beginning of the printed manual.

The service manual includes further information particularly on troubleshooting, repair and exchange of modules.

Maintenance

The instrument does not need a periodic maintenance. What is necessary is essentially the cleaning of the instrument. However, it is recommended to check the rated data from time to time.

Cleaning the Outside and Storing

The outside of the instrument is suitably cleaned using a soft, line-free dust cloth. Make sure that vents are not obstructed.

Caution!

Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.

The storage temperature range of the instrument is given in the data sheet. If the instrument is to be stored for a longer period of time, it must be protected against dust.

The original packing should be used, particularly the protective covers at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

Hardware Interfaces

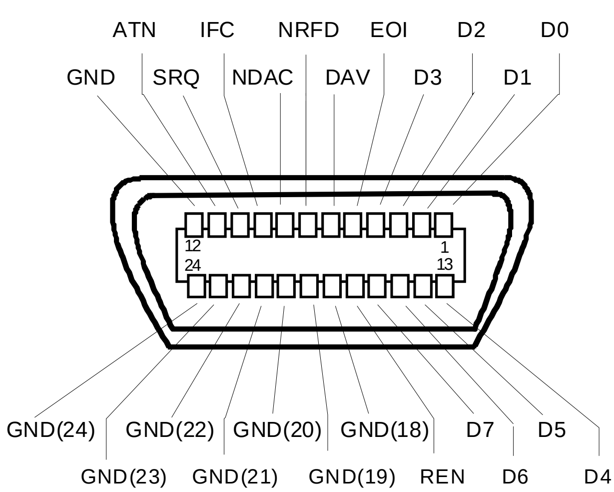
The following section describes the remote control interfaces of the signal generator and the pin assignment of the monitor connector. The AUX IO interface is described with the associated configuration menu in chapter 4, section "*User Marker - AUX-IO - Setup-Environment-Global...Settings*". All other interfaces are described in chapter 1, sections *"Legend for Front Panel View"* and *"Legend for Rear Panel View"*. For specifications refer to the data sheet.

IEC/IEEE Bus Interface

The standard instrument is equipped with an IEC/IEEE bus connector. An IEEE 488 interface connector is located on the rear panel. An external controller for remote control of the instrument can be connected via the IEEE 488 interface connector using a shielded cable.

Interface Characteristics

- 8-bit parallel data transfer
- bi-directional data transfer
- three-line handshake
- high data transfer rate
- up to 15 instruments can be connected
- maximal length of the interconnecting cables 15 m (single connection, 2 m)
- wired-OR connection if several instruments are connected in parallel.



Pin assignment of IEC/IEEE-Bus interface

Bus Lines

1. **Data bus with 8 lines D0 to D7.**

   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. D0 is the least significant bit, D7 the most significant bit.

2. **Control bus with 5 lines**

IFC (Interface Clear)	active LOW resets the interfaces of the instruments connected to the default setting.
ATN (Attention)	active LOW signals the transmission of interface messages. inactive HIGH signals the transmission of device messages.
SRQ (Service Request)	active LOW enables the connected device to send a service request to the controller.
REN (Remote Enable)	active LOW permits switchover to remote control.
EOI (End or Identify)	has two functions in connection with ATN: ATN = HIGH active LOW marks the end of data transmission. ATN = LOW active LOW triggers a parallel poll.

3. **Handshake bus with three lines**

DAV (Data Valid)	active LOW signals a valid data byte on the data bus.
NRFD (Not Ready For Data)	active LOW signals that one of the connected devices is not ready for data transfer.
NDAC (Not Data Accepted)	active LOW signals that the instrument connected is accepting the data on the data bus.

IEC/IEEE-Bus Interface Functions

Instruments which can be remote controlled via the IEC/IEEE bus can be equipped with different interface functions. The following table lists the interface functions appropriate for the instrument.

IEC/IEEE Bus Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake), full capability
AH1	Handshake sink function (acceptor handshake), full capability
L4	Listener function, full capability, unaddress if MTA.
T6	Talker function, full capability, ability to respond to serial poll, unaddress if MLA
SR1	Service request function (Service Request), full capability
PP1	Parallel poll function, full capability
RL1	Remote/Local switch over function, full capability
DC1	Reset function (Device Clear), full capability
DT1	*Trigger function (Device Trigger), full capability*
C0	*No controller function*

IEC/IEEE Bus Messages

Interface messages are transferred on the data lines of the IEC/IEEE bus when the "ATN" control line is active (LOW). They are used for communication between controller and instruments and can only be sent by the controller which currently has control of the IEC/IEEE bus.

