1202.3986.32 – 03

Test and Measurement Division

Operating Manual

R&S® CMW 500 Wideband Radio Communication Tester

ROHDE&SCHWARZ

The Operating Manual describes the following R&S® CMW models and options:

- R&S® CMW 500 1201.0002K50 (with display, selection R&S® CMW-S600B)
- R&S® CMW 500 1201.0002K50 (without display, selection R&S® CMW-S600A)

The following abbreviations are used throughout this manual:
R&S® CMW 500 is abbreviated as R&S CMW 500.

Contents Overview

Note about Faceless Instruments

Chapter 1 of this manual gives an overview of the front panel controls and connectors of the R&S CMW 500 Wideband Radio Communication Testers with display and gives all information that is necessary to put the instrument into operation and connect external devices. The application examples in Chapter 2 and the following chapters are also based on a R&S CMW 500 with display.
The measurement functionality of the two instrument types is identical. You can test all measurement examples reported in this manual using an R&S CMW 500 without display that is controlled from the Graphical User Interface displayed on an external monitor or PC.
For specific information concerning faceless instruments refer to your quick start guide.

Contents

1 Preparing for Use

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

- Front panel tour
- Rear panel tour
- Putting into operation

CAUTION

General Safety Instructions
Please make sure to observe the instructions for instrument setup and connection so that you cannot cause damage to the instrument or endanger people. This is of particular importance when you use the instrument for the first time. Also observe the general safety instructions at the beginning of this manual.

1.1 Front Panel Tour

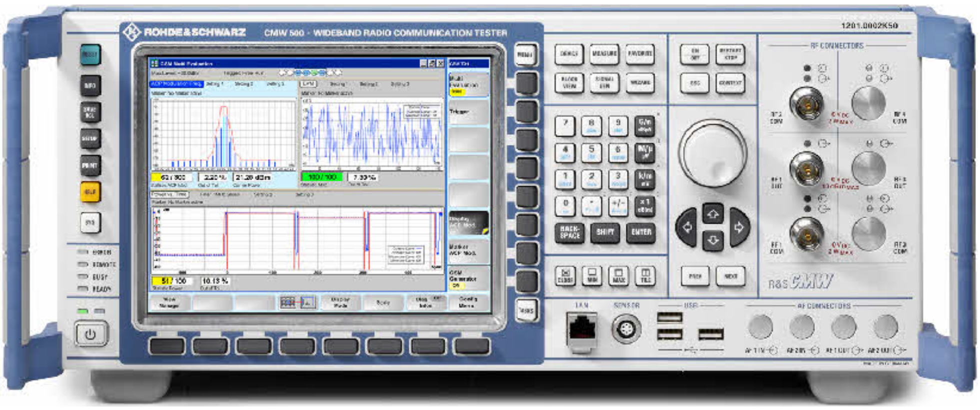
This chapter gives an overview of the front panel controls and connectors of the R&S CMW 500 and gives all information that is necessary to put the instrument into operation and connect external devices. Notes on reinstallation of the instrument software appear at the end of the chapter.

CAUTION

General Safety Instructions
Please make sure to observe the instructions of the following sections so that you cannot endanger people or cause damage to the instrument. This is of particular importance when you use the instrument for the first time. Also observe the general safety instructions at the beginning of this manual.

Chapter 2, "Getting Started", of this manual provides an introduction to the operation of the instrument by means of typical configuration and measurement examples. For a description of the operating concept and an overview of the instrument's capabilities refer to the "System Overview" (chapter 3). For all reference information concerning manual and remote control of the instrument refer to the online help system or its printed/printable version. A more detailed description of the hardware connectors and interfaces is also part of the help system.
The front panel of the R&S CMW 500 wideband radio communication tester with display consists of the VGA display with the softkey area and some utility keys (left side) and the hardkey area with the RF/AF connectors and control interfaces (right side). Brief explanations on the controls and connectors, the hardkey area and the rear

panel can be found on the next pages.



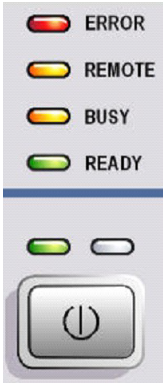
1.1.1 Utility Keys

The keys to the left of the display cause the R&S CMW 500 to return to a definite instrument state and provide information on the instrument and assistance.

- RESET opens the "Reset" dialog. Use this dialog to restore a definite instrument state.
- **INFO** is for future extensions.
- SAVE RCL opens the "Save/Recall" dialog. Use this dialog to store or recall instrument settings.
- SETUP opens the "Setup" dialog. Use this menu to perform administrative tasks, define basic instrument settings, enable options and view the startup results.
- PRINT opens the "Print" dialog. Use this dialog to copy the screen contents to a file or printer.
- **HELP** opens the help system.
- **SYS** closes the R&S CMW 500 software application and gives access to the Windows XP desktop and startup menu (toggle function). Use the operating system level to perform system configurations and call up additional software utilities.

1.1.2 Status LEDs and Standby Key

The status LEDs and the standby toggle switch are located in the bottom left corner of the front panel.



The status LEDs light to indicate the following instrument states:
- **ERROR:** Reserved for future use.
- **REMOTE:** The instrument is controlled via its remote interface; see Remote Control Operation.
- **BUSY:** Reserved for future use.
- **READY:** The instrument is ready for use.

The standby key serves two main purposes:
- Toggle between standby and ready state (indicated by the standby LEDs).
- Shut down the instrument.

1.1.3 Display

The R&S CMW 500 with selection R&S CMW-S600B is equipped with a color display providing control elements for the measurements and various output elements for the results. The display is bordered by two different bars with softkeys and hotkeys.
Refer to the "Specifications" for the technical characteristics of the display.

1.1.4 Softkeys and Hotkeys

Softkeys and hotkeys are located in two bars next to the display.
- The "softkey bar" on the right side consists of 8 softkeys. Softkeys provide quick, direct access to the main settings in the active dialog.
- The "hotkey bar" across the bottom of the display contains 8 keys. Hotkeys provide extended settings, depending on the active softkey. The hotkey bar may be replaced by the task bar; see below.

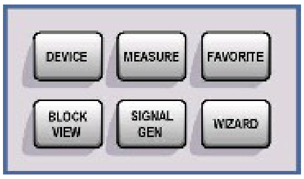
The following additional keys are related to the softkey bar:

MENU is for future extensions.

TASKS displays or hides the task bar across the bottom of the display area (toggle function). A task key gives access to either a generator or measurement control menu. The task bar replaces the hotkey bar; it contains a maximum of 8 tasks of the active session.

1.1.5 Setup Keys

The keys to the right of the display select views and control the measurements and windows. See also Data Entry Keys.

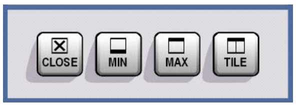


The view selection keys to the right of the display select one of the basic view types. The views provide different (and sometimes alternative) control and monitoring mechanisms for generators and measurements.

- DEVICE – for future extensions
- MEASURE opens the "Measurement Controller" view. Use this view type to select measurement firmware applications.
- BLOCK VIEW – for future extensions
- SIGNAL GEN – opens the "Generator Controller" view. Use this view type to control and configure RF generators.
- FAVORITE – for future extensions
- WIZARD – for future extensions

The keys on top of the rotary knob control measurements, generators and control elements in dialogs.

- ON / OFF starts a measurement from the OFF state or aborts a running measurement; see Measurement Control. ON/OFF also switches generators on or off (see Generator Control) and selects/clears checkboxes in dialogs (toggle function).
- RESTART / STOP re-starts a measurement in the RDY state or stops a running measurement. RESTART/STOP also switches generators on or off (toggle function).
- ESC terminates the current stage of a session, e.g. by closing a dialog.
- CONTEXT – for future extensions.



The keys below the numeric key pad arrange different windows on the display.

- CLOSE closes the active window, e.g. a configuration dialog.
- MIN – for future extensions
- MAX – for future extensions
- TILE – for future extensions

1.1.6 Data Entry Keys

The keys in the data entry keypad are used to enter numbers and units.
Data entry keys are only enabled while the cursor is placed on a data input field in a dialog. Their function depends on the data type of the input field.


The keys 0 to 9 enter the corresponding numbers (in numeric input fields) or characters (character input fields).


The function of these keys depends on the data type of the active input field:

- In numeric input fields, the keys enter the decimal point and change the sign of the entered numeric value. Multiple decimal points are not allowed; pressing plus/minus for a second time cancels the effect of the first entry.
- In hexadecimal input fields, the keys enter the hex values E and F, respectively.
- In character input fields, the keys enter special characters and switch between upper and lower case, respectively.


The function of the four unit keys depends on the data type of the active input field; see Data Entry.

- In numeric input fields, the G/n, M/m, k/m or x1 keys multiply the entered value with factors of 10(-)9, 10(-)6, 10(-)3 or 1 and add the appropriate physical unit. x1 is equivalent to ENTER. It confirms the previous entry and deactivates the input field.
- In hexadecimal input fields, the keys enter the hex values A to D, respectively.
- In character input fields, the keys have no effect.


BACKSPACE deletes the last character before the cursor position or the selected character sequence. If an entire numeric value is selected, BACKSPACE moves the cursor in front of the first digit.


For future extensions.


Activates the edit mode for the selected input field or confirms and terminates the entry.

1.1.7 Rotary Knob and Navigation Keys

The rotary knob, the cursor keys and the PREV and NEXT keys are alternative control elements for data variation and navigation in the graphical user interface.

Rotary knob

- Increases or decreases numeric values in editing mode
- Moves the cursor, e.g. to a function block in the block view
- Scrolls within lists, tables or tree views
- Confirms entries (press the rotary knob, equivalent to ENTER)

Cursor keys

- The cursor up/down keys vary numeric values and scroll within lists, dialogs, or tables.
- The cursor left/right keys move the cursor in input fields and scroll within lists, dialogs or tables.

PREV and NEXT

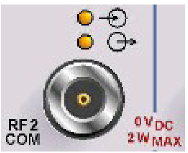
- Switch between several active elements in dialogs, e.g. in order to access all buttons, input fields etc. in a dialog.

1.1.8 Front Panel Connectors

The RF and AF connectors and various additional control interface connectors are located on the front panel.