Universal Commands

The universal commands are encoded 10 - 1F hex. They affect all instruments connected to the bus without addressing.

Universal Commands

Command	VISUAL BASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument settings..
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	Locks switchover from remote control to manual operation by means of the front panel keys
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for serial poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of serial poll.
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of the parallel-poll state.

Addressed Commands

The addressed commands are encoded 00 - 0F hex. They are only effective for instruments addressed as listeners.

Addressed Commands

Command	VISUAL BASIC Command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GET (Group Execute Trigger)	IBTRG (device%)	Triggers a previously active device function (e.g. a sweep). The effect of the command is the same as with that of a pulse at the external trigger signal input.
GTL (Go to Local)	IBLOC (device%)	Transition to the "Local" state (manual operation).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configures instrument for parallel poll. Additionally, the VISUAL BASIC command executes PPE/PPD.

LAN Connector

The unit is equipped with an LAN interface as standard. The LAN connector is at the rear of the instrument. Provided the appropriate rights have been assigned by the network administrator, files can be transmitted via the network, and network resources, e.g. a network folders, can be used. The instrument can also be remote controlled and manually operated in the network. It is connected by means of a commercial RJ45 cable.

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.

Connection of the R&S AMUR&S S is described in Chapter 1, section "*Connection to the Network*", remote control via Ethernet in chapter 5, section "*Remote Control via LAN Interface*", page 5.4. The architecture of a LAN remote-control connection is described in detail in the following.

Remote control of an instrument via a network is based on standardized protocols which follow the OSI reference model (see Fig. below).

Application	SCPI	SCPI [3]
Presentation	XDR (VXI-11)	RFC 1014 [1,2]
Session	ONC-RPC	RFC 1057
Transport	TCP / UDP	RFC 793
Network	IP	RFC 791
Data Link	Ethernet/802.3	8802-3
Physical	802.3/10BASE-T	8802-3

Fig. 8-2 Example for LAN remote control based on the OSI reference model

Based on TCP/UDP, messages between the controller and the instrument are exchanged via open network computing (ONC) - remote procedure calls (RPC). With XDR, legal RPC messages are known as VXI-11 standard. Based on this standard, messages are exchanged between the controller and the instrument. The messages are identical with SCPI commands. They can be organized in four groups: program messages (control command to the instrument), response messages (values returned by the instrument), service request (spontaneous queries of the instrument) and low-level control messages (interface messages).

A VXI-11 link between a controller and an instrument uses three channels: a core, abort and interrupt channel. Instrument control is mainly performed on the core channel (program, response and low-level control messages). The abort channel is used for immediate abort of the core channel; the interrupt channel transmits spontaneous service requests of the instrument. Link setup itself is very complex. For more details refer to the VXI-11 specification ("TCP/IP Instrument Protocol Specification VXI-11, Revision 1.0 VMEbus Extensions for Instrumentation, VXIbus", and "TCP/IP-IEEE 488.2 Instrument Interface Specification VXI-11.3, Draft 0.3 VMEbus Extensions for Instrumentation, VXIbus").

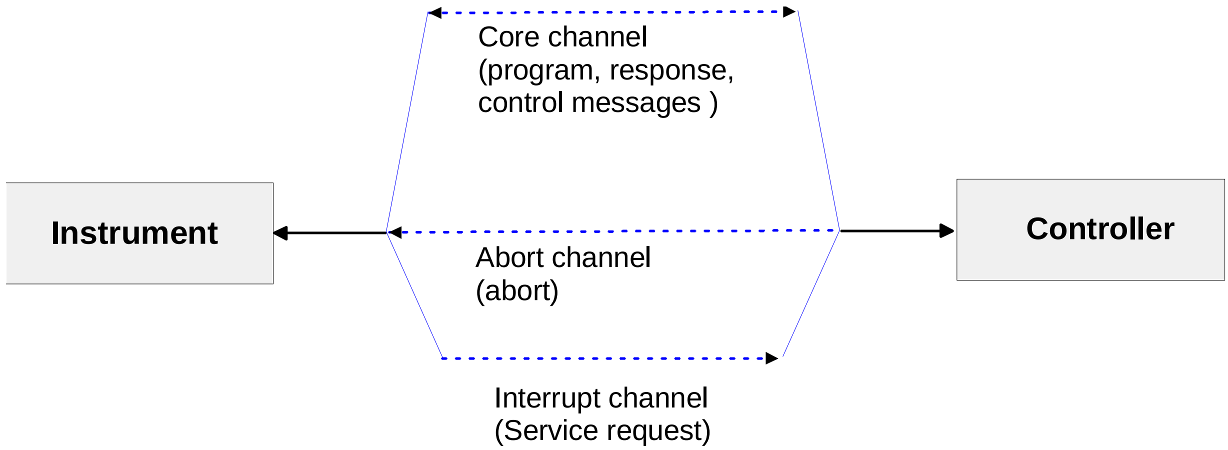


Fig. 8-3 VXI-11 channels between instrument and controller

The number of controllers that can address an instrument is practically unlimited in the network. In the instrument, the individual controllers are clearly distinguished. This distinction continues up to the application level in the controller, i.e. two applications on a PC are identified by the instrument as two different controllers.

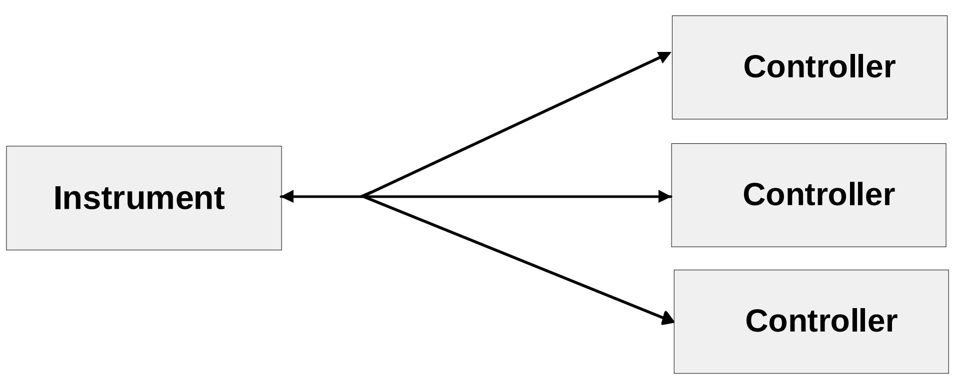
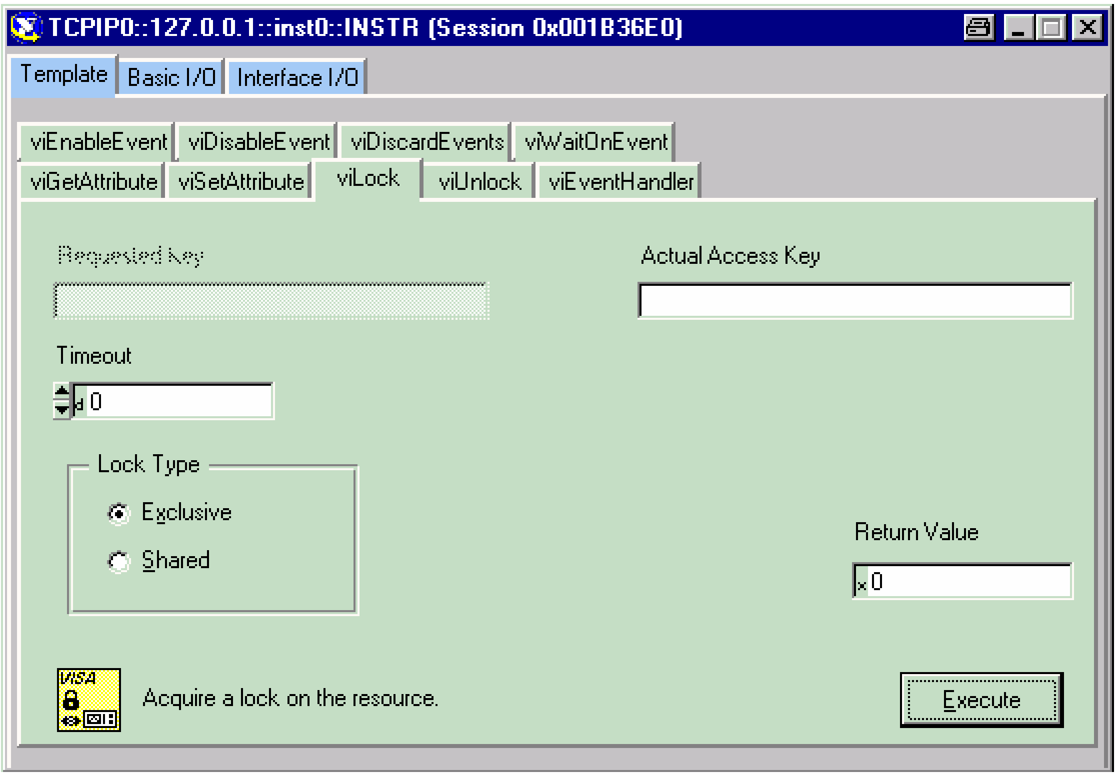