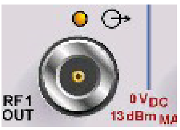
1.1.8.1 RF Connectors

The SNAP N-type connectors on the front panel labeled RF 1 OUT, RF 1 COM, RF 2 COM are used as inputs and outputs for RF signals. The impedance of all RF connectors is 50 Ω. The frequency ranges vary depending on the installed hardware options; the input and output level ranges are also variable (refer to the "Specifications").

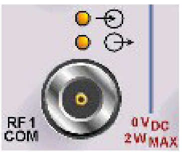


Bidirectional connector for various power ranges depending on the firmware application (refer to the "Specifications"). The two LEDs above the connector indicate the connector state:

- The upper LED is lit as long as the R&S CMW 500 is ready to receive signals.
- The lower LED is lit as long as it transmits an RF signal.



Output connector for high RF output powers depending on the firmware application (refer to the "Specifications"). The upper LED is lit as long as the R&S CMW 500 transmits an RF signal.



Bidirectional connector for various power ranges depending on the firmware application (refer to the "Specifications"). The two LEDs above the connector indicate the connector state:

- The upper LED is lit as long as the R&S CMW 500 is ready to receive signals.
- The lower LED is lit as long as it transmits an RF signal.

ATTENTION

Maximum Input Levels

The maximum input levels at all bidirectional RF connectors according to the front panel labeling or the data sheet must not be exceeded.

In addition, the maximum input voltages of other input connectors at the front and rear panel must not be exceeded.

RF connectors may warm up very much when high RF power is fed in!

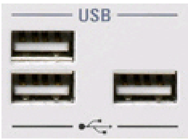
1.1.8.2 LAN Connector

8-pin connector RJ-45 used to connect the R&S CMW 500 to a Local Area Network (LAN). The LAN connector is equivalent to the connector of the same type labeled LAN REMOTE on the rear panel of the instrument. Refer to Remote Control in a LAN and LAN Interface.

1.1.8.3 SENSOR Connector

Lemosa 6-pin socket for NRP-Z27/-Z28 power sensors. An external power sensor can be used to monitor the power of an external signal or calibrate an RF source; see External Power Sensor Measurement.
The SENSOR connector controls the power sensor but also provides the power supply and trigger signals.

1.1.8.4 USB Connectors



Single Universal Serial Bus connectors of type A (master USB), used to connect e.g. a keyboard, mouse or other pointing devices, a printer or an external storage device (USB stick, CD-ROM drive etc.). The USB interface can also be used for remote control of the instrument; see section Remote Control Operation in the "Remote Control" chapter. All front panel USB connectors comply with standard USB 2.0; refer to the "Specifications".

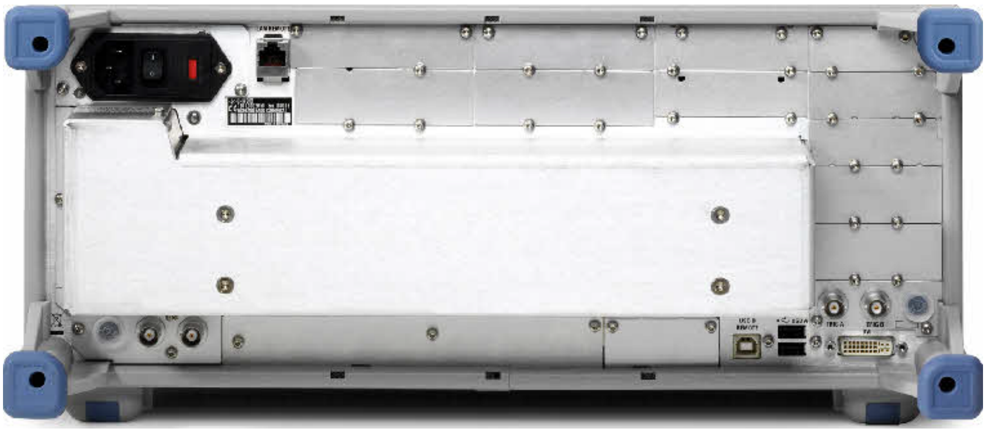
USB Connection
The length of passive connecting USB cables should not exceed 1 m. The maximum current per USB port is 500 mA.

1.1.8.5 AF Connectors

For future extensions.

1.2 Rear Panel Tour

This section gives an overview of the rear panel controls and connectors of the R&S CMW 500.



The rear connectors and interfaces are described in detail in the online help system or in the complete operating manual. The following connectors are available on all instruments:.

- LAN REMOTE is equivalent to the LAN connector (RJ-45) on the front panel. Use this connector to integrate the instrument to a Local Area Network, primarily for remote control purposes.
- REF IN is a BNC input for an external reference frequency. Use this connector to synchronize the R&S CMW 500 to another device.
- REF OUT 1 is a BNC output for the internal reference frequency of the R&S CMW 500. Use this connector to synchronize other instruments to the tester.
- The USB connectors can be used to connect e.g. a keyboard, mouse or other pointing devices, a printer or an external storage device (USB stick, CD-ROM drive etc.).
- TRIG A and TRIG B are two BNC connectors for external trigger signals.

The following connectors are optional:

- IEEE 488 CH 1 and IEEE 488 CH 2 are two equivalent GPIB bus connectors according to standard IEEE 488 /IEC 625. The connectors are available as options R&S CMW-B612A and R&S CMW-B612B, respectively. Use these connectors for remote control of the instrument in a GPIB bus system.
- DVI CMW-B620A is an external monitor connector which is available as option R&S CMW-B620A.

ATTENTION

Maximum Input Levels

The maximum input levels and voltages of the input connectors at the front and rear panel must not be exceeded.

1.3 Putting the Instrument into Operation

This section describes the basic steps to be taken when setting up the R&S CMW 500 for the first time.

ATTENTION

Instrument setup

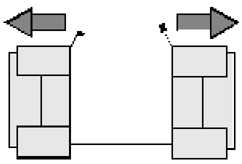
Before turning on the instrument, please make sure that the following conditions are fulfilled:

- Instrument covers are in place and all fasteners are tightened.
- Fan openings are unobstructed.
- Signal levels at the input connectors are all within the specified ranges.
- Signal outputs are correctly connected and not overloaded.
- The instrument is dry and shows no condensation.

Non-observance may cause damage to the instrument or other devices in the test setup.

1.3.1 Unpacking the Instrument and Checking the Shipment

1. Unpack the instrument and the other contents of the shipping container.
2. Check the shipment against the list of accessories to ensure that all items are included.
3. Remove the two protective caps from the front and rear and carefully inspect the instrument to make sure that it was not damaged during shipment.



Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the container and packing material.

Equipment returned or sent in for repair must be packed in the original container or packing with electrostatic protection. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors.

1.3.2 Instrument Setup

The R&S CMW 500 is designed for use under laboratory conditions, either on a bench top or in a rack. The general ambient conditions required at the operating site are as follows:

- The ambient temperature must be in the ranges specified for operation and for compliance with specifications (see "Specifications").
- All fan openings including the rear panel perforations must be unobstructed. The distance to the wall should be at least 10 cm.

1.3.3 Bench Top Operation

If the R&S CMW 500 is operated on a bench top, the surface should be flat.
The instrument can be used in horizontal position, standing on its feet, or with the support feet on the bottom extended.

WARNING

Danger of injury

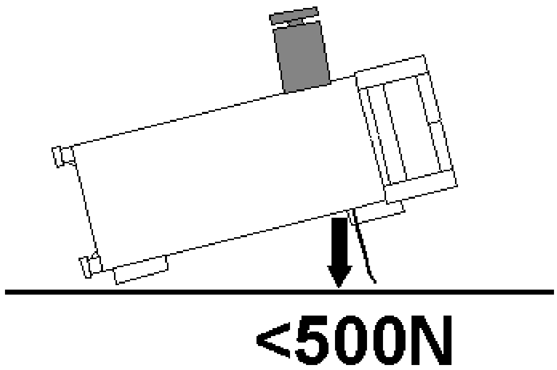
The feet may fold in if they are not folded out completely or if the instrument is shifted. The feet may break if they are overloaded.

Fold the feet completely in or completely out to ensure stability of the instrument and personal safety. To avoid injuries, never shift the instrument when its feet are folded out.

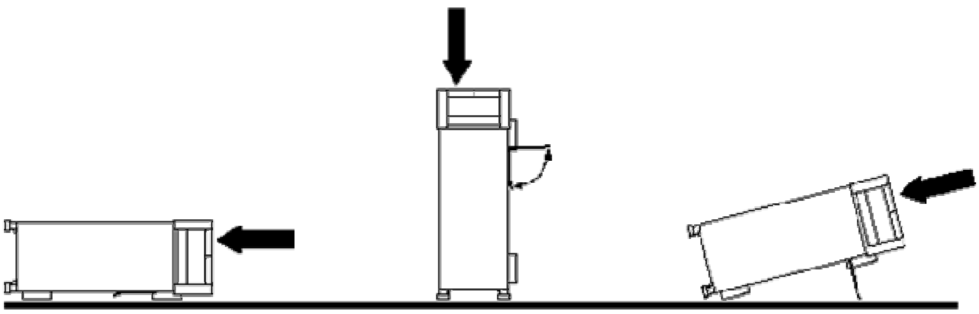
The overall load (the instrument's own weight plus that of the instruments stacked on top of it) on the folded-out feet must not exceed 500 N.

Place the instrument on a stable surface. Secure the instruments stacked on top of it against slipping (e.g. by locking their feet on the top front frame).

When the instrument is standing on its folded-out feet, do not work under the instrument and do not put anything under it, otherwise injuries or material damage could occur.



The instrument can be used in each of the positions shown here.



1.3.4 Mounting in a 19" Rack

The instrument can be mounted in 19" racks using a ZZA-411 (order number 1096.3283.00) adapter. Please note the mounting instructions supplied with the rack adapter.

ATTENTION

Operation in a rack

- Allow for sufficient air supply in the rack.
- Make sure that there is sufficient space between the ventilation holes and the rack casing.

1.3.5 EMI Protective Measures

In order to avoid electromagnetic interference (EMI), the instrument may only be operated when it is closed and with all shielding covers fitted. Only appropriate shielded signal and control cables may be used.