Fig. 8-4 Remote control via LAN from several controllers

The controllers can lock and unlock the instrument for exclusive access. This regulates access to the instrument of several controllers.

In the **'Measurement & Automation Control'** program, this setting is made on the **Template** tab.



VXI-11 Interface Messages

On the Ethernet link, the interface messages are called low-level control messages. These messages can be used to emulate interface messages of the IEC/IEEE bus.

VXI-11 Interface Messages

Command		Effect on the instrument
&ABO	(Abort)	Aborts the processing of the commands just received.
&DCL	(Device Clear)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
&GTL	(Go to Local)	Transition to the "Local" state (manual operation)
&GTR	(Go to Remote)	Transition to the "Remote" state (remote control)
&GET	(Group Execute Trigger)	Triggers a previously active device function (e.g. a sweep). The effect of the command is the same as with that of a pulse at the external trigger signal input.
&LLO	(Local Lockout)	Disables switchover from remote control to manual operation by means of the front panel keys
&POL	(Serial Poll)	Starts a serial poll
&NREN	(Not Remote Enable)	Enables switchover from remote control to manual operation by means of the front panel keys

USB Connection (USB and USB IN)

The instrument is equipped as standard with five USB (universal serial bus) interfaces.

USB

Four of them are type A interfaces (host USB) which establish a connection to the controller. They can be used for connecting peripherals such as mouse and keyboard or a memory stick for data transmission. Two of the master USBs are at the instrument frontand two are at the rear.

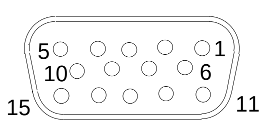
USB IN

The fifth USB interface is a type B interface (device USB) and located at the rear of the instrument. It establishes a connection to the DACIF module and can be used for data transmission and remote control.

If required, separate drivers can be developed for this interface. The device ID required in this case is 11 (HEX) for remote control and 12 (HEX) for the transmission of modulation data. The vendor ID is AAD (HEX).

Monitor Connector (MONITOR)

The 15-pin Sub-D female connector MONITOR at the rear panel is intended for connecting an external VGA monitor.



Pin	Signal	Pin	Signal	Pin	Signal
1	Red (output)	6	GND	11	(NC)
2	Green (output)	7	GND	12	(NC)
3	Blue (output)	8	GND	13	HSYNC (output)
4	(NC)	9	GND	14	VSYNC (output)
5	GND	10	GND	15	(NC)

Pin assignment of the MONITOR connector

BERT Connector

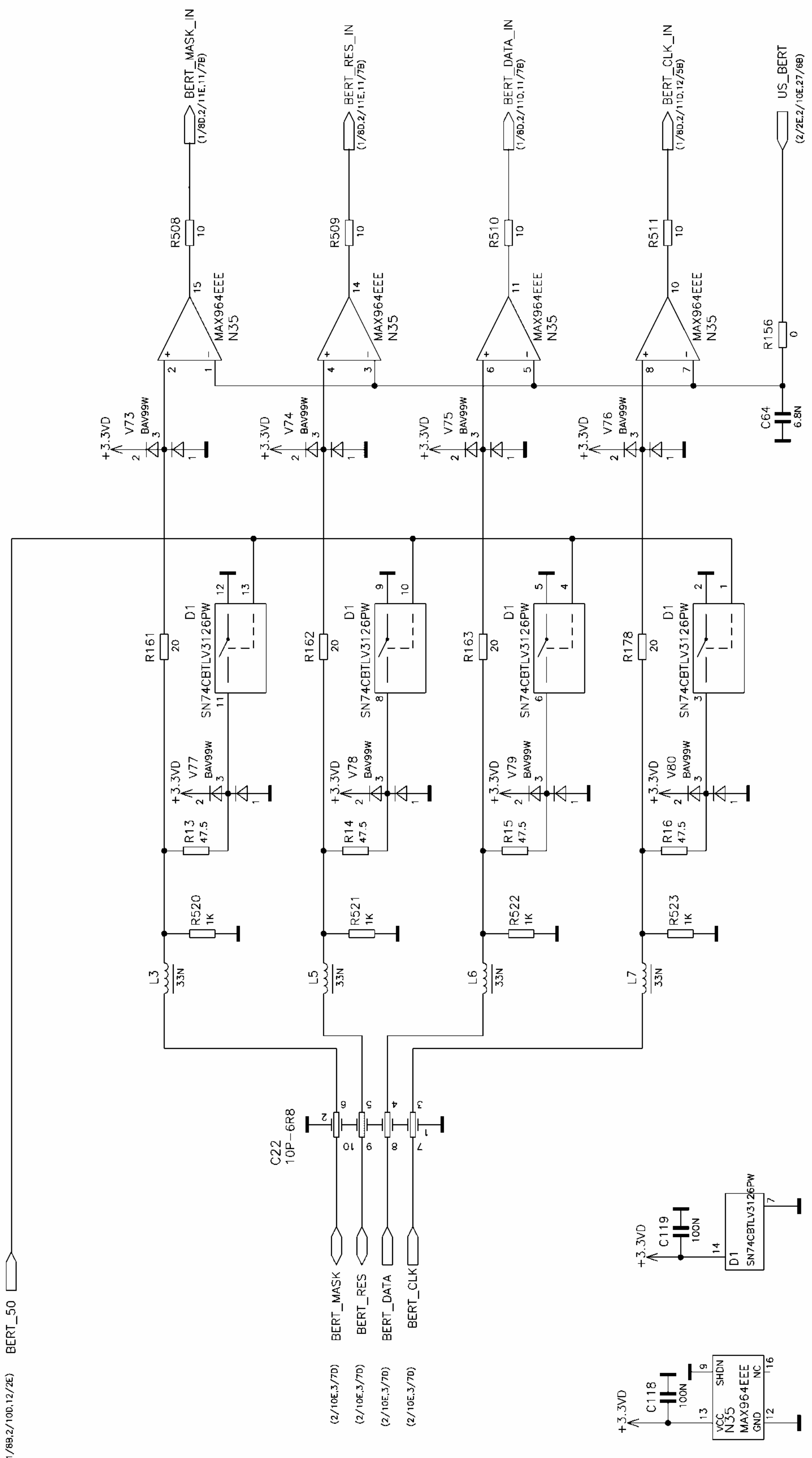
The 9-pin Sub-D connector BERT at the rear panel is available for the input signals of the integrated bit error rate tester (option BER/BLE Measurement (K80)).

Pin	Signal	Pin	Signal
1	GND	6	CLOCK
2	GND	7	DATA
3	GND	8	DATA ENABLE
4	GND	9	RESTART
5	GND		

Pin assignment of the BERT connector

The input signals are not terminated in the R&S AMU. The impedance (50 ohm) and the threshold (0.0128..1.998 V) of the inputs can be set in the BERT menu. The following figure shows the circuit diagram of the BERT function.

BERT circuit diagram



Contents - Chapter 9 - "Error Messages"

9 Error Messages

Introduction - Status Information and Messages

This chapter describes the error messages of the R&S AMU 200A Baseband Signal Generator and Fading Simulator. The error messages are output in the **Info** line on the screen and entered in the error error/event queue of the status reporting system.

A great variety of different messages such as status messages, error messages, warnings or information are displayed in the header field of the screen. Some error messages require that the error must be eliminated before correct instrument operation can be ensured. The info window with a list of current messages and a detailed description of each message can be opened with the [INFO] key

In the remote control mode, error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. If the error queue is empty, 0 ("No error") is returned.