1.3.6 Connecting the Instrument to the AC Supply

The R&S CMW 500 is automatically adapted to the AC supply voltage supplied. The supply voltage must be between 100 V and 240 V with frequencies ranging from 50 Hz to 60 Hz (see also the tolerances quoted in the "Specifications"). The mains connector is located in the upper left corner of the rear panel.

- Connect the instrument to the AC power source using the AC power cable delivered with the instrument.

The maximum power consumption of the tester depends on the installed options. The typical power consumption is also listed in the "Specifications".
The R&S CMW 500 is protected by two fuses located in the fuse holder to the right of the AC power switch; see Replacing Fuses.

1.3.7 Power on and off

The mains connector is located at the bottom left corner of the rear panel.

- To turn the power on or off, press the AC power switch to position I (On) or 0 (Off).
- See also replacing fuses.

After power-on, the R&S CMW 500 is in standby or ready state, depending on the state of the standby toggle switch at the front panel of the instrument when the instrument was switched off for the last time.
The AC power switch can be permanently on. Switching off is required only if the instrument must be completely removed from the AC power supply.

1.3.8 Replacing Fuses

The instrument is protected by two fuses (T10 IEC 127-2/V, stock no. 0606.3136.00) located in the fuse holder to the right of the AC power switch on the rear panel.

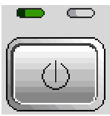
DANGER

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.

To replace the fuses

1. Open the lid of the AC power connector.
2. Lift the fuse holder out of its slot.
3. Exchange the two fuses.
4. Put the fuse holder back in its slot and close the lid.

1.3.9 Standby and Ready State



The STANDBY toggle switch is located in the bottom left corner of the front panel.

- After switching on the AC power, press the STANDBY key briefly to switch the R&S CMW 500 from the standby to ready state or vice versa.

In standby state, the right, amber LED is on. The standby power only supplies the power switch circuits and the optional oven quartz (Timebase OCXO, option R&S CMW-B690A). In this state it is safe to switch off the AC power and disconnect the instrument from the power supply.
In ready state, the left, green LED is on. The R&S CMW 500 is ready for operation. All modules are power-supplied and the R&S CMW 500 initiates its startup procedure.

CAUTION

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

1.4 Maintenance

The R&S CMW 500 does not require any special maintenance. Make sure that the air vents are not obstructed. The outside of the instrument is suitably cleaned using a soft, line-free dust cloth.

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.

For our support center address and a list of useful R&S contact addresses refer to the pages at the beginning of this manual.

1.4.1 Storing and Packing

The R&S CMW 500 can be stored at the temperature range quoted in the data sheet. When it is stored for a longer period of time the instrument should be protected against dust.
The original packing should be used, particularly the protective caps 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.

1.5 Connecting External Accessories

The equivalent USB ports on the front and rear panel of the R&S CMW 500 can be used to connect a variety of accessories:

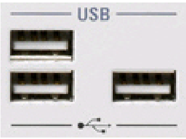
- A mouse simplifies operation of the instrument using the controls and dialogs of the Graphical User Interface (GUI).

- A keyboard simplifies the entry of data.
- A printer generates hard copies of the screen contents.

In addition the R&S CMW 500 provides interfaces for monitor connection and network integration:

- An external monitor shows the magnified Graphical User Interface (GUI) with all diagram areas and controls.
- A LAN connection can be established in order to access the hard disk or control the tester from an external PC.

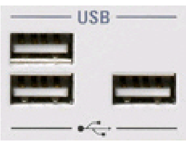
1.5.1 Connecting a Mouse



A USB mouse can be connected to one of the Universal Serial Bus connectors on the front panel or on the rear panel.
The mouse is detected automatically when it is connected. It is safe to connect or disconnect the mouse during the measurement.

Mouse configuration
Use the "Start – Control Panel – Mouse" menu of Windows XP to configure the mouse properties. To access Windows XP, press the Windows key on the external keyboard or the SYS key on the front panel.
Operating the R&S CMW 500 does not require a mouse. You can access all essential functions using the keys on the front panel.

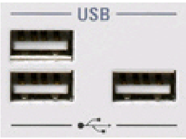
1.5.2 Connecting a Keyboard



A keyboard can be connected to one of the Universal Serial Bus connectors on the front panel or on the rear panel.
The keyboard is detected automatically when it is connected. The default input language is English – US. It is safe to connect or disconnect the external keyboard during the measurement.

Keyboard configuration
Use the "Start – Control Panel – Keyboard" or "Regional and Language Options" menu of Windows XP to configure the keyboard properties. To access Windows XP, press the Windows key on the external keyboard or the SYS key on the front panel.
Operating the tester does not require a keyboard. You can access all essential functions using the keys on the front panel. In combination with a mouse, the front panel keys provide access to all instrument functions.

1.5.3 Connecting a Printer



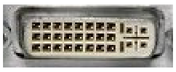
A printer can be connected to one of the Universal Serial Bus connectors on the front panel or on the rear panel.
It is safe to connect or disconnect the printer during the measurement. When printing a file, the tester checks whether a printer is connected and turned on and whether the appropriate printer driver is installed. If required, printer driver installation is initiated using Windows XP's "Add Printer Wizard". The wizard is self-explanatory. A printer driver needs to be installed only once, even though the printer may be temporarily removed from the tester.
To access Windows XP, press the Windows key on the external keyboard or the SYS key on the front panel.

Print dialog
Generating a hardcopy of a file requires the operating system and an appropriate application program. While in the R&S CMW 500 software application, you can use the Print Dialog to save the display contents to a file.

Printer driver installation
A great variety of printer drivers is available on the R&S CMW 500. To obtain the complete list, access Windows XP (press the Windows key) and open the "Add Printer Wizard" in the "Start – Control Panel – Printer and Faxes" menu.
You can load updated and improved driver versions or new drivers from an installation disk, USB memory stick or another external storage medium. Alternatively, if the tester is integrated in a network, you can install driver data stored in a network directory. In either case, use the "Add Printer Wizard" to complete the installation.

Printer configuration
Use the "Start – Control Panel – Printers and Faxes" menu of Windows XP to configure the printer properties.

1.5.4 Connecting a Monitor



A standard monitor can be connected to the DVI-D connector on the rear panel of the R&S CMW 500 (option R&S CMW-B620A).

ATTENTION

Monitor connection
The monitor must be connected while the instrument is switched off (in standby mode). Otherwise correct operation can not be guaranteed.

The monitor displays the magnified R&S CMW 500 screen with all dialogs, measurement results and control elements. No extra configuration is required.

Instrument control from the monitor
With an additional mouse or keyboard connected to the tester, you can control the measurement from the external monitor.
You may also connect a VGA monitor using an appropriate adapter.

1.5.5 Connecting a LAN Cable

A LAN cable can be connected to one of the LAN connectors on the front or rear panel of the R&S CMW 500. To establish a LAN connection proceed as follows:

1. Refer to section Assigning an IP Address and learn how to avoid connection errors.
2. Connect an appropriate LAN cable to one of the LAN ports. Use a commercial RJ-45 cable to establish a non-dedicated network connection, or a cross-over RJ-45 cable to establish a dedicated connection between the tester and a single PC.

Dedicated vs. non-dedicated network connections
There are two methods to establish a LAN connection of the R&S CMW 500:

- A non-dedicated network (Ethernet) connection from the tester to an existing network made with an ordinary RJ-45 network cable. The tester is assigned an IP address and can coexist with a computer and with other hosts on the same network.
- A dedicated network connection between the tester and a single computer made with a cross-over RJ-45 network cable. The computer must be equipped with a network adapter and is directly connected to the tester. The use of hubs, switches, or gateways is not needed, however, data transfer is still made using the TCP/IP protocol.

The IP address information is displayed in the Setup Dialog.

The two LAN connectors on the front and rear panel of the R&S CMW 500 are equivalent. Choose the one that is more convenient for your application.

ATTENTION

Avoid parallel connection

Never use both LAN connectors to connect the R&S CMW 500 in parallel to the same network as this will result in connection errors.

1.6 Starting the R&S CMW 500 and Shutting Down

To start the R&S CMW 500, proceed as follows:

1. Make sure that the tester is connected to the AC power supply and the power switch on the rear panel is in position I (On).
2. If necessary, press the STANDBY toggle switch on the front panel to switch the instrument to ready state (the green LED is on).

In ready state, the tester automatically performs a system check, boots the Windows XP operating system and then starts the CMW application with its Startup Dialog (see description in the "System Overview" chapter of the help system). If the previous session was terminated regularly, the CMW application uses the last setup with the relevant instrument settings.

Once the startup procedure has been terminated, the measurement or generator dialog opened in the previous session is displayed.

To shut down the R&S CMW 500, proceed as follows:

1. Press the STANDBY key to save the current setup, close the CMW application, shut down the Windows XP operating system and set the instrument to standby state. Of course you can also perform this procedure step by step like in any Windows session.
2. If desired, set the AC power switch to position 0 (Off).

ATTENTION

Standby state
It is strongly recommended to switch the R&S CMW 500 to standby state before disconnecting it from the AC supply. If you set the power switch to 0 while the CMW application is still running, you will lose the current settings. Moreover, loss of program data can not be excluded if the application is terminated improperly.

1.7 Remote Operation in a LAN

A LAN connection is used to integrate the R&S CMW 500 into a home/company network. This offers several applications:

- Transfer data between a controller and the tester, e.g. in order to run a remote control program. See "Remote Control Operation" on page 68.
- Transfer data from a remote computer and back, in particular waveform files (arb files).
- Control the measurement from a remote computer using the "Remote Desktop" application.
- Use external network devices (e.g. printers).

ATTENTION

Virus protection
An efficient virus protection is a prerequisite for secure operation in the network. Never connect your R&S CMW 500 to an unprotected network because this may cause damage to the instrument software.

To establish the connection proceed as follows:

1. Press the Windows key on the external keyboard or the SYS key on the front panel and open Windows XP's control panel.
2. Select "System" and open the "Remote" tab in the "System Properties" dialog. Enable "Allow users to connect remotely to this computer".
3. Assign an IP address to the tester following the directions below and connect the tester to the network as described in Connecting a LAN Cable.
4. Create a Remote Desktop Connection using the tester's IP address.