Status Information

The status messages are displayed in the header section of the screen. The status information gives the user an overview of the main operating states and settings of the instrument. The states are indicated for information only and do not necessitate any action by the user. Status information is displayed between the frequency and level fields, at the left of the info line or in the info line itself. On two-path instruments, all states that can occur independently in the two paths are displayed separately for each path. The associated path is indicated in the info line.

Status information displayed between the output state and level fields:

EXT REF An external reference is used.

The external signal with selectable frequency and defined level must be input at the REF IN connector. It is output at the REF OUT connector.

The reference frequency setting is effective for both paths.

I/Q Out OFF The I/Q output is switched off.

BUSY A setting or calculation is executed.

Status information displayed to the left of the Info line:

REMOTE The instrument is remote controlled. The keys on the front panel are usable, but all parameters are in **read only** mode.

The LOCAL key switches the instrument from remote control to manual operation. The current command must be fully processed before the mode is switched, otherwise the instrument switches immediately back to remote control.

REM-LLO The instrument is remote (**REM**ote) controlled. The LOCAL key is disabled by remote control with the command LLO (**L**ocal**L**ock**O**ut). The keys on the front panel are usable, but all parameters are in **read only** mode.
The instrument can be switched from remote control to manual operation by means of remote control only (e.g. with the Visual Basic command `CALL IBLOC (generator%)`).

LOC-LLO For operating directly the instrument is placed from remote control to manual operation (Local State). The LOCAL key was disabled by remote control with the command **L**ocal**L**ock**O**ut).

With the next activating of the remote control mode, the instrument cannot be switched to manual operation by the operator. The status information changes to REM LLO.

The instrument can be switched to manual operation by means of remote control only (e.g. with the Visual Basic command `CALL IBLOC (generator%)`).

SYS CTRL **SYS CTRL** indicates that the instrument is controlling another instrument.

Error Messages

Messages indicate errors in the instrument. They are displayed in the info line in different colors depending on their importance and display duration. Errors (e.g. no calibration data) are displayed in red, information (e.g. file not found) and warnings in black. Warnings indicate less significant errors (e.g. the instrument operates outside specified data).

Brief messages

Brief messages report automatic settings in the instrument (e.g. switching off of incompatible types of modulation) or on illegal entries that are not accepted by the instrument (e.g. range violations). They are displayed in the info line on a yellow background. They are displayed on top of status information or permanent messages.

Brief messages do not normally demand user actions and disappear automatically after a brief period of time. They are stored in the history, however.

Permanent messages

Permanent messages are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signaled by a permanent message must be eliminated before correct instrument operation can be ensured.

The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

Alphabetical List of SCPI-Error Messages

The following list contains all error messages defined in SCPI in alphabetical order. SCPI error messages are the same in all SCPI instruments. The errors are assigned negative numbers.

The error text being entered into the error/event queue or being displayed is printed in bold face on the left together with the error code. Below the error text, there is an explanation as to the respective error.

Note:
The index provides a list of the error messages sorted according to their error codes.

Block data not allowed (-168)

The command contains legal block data which are not allowed at this point.

Example: The command `SOURce:BB:FOFFset` requires a numeric parameter – `BB:FOFF #13a`

SCPI: Command error - sets bit 5 in the ESR register

Character data not allowed (-148)

The character data is prohibited for this command or at this point of the command.

SCPI: Command error - sets bit 5 in the ESR register

Character data too long (-144)

The character data element contains more than 12 characters.

SCPI: Command error - sets bit 5 in the ESR register

Command error (-100)

Generic error message that cannot detect a more specific error.

SCPI: Command error - sets bit 5 in the ESR register

Data out of range (-222)

A value of the transmitted command was outside the legal range.

Example: Command `SOUR:BB:FOFF 50MHz` only permits entries in the range of min to max frequency.

SCPI: Execution error - sets bit 4 in the ESR register

Device-specific error (-300)

Device-specific error not defined in greater detail.

SCPI: Device-specific error - sets bit 3 in the ESR register

Exponent too large (-123)

The magnitude of the exponent is too large.

SCPI: Command error - sets bit 5 in the ESR register

Expression data not allowed (-178)

The command contains a mathematical expression at an impermissible position.