1.7.1 Assigning an IP Address

Depending on the network capacities, the TCP/IP address information for the R&S CMW 500 can be obtained in different ways.

- If the network supports dynamic TCP/IP configuration using the Dynamic Host

Configuration Protocol (DHCP), all address information can be assigned automatically.

- If the network does not support DHCP, or if the tester is set to use alternate TCP/IP configuration, the addresses must be set manually.

By default, the R&S CMW 500 is configured to use dynamic TCP/IP configuration and obtain all address information automatically. This means that it is safe to establish a physical connection to the LAN without any previous R&S CMW 500 configuration.

ATTENTION

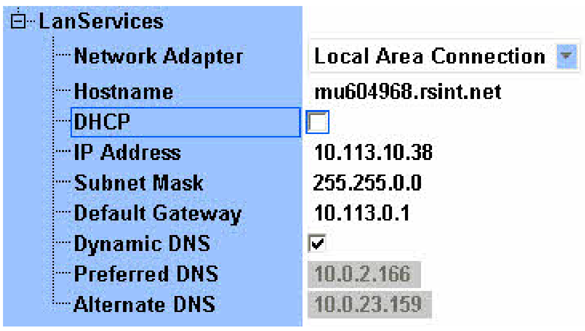
Valid IP addresses

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the R&S CMW 500 to the LAN. Contact your network administrator to obtain a valid IP address, because connection errors can affect the entire network.

Manual TCP/IP configuration

To disable dynamic TCP/IP configuration and enter the TCP/IP address information manually proceed as follows:

- Obtain the IP address and subnet mask for the R&S CMW 500 and the IP address for the local default gateway from your network administrator. If needed, also obtain the name of your DNS domain and the IP addresses of the DNS and WINS servers on your network. If you use both LAN connectors, you need two different sets of address information.
- Connect an external monitor and an external keyboard to your instrument and perform the startup procedure.
- Press the SETUP key on the front panel to open the "Setup" dialog.
- In the "Lan Services" section, disable DHCP and enter your address information, e.g.:



- If necessary, you can also disable "Dynamic DNS" assignment and enter your own DNS addresses.

1.7.2 Remote Desktop Connection

"Remote Desktop" is a Windows application which can be used to access and control the R&S CMW 500 from a remote computer through a LAN connection. While the measurement is running, the screen contents of the tester are displayed on the remote computer, and "Remote Desktop" provides access to all of the applications, files, and network resources of the R&S CMW 500.

To set up a "Remote Desktop" connection

1. Connect the R&S CMW 500 to a LAN and determine its IP address; see Remote Operation in a LAN.
2. Set up your remote computer (integrated in the LAN) to use "Remote Desktop" and create the "Remote Desktop" connection to the tester.

For detailed information about "Remote Desktop" and the connection refer to the Windows XP help system.

1.8 Windows XP

The R&S CMW 500 is equipped with a Windows XP operating system which has been configured according to the instrument's features and needs. Changes in the system configuration can be necessary in order to

- Establish a LAN connection.
- Customize the properties of the external accessories connected to the R&S CMW 500.
- Call up additional software tools.

ATTENTION

Configuration of the operating system, updates

The operating system is adapted to the R&S CMW 500. To avoid impairment of instrument functions, only change the settings described in this manual. Existing software must be modified only with update software released by Rohde & Schwarz. Likewise, only programs authorized by Rohde & Schwarz for use on the instrument must be executed.

The desktop of the operating system is accessed by pressing the SYS key to the left of the display or the Windows key + D on the external keyboard. All necessary settings can be accessed from the "Start" menu, in particular from the "Control Panel".

1.9 Firmware Update

The R&S CMW 500 firmware consists of the the CMW base software package plus several additional packages for firmware applications and additional utilities. All packages for the R&S CMW 500 are integrated in a single setup file "SetupCMW<xxx>.exe" (<xxx> denotes the type of the installation version). The setup file is located in an installation directory, possibly together with additional files.

A valid firmware configuration contains the base system plus at least one firmware application. Optional firmware packages must be enabled in the "Setup" dialog before they can be executed.

To perform a firmware update,

1. Shut down a running R&S CMW 500 software using an external keyboard and "Alt + F4".
2. Open Windows XP's "start" menu, click "All Programs" and start the uninstall tool "uninstall_cmw.bat".

The uninstall tool opens a command prompt window.

3. During the uninstall process, confirm possible popup dialogs. Wait until the command prompt is automatically closed.
4. Press the standby key to shut down and reboot the instrument. Cancel possible messages during the startup procedure.
5. Copy the complete installation directory to drive c: of the the internal hard disk of your R&S CMW 500.
6. Double-click the setup file. In the "R&S Software Distributor" opened, select "Local Installation". See background information about the "R&S Software Distributor" below.
7. In the next screen, select the R&S CMW 500 base system and the desired additional packages. Click "Install".
8. Follow the instructions of the setup wizard until the installation is finished.
9. To finalize the installation, shut down and restart the instrument using the standby key. In the startup dialog, click "Cold Boot" in order to update the firmware-specific data that the R&S CMW 500 stores internally.

The R&S CMW 500 is now ready to operate with the new firmware version.

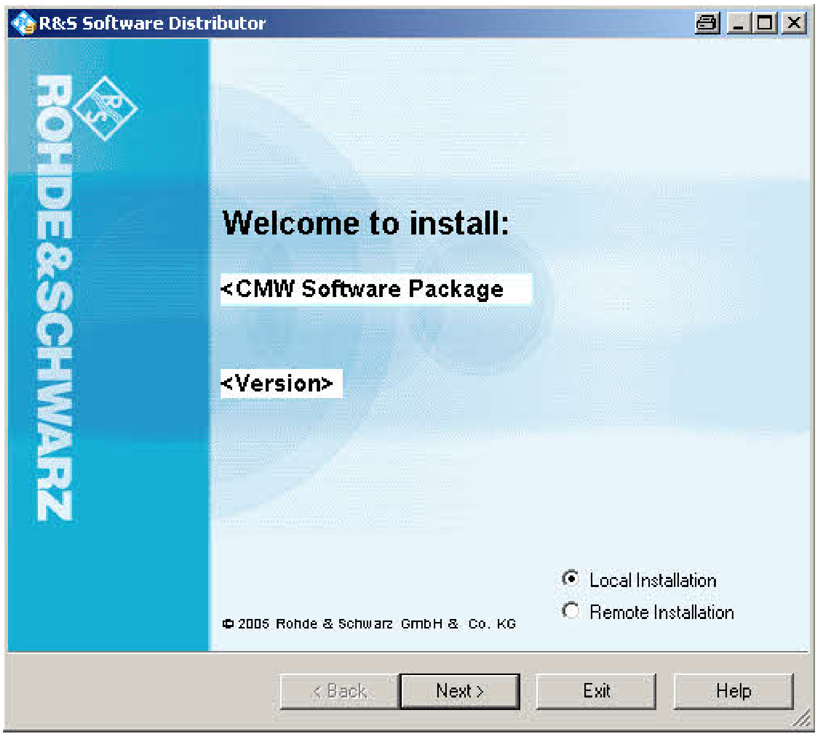
Setup files can be stored and installed again. The internal hard disk contains two partitions, corresponding to the drives c: and d:.

- Drive C: contains the installation data. It is recommended to reserve drive C for installation files.
- Drive D: is the preferred partition for all other data (e.g. user data, log files).

External storage devices (USB memory sticks) are automatically mapped to the next free drive, i.e. E:, F:etc.

R&S Software Distributor

The "R&S Software Distributor" is a software utility that is opened when a R&S CMW 500 setup file is started.



R&S Software Distributor

The software distributor can initiate a local or a remote installation. Local installation according to the procedure described above is recommended.

The installation process itself is self-explanatory.

2 Getting Started

This chapter helps you to get familiar with the R&S CMW 500and explains how to solve basic tasks that you will frequently encounter when working with the instrument.

- Basic Tasks
- Sample Session

CAUTION

Risk of shock hazard and instrument damage
Before starting any measurement on your R&S CMW 500, please note the instructions given in chapter Preparing for Use.

In the System Overview chapter you will find detailed information on customizing the instrument and the display according to your personal preferences. The system overview also provides information on the utility menus of the R&S CMW 500 platform.
For information about general purpose RF (GPRF) measurements and GSM, WCDMA... measurements refer to the relevant chapters.
In the following we assume that you are familiar with standard Windows dialogs and mouse operation. Refer to sections Accessing Dialogs, Using Front Panel Keys, and Data Entry to learn how to control the instrument without a mouse and keyboard.

2.1 Basic Tasks

The following sections can help you to make efficient use of the Graphical User Interface (GUI) and its control elements:

- Accessing Dialogs
- Using Keyboard Shortcuts
- Data Entry
- Using Front Panel Keys
- Using an External Keyboard
- Configuring the Task Bar

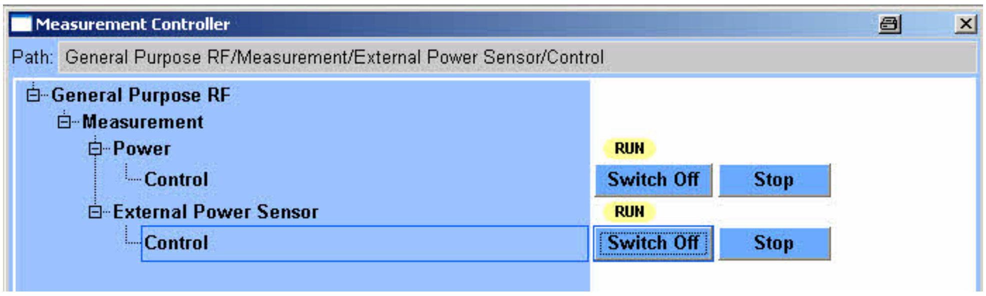
2.1.1 Accessing Dialogs

The R&S CMW 500 provides different alternative methods for a quick access to its dialogs.