SCPI: Command error - sets bit 5 in the ESR register

GET not allowed (-105)

A Group Execute Trigger (GET) is within a command line.

Note: A Group Execute Trigger (GET) is only allowed at the end of a command line or in a separate command line.

SCPI: Command error - sets bit 5 in the ESR register

Hardware error (-240)

A legal program command or a query could not be executed because of a hardware problem in the device.

SCPI: Execution error - sets bit 4 in the ESR register

Hardware missing (-241)

A legal program command or a query could not be executed because of a missing device hardware.

Example: An option is not fitted.

SCPI: Execution error - sets bit 4 in the ESR register

Header suffix out of range (-114)

The command contains an illegal numeric suffix.

Example: `:SOURce22` is not defined for the instrument.

SCPI: Command error - sets bit 5 in the ESR register

Invalid block data (-161)

The command contains illegal block data.

Example: An END message was received before the expected number of data had been received or no numeric data element is sent after the introductory #

SCPI: Command error - sets bit 5 in the ESR register

Invalid character data (-141)

The command contains an invalid value indication.

Example: ON is indicated instead of a numeric value for frequency setting - `SOUR:BB:FOFF ON`

SCPI: Command error - sets bit 5 in the ESR register

Invalid separator (-103)

The command contains an impermissible sign instead of a separator.

SCPI: Command error - sets bit 5 in the ESR register

Invalid suffix (-131)

The suffix is not appropriate for this command.

Example: nHz is not defined.

SCPI: Command error - sets bit 5 in the ESR register

Missing parameter (-109)

The command does not contain the required parameters.

SCPI: Command error - sets bit 5 in the ESR register

No error (0)

This message is output if the error queue does not contain entries.

Numeric data not allowed (-128)

The command contains a numeric data element the device does not accept in this position.

Example: The command `:SOUR:BB:DM:COD` requires an alphanumeric parameter - `SOUR:BB:DM:COD GSM`.

SCPI: Command error - sets bit 5 in the ESR register

Out of memory (-225)

The storage space available in the instrument is exhausted.

SCPI: Execution error - sets bit 4 in the ESR register

Parameter not allowed (-108)

The command contains too many parameters.

SCPI: Command error - sets bit 5 in the ESR register

Program mnemonic too long (-112)

The header contains more than 12 characters.

SCPI: Command error - sets bit 5 in the ESR register

Query interrupted (-410)

This query has been interrupted.

Example After a query, the instrument receives new data before the response has been sent completely.

SCPI: Query error - error in data request - sets bit 2 in the ESR register.

Query unterminated (-420)

This query is missing or incomplete.

Example The instrument is addressed as a talker and receives incomplete data.

SCPI: Query error - error in data request - sets bit 2 in the ESR register.

Query deadlocked (-430)

This query cannot be processed.

Example The input and output buffers are full, the instrument cannot be operated.

SCPI: Query error - error in data request - sets bit 2 in the ESR register.

Queue overflow (-350)

This error code is entered into the queue instead of the actual error code if the queue is full. It indicates that an error has occurred but not been recorded in the queue. The original error message is lost.

Remedy: Reading out the error messages e.g. with command `SYSTem:ERRor:ALL?` clears the error queue.

SCPI: Device specific error- sets bit 3 in the ESR register

Self test failed ... (-330)

An error was detected in the selftest named after the semicolon. An error-free operation of the module concerned is no longer guaranteed.

SCPI: Device specific error- sets bit 3 in the ESR register

Settings conflict ... (-221)

There is a setting conflict between the two parameters indicated after the semicolon.

Example: The set FSK deviation is too large for the selected symbol rate.

Remedy One of the given values has to be corrected to obtain a valid output signal.

SCPI: Execution error - sets bit 4 in the ESR register

String data not allowed (-158)

The command contains a legal string data element which is not allowed at this point.

Example: A text parameter is set in quotation marks.
`SOURce:BBIN:MODE "ANAL".`

SCPI: Command error - sets bit 5 in the ESR register

Syntax error (-102)

The command is invalid.

Example: The command contains block data the instrument does not accept.

SCPI: Command error - sets bit 5 in the ESR register

System error (-310)

This error message suggests an error within the instrument. Please inform the R&S Service.

SCPI: Device specific error- sets bit 3 in the ESR register

Too many digits (-124)

The decimal numeric data element contains too many digits.