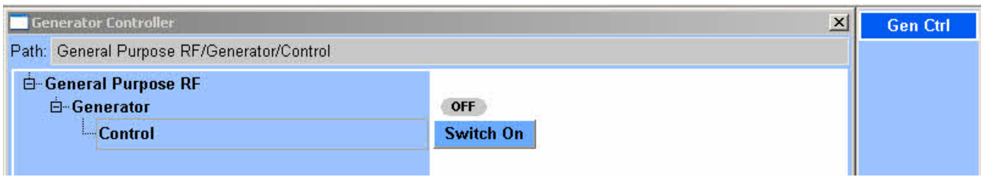
- Press the "TASKS" key at the bottom of the softkey bar to display the installed generators and measurements across the bottom of the screen.

- Press one of the hotkeys to open the main dialog of the associated firmware application.

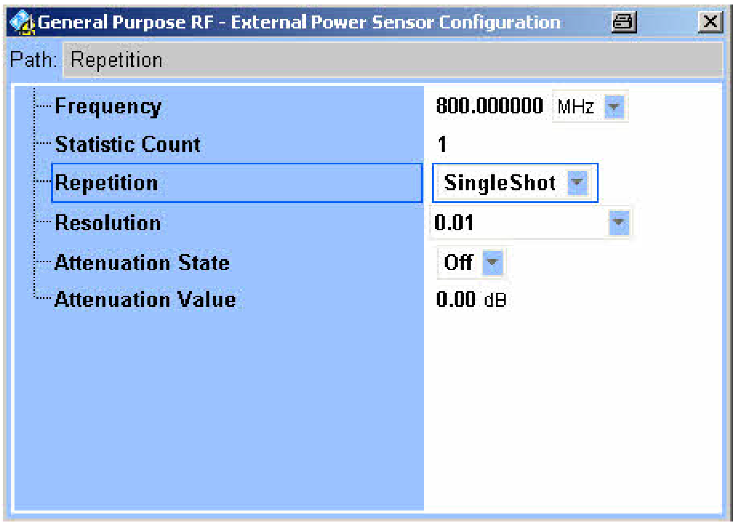
- Press the "MEASURE" key on the front panel or "Ctrl + M" on the external keyboard to open the "Measurement Controller" dialog, from where you can select each of the measurement applications which are enabled on your instrument.



- Press the "SIGNAL GEN" key on the front panel or "Ctrl + G" on the external keyboard to open the "Generator Controller" dialog and activate a generator application.



- Within a measurement application, press the "Config." hotkey in the lower right corner of the screen to open the configuration dialog for the measurement.



Keyboard Shortcuts
Keyboard shortcuts (e.g. "Ctrl + M" for the "Measurement Controller"; see above) provide direct access to all utility menus of the R&S CMW 500. Keyboard shortcuts are indispensable if you operate the instrument from an external monitor.

2.1.2 Using Keyboard Shortcuts

Keyboard shortcuts provide direct access to the utility dialogs of the Graphical User Interface. The R&S CMW 500 provides the keyboard shortcuts listed in the following tables.

Dialog opened	Shortcut
Generator Controller	Ctrl + G
Help	F1
Info	Ctrl + I
Measurement Controller	Ctrl + M
Print	Ctrl + P
Reset	Ctrl + R
Save/Recall	Ctrl + S
Setup	Ctrl + E
Task Bar	Ctrl + Tab

Keyboard Shortcuts for utility dialogs

Front Panel Key / Action	Shortcut
ON | OFF / Switch generator on or off	Ctrl + Enter, Ctrl + Return
ON | OFF or RESTART | STOP / Switch measurement on or off	Ctrl + Enter, Ctrl + Return

Keyboard Shortcuts for front panel keys

2.1.3 Data Entry

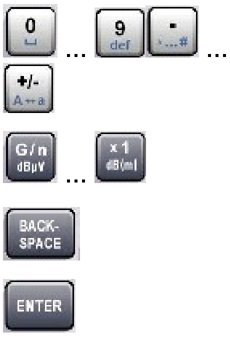
The R&S CMW 500 provides dialogs with various types of input fields where you can enter numeric values and character data. Data entry with a mouse and an external keyboard is a standard procedure known from all Windows applications (see also Using an External Keyboard). However, you can also enter data using the front panel keys.
The data entry keys are used to enter numbers and units.

To access and activate an input field:

- Access the dialog using one of the methods described in Accessing Dialogs.
- Turn the rotary knob to the clockwise or counterclockwise to step forth and back through the active elements in the dialog. Alternatively, use the cursor up/down keys.
- Press the rotary knob or press "ENTER" to activate an input field.

A tooltip shows the allowed range for numeric input values.

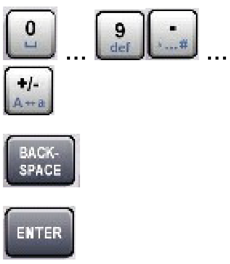
To enter a numeric value:



- Use the data entry keys to enter numbers, signs, and units.
- Use the keys 0 to 9 to enter the corresponding number.
- Use the dot and plus/minus keys to enter the decimal point and change the sign of the entered numeric value. Press the plus/minus key for a second time to cancel the effect of the first entry.
- Press the G/n, M/m, k/m or x1 keys to multiply the entered value with factors of 10(-)9, 10(-)6, 10(-)3 or 1 and add the appropriate physical unit.
- Press "BACKSPACE" to correct an entry.
- Press "ENTER" or the rotary knob to confirm an entry and de-activate the input field.

In hexadecimal input fields, you can use the unit keys, the plus/minus key, and the sign key to enter the numbers A to F.

To enter characters:

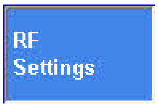


- Use the data entry keys to enter characters.
- Press the 0 to 9 repeatedly to enter different characters.
- Press the dot key for special characters.
- Press plus/minus to switch between upper and lower case.
- Press "BACKSPACE" to correct an entry.
- Press "ENTER" or the rotary knob to confirm an entry and de-activate the input field.

2.1.4 Using Front Panel Keys

Most dialogs of the Graphical User Interface provide a softkey/hotkey scheme for control via front panel keys. Together with the navigation keys and the data entry keys, softkeys and hotkeys ensure that you can access any instrument function without a mouse or an external keyboard.

To use softkeys and hotkeys:

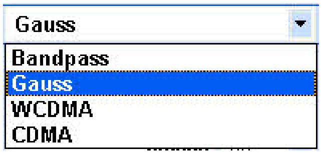


- Access the dialog using one of the methods described in Accessing Dialogs.
- Press the associated front panel key to activate a softkey.

The hotkeys which depend on the active softkey are displayed across the bottom of the screen.

- Press the front panel key below a hotkey to activate the hotkey.
- Use the rotary knob, the cursor keys, or the data entry keys to select parameters or enter data.

To access and activate control elements in dialogs:

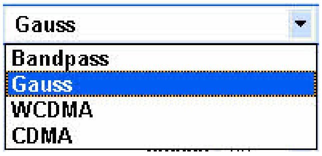


- Access the dialog using one of the methods described in Accessing Dialogs.
- Turn the rotary knob to the clockwise or counterclockwise to step forth and back through the active elements in the dialog. Alternatively, use the cursor up/down keys.
- Press the rotary knob or press "ENTER" to activate a control element.
- Turn the rotary knob or use the cursor keys to select a value from a pull-down list.

2.1.5 Using an External Keyboard

Control of the Graphical User Interface by means of an external keyboard can be a convenient alternative for mouse or front panel key control.

To access and activate control elements in dialogs:



- Access the dialog using one of the methods described in Accessing Dialogs.
- Use the cursor down/up keys on the external keyboard to step forth and back through the active elements in the dialog. Use the cursor left/right keys to change between menu levels or step to the first/last entry in a list.
- Press "ENTER" or "Return" to activate/deactivate a control element or confirm and entry.
- Use the cursor keys to select a value from a pull-down list.

A tooltip shows the allowed range for numeric input values.

To enter characters and numeric values:

- Use the data entry keys to enter characters, numbers, and signs in an active input field.
- Use the dot key to enter the decimal point of a numeric value.
- Use the minus key to change the sign of the entered numeric value. Press the minus key for a second time to cancel the effect of the first entry.
- Use the cursor up/down keys to increment/decrement numbers. Use the cursor left/right keys to move the cursor within a field, e.g. if you wish to change the different digits of a decimal number separately.
- Press "BACKSPACE" to correct an entry.
- Press "ENTER" or "Return" to confirm an entry and de-activate the input field.

2.1.6 Task Bar

The task bar is a hotkey bar across the bottom of the display. The keys in the task bar give direct access to generator or measurement applications.

To access the task bar:

- Press the TASKS front panel key or "Ctrl + Tab" on your external keyboard to open the task bar.
- Use the mouse or the front panel hotkeys to click a particular task key.

2.2 Sample Session

The following measurement example consists of the following stages:

- Generating an RF Signal
- Measuring an RF Signal

Reset
To obtain predictable results it is recommendable to reset the R&S CMW 500. to a definite state before you check out any of the measurement examples reported below. Press the RESET front panel key to open the "Reset" dialog and select a "Preset".

2.2.1 Generating an RF Signal

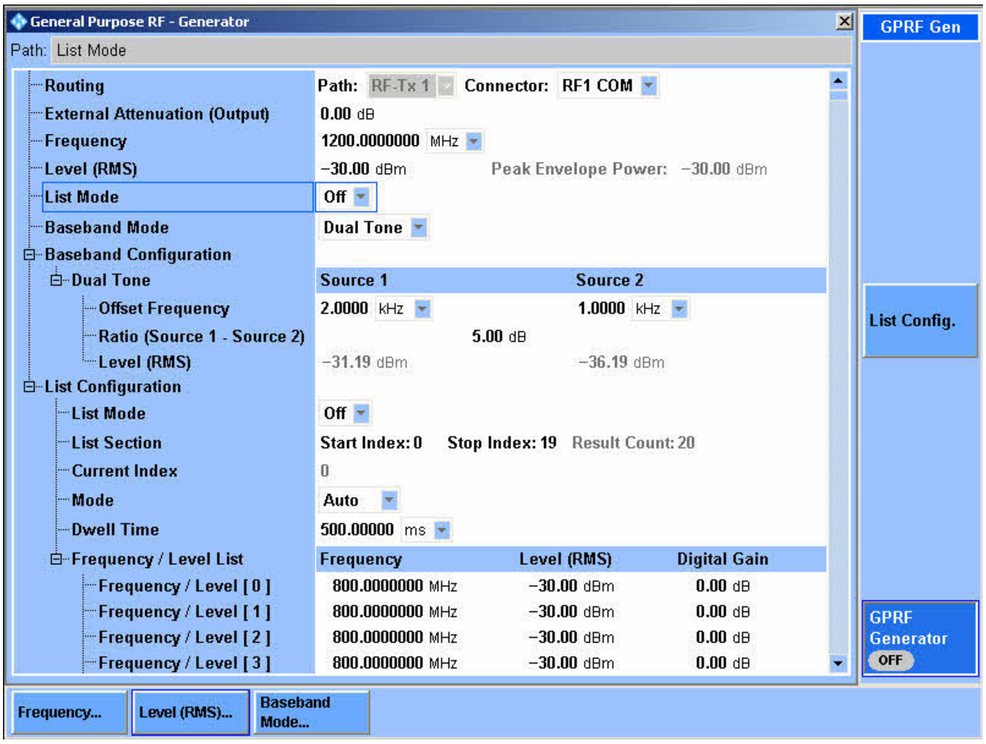
Generators provide RF signals for test purposes.
All generators are controlled in an analogous manner.