SCPI: Command error - sets bit 5 in the ESR register

Too much data (-223)

More data were sent by the host than the instrument can handle.

SCPI: Execution error - sets bit 4 in the ESR register

Undefined header (-113)

The sent command header has not been defined.

Example: Header `":*XYZ"` or `":SOURCe&"` is undefined for every instrument.

SCPI: Command error - sets bit 5 in the ESR register

Alphabetical List of Device-Specific Error Messages

The following list contains all error messages specific of the instrument in alphabetical order. The positive error codes mark the errors specific of the instrument.

The error text being entered into the error/event queue or being displayed is printed in bold face on the left together with the error code. Below the error text, there is an explanation as to the respective error.

Note:
The index provides a list of the error messages sorted according to their error codes.

Adjustment data invalid (183)

Adjustment data are invalid and must be restored.

Remedy: The adjustment data have to be generated again by an internal or external adjustment or to be loaded into the instrument.

SCPI: Device-specific error - sets bit 3 in the ESR register

Adjustment data missing (182)

Adjustment data are missing.

Remedy: The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the instrument.

SCPI: Device-specific error - sets bit 3 in the ESR register

Adjustment failed (180)

Adjustment could not be executed

Remedy: The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the device (see section Adjustment).

SCPI: Device-specific error - sets bit 3 in the ESR register

Cannot access the EEPROM (202)

A error occurs when writing or reading a EEPROM.

Example: The EEPROM is defect.

SCPI: Device-specific error - sets bit 3 in the ESR register

Cannot access hardware (200)

The data transmission to a module was unsuccessful.

Example: The module is not installed, not properly installed or missing.

SCPI: Device-specific error - sets bit 3 in the ESR register

Cannot open file (460)

The selected file can not be opened.

Remedy: Check the path and file name.

SCPI: Device-specific error - sets bit 3 in the ESR register

Cannot read file (462)

The file can not be read.

Example: The file contents are not compatible with the file type.

SCPI: Device-specific error - sets bit 3 in the ESR register

Cannot write file (461)

The file can not be written.

Example: The file is read-only.

SCPI: Device-specific error - sets bit 3 in the ESR register

Driver initialization failed (204)

Initialization of a driver fails when booting the instrument firmware

Example: The driver is not compatible with the hardware or software configuration of the instrument.

SCPI: Device-specific error - sets bit 3 in the ESR register

File contains invalid data (465)

The selected file contains data that is not valid for the file type. The file extension determines the data that is valid for this file type. If the file extension is changed the lists are no longer recognized and the data are therefore invalid.

Example: The extension of a waveform file (= *.wv) was changed to *.txt.

SCPI: Device-specific error - sets bit 3 in the ESR register

Filename missing (463)

The desired operation cannot be executed because the file name is not specified.

Example: A file name has to be entered when creating a new list.

SCPI: Device-specific error - sets bit 3 in the ESR register

Hardware revision out of date (201)

A later version of certain parts of the instrument is necessary to execute the function selected.

Example: The driver does not support the installed version of a module.

SCPI: Device-specific error - sets bit 3 in the ESR register

Invalid EEPROM data (203)

Reading a EEPROM is possible, however the data are inconsistent.

SCPI: Device-specific error - sets bit 3 in the ESR register

Invalid filename extension (464)

The file extension is not valid for the desired operation.

Example: The file extension for waveform list files is ***.wv**. It is not possible to enter another file extension when storing a list.

SCPI: Device-specific error - sets bit 3 in the ESR register

No current list (241)

There is no list selected. To execute the desired operation a list has to be selected in the related menu. If no list is available, a new list must be created.

SCPI: Device-specific error - sets bit 3 in the ESR register

This modulation forces other modulations off (140)

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.

SCPI: Device-specific error - sets bit 3 in the ESR register

Unknown list type specified (242)

The list type selected is not valid for the desired operation

Example: The file extension for waveform list files is ***.wv**. It is not possible to enter another file extension when selecting a list.

SCPI: Device-specific error - sets bit 3 in the ESR register

Waveform Protected (261)

The selected waveform file cannot be transferred to a controller. The waveform is produced with simulation software WinIQSIM and is protected.

SCPI: Device-specific error - sets bit 3 in the ESR register

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