2.2.1.1 GPRF Generator

The General Purpose RF (GPRF) generator provides an RF signal at constant frequency or at a series of configurable frequencies and levels. It is also possible to generate an RF signal that is modulated using a waveform file (ARB generator, option R&S CMW-B110 A required). All RF signals are configured in a similar way.
To configure the GPRF generator for dual-tone signal at constant frequency,

1. Press the TASKS key on the front panel and select the "GPRF Generator" from the task bar across the bottom of the display. See also Configuring the Task Bar.

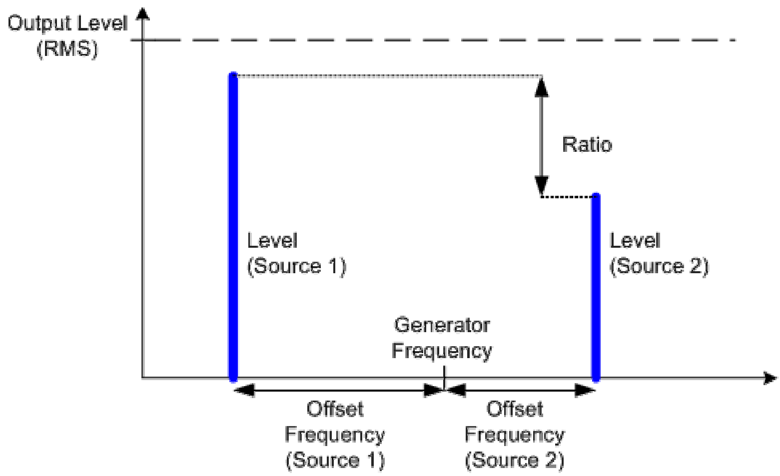
The "General Purpose RF – Generator" dialog is opened.



General Purpose RF Generator dialog

2. Click "Routing > Connector" and select your RF output connector, depending on the required RF output level (see "Specifications"). To generate the RF output levels that are typically used for mobile phone receiver tests, you can choose the (default) RF1 COM connector.
3. Select the "Frequency" (1200 MHz) and "Level (RMS)" (–30 dBm) of the RF output signal.
4. If your test setup contains a known, frequency-independent attenuation, enter the value as an "External Attenuation (Output)".
5. Ensure that the "List Mode" is disabled (Off).
6. Select "Baseband Mode: Dual Tone".
7. In the "Baseband Configuration > Dual Tone" section, configure the properties of the dual-tone signal. To superimpose two CW signals at different frequencies and levels, set the "Offset Frequency" of both signals and define a "Ratio (Source 1 – Source 2) that is different from 0 dB; see figures below.
8. Press ON | OFF to switch the RF generator on.

Dual Tone Settings



SSB modulated generator signal

You can now tap the RF generator signal with the selected properties at the RF1 COM connector. For an instructive configuration check, you can connect RF1 COM to RF2 COM using a coax cable and observe your signal using the "GPRF Power" measurement; see Measuring an RF Signal.

2.2.2 Measuring an RF Signal

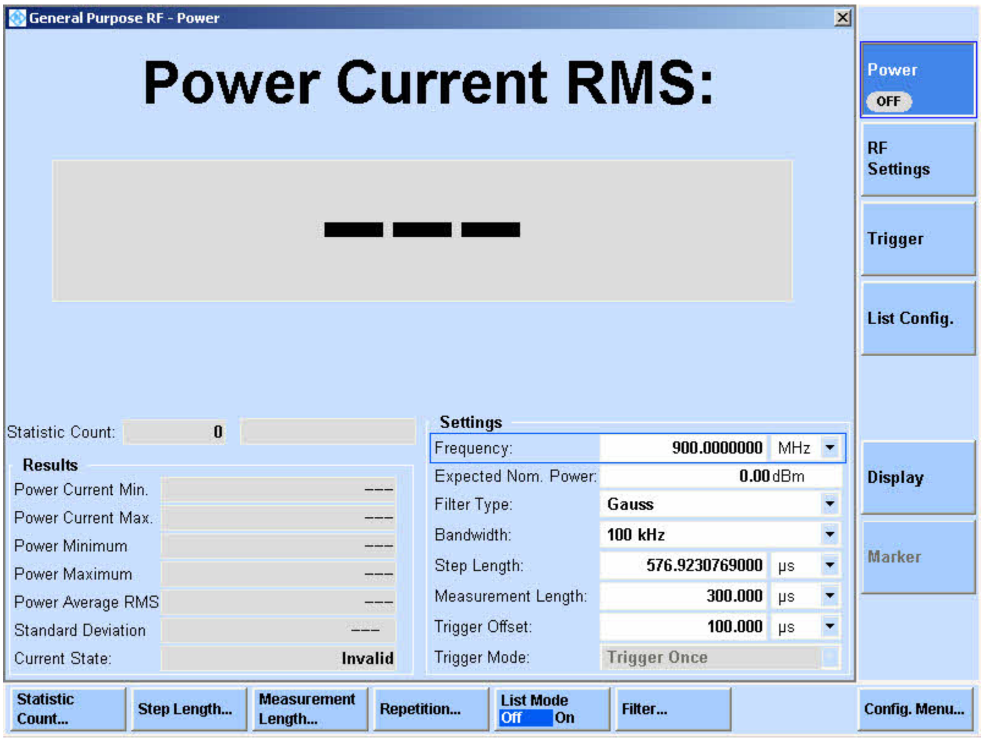
The R&S CMW 500 provides various general purpose and network-specific measurements. All measurements are controlled in an analogous manner.

2.2.2.1 GPRF Power

The Generator Purpose RF (GPRF) Power measurement measures a series of power steps at (possibly) different powers and frequencies and performs a statistical evaluation. As a simple example we can measure the RF signal generated by the GPRF generator of the R&S CMW 500. The signal is tapped at the RF1-COM connector and measured at RF2-COM.

1. Configure the GPRF generator as described in Generating an RF Signal.
2. Connect a coax cable between the two RF connectors RF1 COM and RF2 COM at the front panel of the R&S CMW 500 to ensure that the generator signal is fed to RF2-COM.
3. Press the TASKS key on the front panel and select the "GPRF Meas Power" measurement from the task bar across the bottom of the display. See also Configuring the Task Bar.

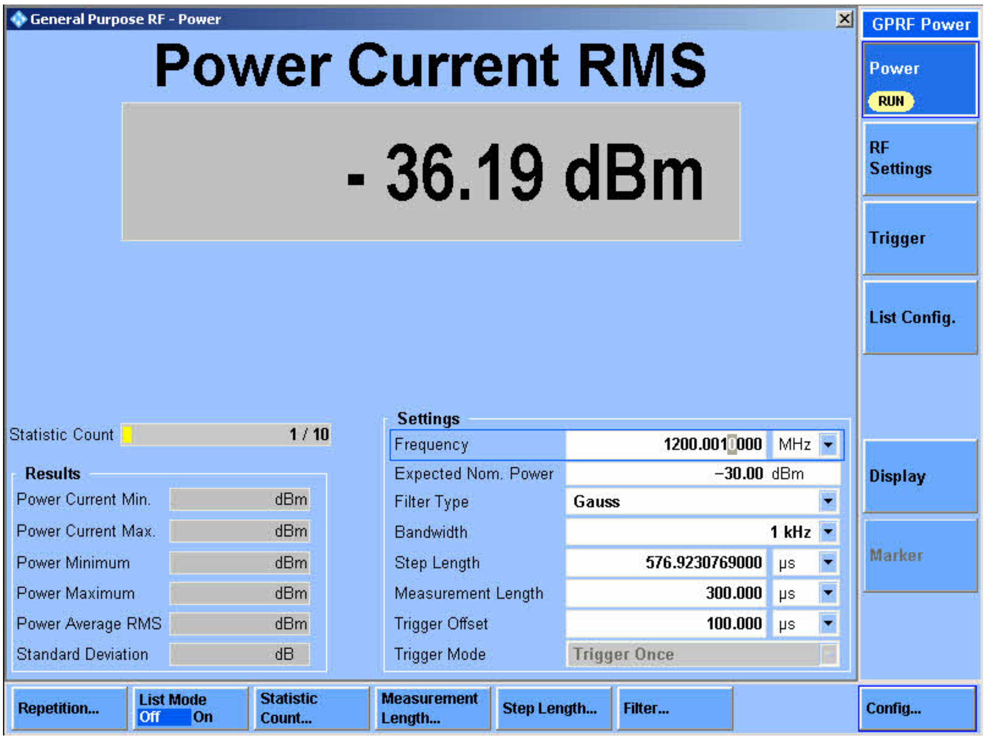
The "General Purpose RF – Power" dialog is opened.



General Purpose RF Power measurement dialog

4. Press ON / OFF (or RESTART / STOP) to start the measurement.
5. In the "Settings" panel of the measurement dialog, adjust the "Frequency", the "Expected Nominal Power", and the filter "Bandwidth" to the properties of your input signal.
6. Observe the measurement result on the screen.

In the present example, the upper tone (at 1200.001 MHz) of the generated dual-tone signal is observed in a 1 KHz bandwidth.



RF Power Results

3 System Overview

The following chapter provides an overview of the capabilities of the R&S CMW 500 and their use. This includes a description of the basic concepts that the tester uses to organize, process and display measurement data.
For a systematic description of the firmware applications (General Purpose RF, GSM measurements etc.) including background information refer to the relevant manuals.

3.1 Generators

The R&S CMW 500 provides generators for many of the supported network standards or general purpose applications. All generators are controlled in an analogous way. The following topics describe the principles of generator control and settings that are similar for many generators.

3.1.1 Generator Control

Generators can be in the "ON" or "OFF" states. In the default configuration, all generators are switched off; no output signal is available. The generator state is shown in the generator control softkey.

- To turn the generator on or off, press ON | OFF or RESTART | STOP. It is not necessary to select the generator control softkey.
- Alternatively, use the "Generator Controller" dialog to select and control generators.

As soon as an output signal is available at the selected connector, the generator control softkey indicates the generator "ON" state:

"Generator pending" state

Depending on the generator type and configuration, the R&S CMW 500 may require some time to provide the generator signal. E.g. the ARB generator signal is available only after a waveform file has been loaded:

While the generator is turned on but still waiting for resource allocation, adjustment, hardware switching, a yellow sandglass symbol in the generator control softkey indicates the "generator pending" state.

The yellow symbol disappears as soon as the generator signal is available.

3.1.2 RF Path Settings (Generators)

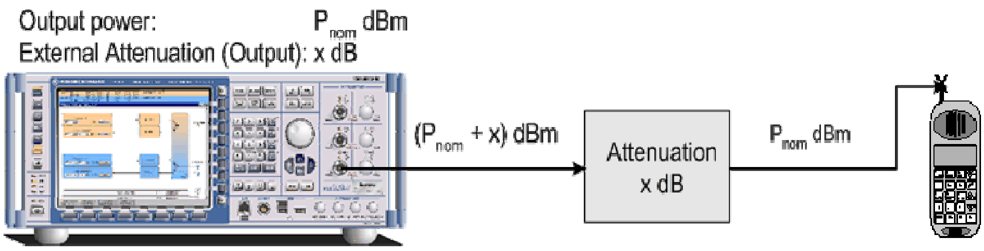
The R&S CMW 500 provides a number of settings that are very similar in different generators but can be configured independently. These settings control the routing of signals and the correction of the generator level.

Connector selection (input/output)

The R&S CMW 500 provides RF input and output connectors for different power ranges.
The RF connector is selected in the "RF Routing" section at the beginning of the measurement and generator configuration dialogs.

External attenuation (output)

Defines the value of an external attenuation (or gain, if the value is negative) in the output path. This is suitable if the RF generator is to compensate for the effect of a frequency-independent attenuating component (e.g. a cable) that is included in the test setup.
With an external attenuation of x dB, the generator power is increased by x dB so that the actual generator power differs from the output power shown in the dialog. The output power in the dialog is available at the input of the DUT. Negative values of the external attenuation decrease the effective generator power.



3.2 Measurements

The R&S CMW 500 provides several measurements for each of the supported network standards or general purpose applications. All measurements are controlled in an analogous way. The following topics describe the principles of measurement control and measurement results that are similar in many measurement contexts.

3.2.1 Measurement Control

Measurements can be in the "ON", "RDY", or "OFF" states. In the default configuration, all measurements are switched off; no results are available. The measurement state is shown in the measurement control softkey.

- To turn the measurement on or off, select the measurement control toggle softkey and press ON | OFF or RESTART | STOP. It is not necessary to select the measurement control softkey.
- Alternatively, use the "Measurement Controller" dialog to select and control measurements.

The behavior of the measurement control softkey depends on the "Repetition" mode selected in the configuration menu:

- If the measurement is turned on in "Single Shot" repetition mode, it enters the "RUN" state and returns to "RDY" as soon as a single shot result has been acquired.

- If the measurement is turned on in "Continuous" repetition mode, it remains in the "RUN" state until it is turned off explicitly using the measurement control softkey or the front panel keys (ON/OFF or RESTART/STOP).

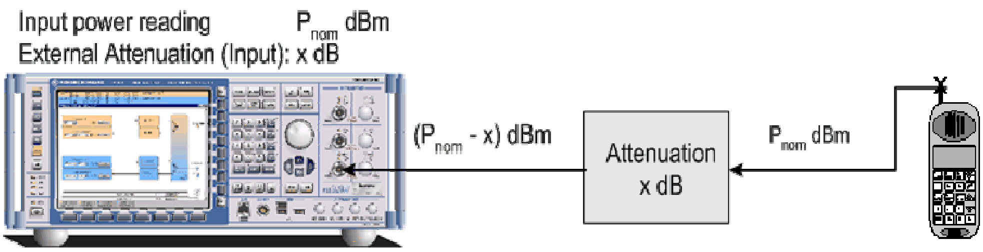
3.2.2 Connection Control (Measurements)

The R&S CMW 500 provides a number of settings that are very similar in different measurements but can be configured independently. These settings control the routing of input signals, the correction of the input power, the RF analyzer and trigger system.

Connector selection (input/output)
The R&S CMW 500 provides RF input and output connectors for different power ranges.
The RF connector is selected in the "RF Routing" section at the beginning of the measurement and generator configuration dialogs.

External attenuation (input)
Defines the value of an external attenuation (or gain, if the value is negative) in the input path. This is suitable if the test setup contains frequency-independent attenuating components (e.g. a cable, a test fixture or an RF shielding chamber used to hold the DUT).
An appropriate attenuation value corrects the power reading of the measurement and ensures that the measured powers are referenced to the output of the DUT.

- Positive values increase the power reading, compensating for an attenuation.
- Negative values reduce the power reading, compensating for an amplification factor.



The external attenuation also enters into the internal calculation of the maximum input power that the R&S CMW 500 can measure (see "Expected Nominal Power" below).

Expected Nominal Power
Defines the nominal power of the RF signal to be measured. The nominal power should be set in accordance with the actual transmitter output power of the DUT; an additional "External Attenuation" (see above) can be used to compensate for the loss in the test setup. Some measurements provide additional parameters to account for variations of the signal power (e.g. the "User Margin" for the GPRF Power measurement).

With an inappropriate setting of the expected nominal power, the measurement results generally deteriorate:

- If the "Expected Nominal Power" setting is too low, the RF input connector is overdriven. This can cause unwanted responses in the input path.
- If the "Expected Nominal Power" setting is too high, the RF input connector is underdriven, which also impairs the accuracy of the measurements.

Analyzer Frequency

Sets the center frequency of the RF analyzer. This value must be in accordance with the measured RF signal in order to obtain meaningful measurement results.

3.2.3 Statistical Settings

Measurements generally cover a basic time interval and can be repeated periodically. The measurement interval depends on the measurement context.

The number of measurement intervals that the R&S CMW 500 repeats in order to calculate statistical results is termed "statistic count" or "statistic length" (multi-measurement count). After one statistic count, the instrument has terminated a basic measurement cycle ("single shot" measurement). Measurement cycles can be repeated for an unlimited number of times, resulting in the "continuous" repetition mode.

Most measurement contexts provide different sets of measurement results; they are calculated as described in section Statistical Results.

The statistical settings described below are set in the configuration dialogs assigned to each measurement.

Statistic Count / Measurement Cycle

The statistic count (also termed statistic length) is the integer number of measurement intervals per measurement cycle (statistics cycle, single shot measurement). The length of a measurement interval is measurement-specific.

- The measurement interval for the GPRF Power measurement is a configurable time interval termed the Measurement Length/Step Length. This corresponds to either a single power step (if no sequence mode is active) or a step sequence.
- The measurement interval for the GPRF External Power Sensor measurement is the time to request and obtain a single power result from the power sensor.
- The measurement interval in most network test applications is related to a network-specific periodic time interval, e.g. a timeslot or burst.

Depending on the repetition mode (see below), a measurement may extend over one or several measurement cycles.

Statistic length in continuous measurement
The statistic length has an impact on continuous measurements because it enters into the averaging procedures.

Repetition Mode
The repetition mode defines how many statistics cycles are measured. Two modes are available for all measurements:

- **Single Shot:** The measurement is stopped after one statistics cycle.
- **Continuous:** The measurement is continued until explicitly terminated by the user; the results are periodically updated.

Manual and remote control
In contrast to mode other instrument settings, the repetition modes in manual and remote control are independent and do not overwrite each other. The default repetition mode in manual control is "Continuous" (observe results over an extended period of time), the default mode in remote control is "Single Shot" (perform one measurement and retrieve results). See also Reset Dialog.

Stop Condition
For measurements providing a limit check, two stop conditions can be selected:

None	The measurement is performed according to its "Repetition" mode and "Statistic Length", irrespective of the limit check results.
On Limit Failure	The measurement is stopped as soon as one of the limits is exceeded, irrespective of the repetition mode set. If no limit failure occurs, it is performed according to its "Repetition" mode and "Statistic Length". Use this setting for measurements that are essentially intended for checking limits, e.g. production tests.

3.2.4 Statistical Results

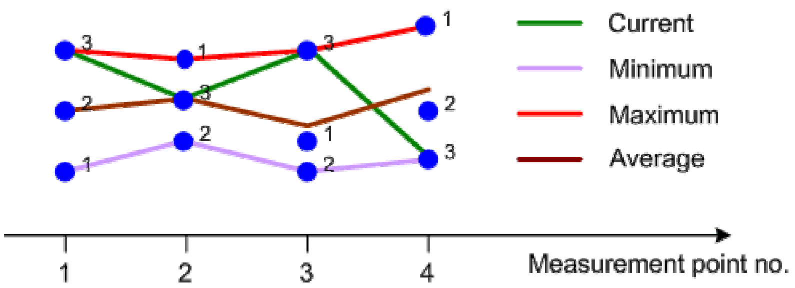
The R&S CMW 500 repeats the measurements according to the selected statistic count and repetition mode; see General Measurement Settings. Consecutive measurement values are stored and used to calculate statistical results. The following settings are related to measurement statistics:

- Statistics Type
- Detectors
- Peak Values
- Averaging
- Standard Deviation

3.2.4.1 Statistics Type

The statistics type defines how the R&S CMW 500 calculates the displayed values if the measurement extends over several measurement intervals. Assume that a trace or a bar graph contains a series of different measurement points. After n consecutive measurement intervals, the instrument has collected n complete traces, corresponding to n measurement results at each point. The different statistics types are calculated as follows:

- **Current:** The current trace, i.e. the last result at all measurement points
- **Minimum:** The smallest of the n collected values at each measurement point
- **Maximum:** The largest of the n collected values at each measurement point
- **Average:** At each test point, a suitably defined average over all collected values is displayed; see Averaging Procedures.
- **Standard Deviation:** At each test point, the root mean square deviation of all collected values from the "Average" value is displayed; see Standard Deviation.



Statistics Types

Differences between statistical calculations

Minimum/Maximum and Average results are calculated differently if the measurement extends over more than one statistics cycle (repetition mode "Continuous", measurement time longer than one statistics cycle):

- The "Minimum" and "Maximum" values represent the smallest and largest values ever measured.
- The "Average" result is referenced to the last statistics cycle; see paragraph on Averaging Procedures below.

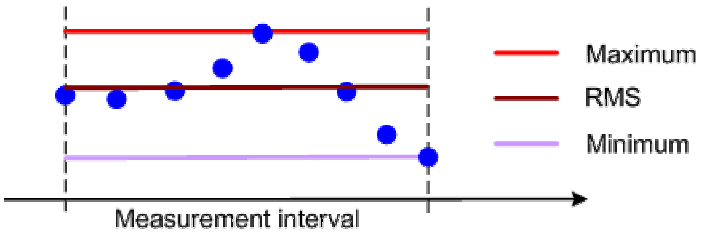
The statistics type of the displayed trace generally belongs to the display configuration

settings in the measurement configuration dialogs. For single measurement results, the R&S CMW 500 often displays a table with all statistics types.
The statistics type is often combined with detector settings; see below.

3.2.4.2 Detectors

The detector setting specifies how a single measurement result is calculated from a set of adjacent measurement points:

- **RMS:** The displayed result represents the RMS average (e.g. the mean power) in a specified measurement interval.
- **Minimum:** The displayed result represents the minimum value in a specified measurement interval.
- **Maximum:** The displayed result represents the maximum value in a specified measurement interval.



Detector Type

The measurement interval varies from one measurement to another; it is typically a particular time or frequency interval.
Detector and statistics type settings can be combined. E.g. in the GPRF Power measurement, the following results are available:

- **Statistics type: Current, Detector: RMS:** The current trace, calculated from RMS-averaged values over the specified "Measurement Length".
- **Statistics type: Current, Detector: Minimum:** The current trace, calculated from minimum values within the "Measurement Length".
- **Statistics type: Current, Detector: Maximum:** The current trace, calculated from maximum values within the "Measurement Length".
- **Statistics type: Average, Detector: RMS:** The average trace, calculated from RMS-averaged values over the "Measurement Length".
- **Statistics type: Minimum, Detector: Minimum:** The minimum trace, calculated from minimum values within the "Measurement Length".
- **Statistics type: Maximum, Detector: Maximum:** The maximum trace, calculated from maximum values within the "Measurement Length".

3.2.4.3 Peak Values

"Peak" values are calculated as the maximum of the magnitude times the sign:

- For positive quantities such as the EVM, the peak value is equal to the maximum.

- For negative quantities such as the I/Q offset and the I/Q imbalance, expressed in dB, the peak value is equal to the minimum.
- For symmetric quantities with alternating sign such as the phase, frequency or timing error, the peak value is either the maximum or minimum, whichever has the larger magnitude.

3.2.4.4 Averaging

In single shot measurements, "Average" values (traces and single values) are calculated as the arithmetic mean value over all measurement intervals since the start of the measurement. Assume that n measurement intervals have been measured. The average result at each measurement point is obtained recursively from the preceding $(n-1)^{st}$ average result and the n^{th} current result:

$$Avg(n) = \frac{n-1}{n} \cdot Avg(n-1) + \frac{1}{n} \cdot Cur(n) \quad \text{(Equation 1)}$$

To obtain average traces, the R&S CMW 500 calculates the average of consecutive measurement intervals at each trace point.
The formula above is modified for symmetric quantities like the magnitude error and the phase error, where positive and negative contributions tend to compensate each other. The "Average" of these quantities is obtained as the average of the absolute values:

$$Avg(n) = \frac{n-1}{n} \cdot Avg(n-1) + \frac{1}{n} \cdot |Cur(n)| \quad \text{(Equation 2)}$$

Logarithmic quantities are first averaged and then converted to a dB-value.
Note that the frequency error and timing error, although symmetric, is averaged according to Equation 1.

Modification for continuous measurements
For continuous measurements after the first statistic cycle, Equation 1 and Equation 2 above are modified in order to ensure that the statistical weight of the last trace measured does not fall below the "statistic length". For a statistic length c (c measurement intervals per cycle) and n > c, Equation 1 is replaced by:

$$Avg(n) = \frac{c-1}{c} Avg(n-1) + \frac{1}{c} Curr(n) \qquad (n > c)$$

As a consequence, the statistic length has an impact on average results obtained in continuous measurements.

3.2.4.5 Standard Deviation

The "Standard Deviation" σ_n indicates the spread of the n values at each measurement point. It is defined as the square root of the variance, which is the mean square of the deviation of the values from their own arithmetic mean.

$$\sigma_n^2 = \frac{\sum_{i=1}^{n} \left(x_i - \overline{x_n}\right)^2}{n}; \quad \sigma_n = \sqrt{\sigma_n^2}$$

The variance can be calculated using the following recursive equation:

$$\sigma_n^2 = \left[\left(x_n - \overline{x_{n-1}}\right)^2 \cdot \frac{1}{n} + \sigma_{n-1}^2\right] \cdot \frac{n-1}{n}$$

with the arithmetic mean value:

$$\overline{x_n} = \frac{\sum_{i=1}^{n} x_i}{n} = x_n \cdot \frac{1}{n} + \overline{x_{n-1}} \cdot \frac{n-1}{n}$$

The formula above is modified for symmetric quantities like the magnitude error and the phase error, where positive and negative contributions tend to compensate each other. The arithmetic mean value and the standard deviation of these quantities is obtained as the average of the absolute values.

3.2.5 Trigger Settings

The trigger system synchronizes a particular measurement with events. The following sources of trigger events are used in many different measurements:

- With the "Free Run" trigger source setting, the measurement is not related to any trigger events. The R&S CMW 500 measures as fast as possible.
- With a "Power Meas. Trigger", the measurement is started when the level of the measured RF signal crosses a definite "Trigger Threshold" value. This trigger setting requires an RF input signal with variable power (power ramp, bursts). The trigger event can be set to occur at the rising or falling edge of the bursts.

Many measurements provide refined trigger settings to improve the flexibility and performance.

3.2.6 TX Measurements

The purpose of a TX measurement is to assess the performance of an RF transmitter. Despite the differences in detail, TX measurements for different network standards have many properties in common.

- Transmitter Output Power
- Modulation Accuracy
- Adjacent Channel Power
- Multi-Evaluation Measurements

3.2.6.1 Power Results

Power measurements are essential, e.g. for checking whether the transmitter output power complies with the power class of the device under test, or testing various power control mechanisms. The R&S CMW 500 provides two different types of power results:

- Most of the power results are averaged over an appropriate time interval (e.g. a section within the useful part of a GSM burst or a WCDMA slot minus the guard period on both sides of the slot boundary). Average powers are used to check whether a transmitter produces the correct output power, according to the device's power class and the desired power step.
- Traces for the power versus time give detailed insight into the transmitted power, including the structure of power ramps and possible effects of the modulation.

For details refer to the description of the measurement firmware applications.

3.2.6.2 Modulation Accuracy

Modulation accuracy is the ability of the UE transmitter to generate an ideally modulated signal. Modulation accuracy is assessed by a number of quantities which are analogous for all digital phase modulation schemes.

- Timing and frequency error
- Error vector magnitude, magnitude error, phase error
- I/Q Offset, I/Q Imbalance

The modulation parameters are acquired in a single measurement process. The calculation is based on the comparison of the actual output signal Z of the transmitter under test with a reference signal R that is generated by the R&S CMW 500 and represents an ideal error-free received signal. An example for the process (WCDMA signals) is described in standard 3GPP TS 24.121, Annex B.

Timing and Frequency Error

The R&S CMW 500 must establish time synchronization with the input RF signal and estimate its timing, carrier frequency and power. The frequency error is the offset of the measured carrier frequency from the nominal RF frequency of the measured radio channel.
The calculated reference signal R is modified using the estimated timing, frequency error and power. The resulting corrected reference signal R' is used to determine the error vector magnitude, magnitude error and phase error.
The timing error is the deviation of the measured signal timing from the expected timing, which is generally derived from a trigger event.

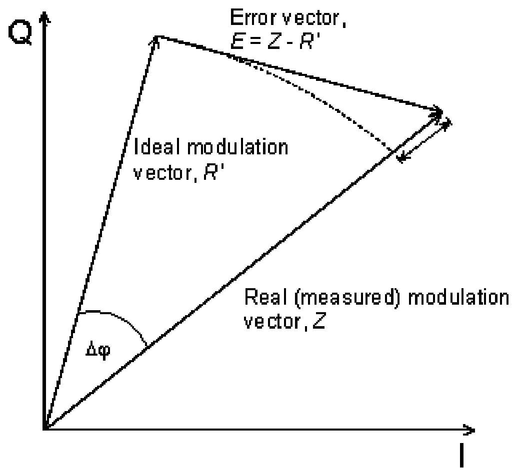
Error Vector Magnitude (EVM), Phase Error, Magnitude Error

The error vector E = Z – R’ is calculated as an array at each sample in the measurement interval. From E and Z the following arrays can be calculated:

$|E| = |Z - R'|$ **Magnitude of the error vector**, calculated at each sample in the measurement interval.

Δφ **Phase error**

| Z | - | R' | **Magnitude error**



In general the measurement dialogs show the relative magnitude error and the relative EVM, i.e. the quantities defined above divided by the magnitude of the ideal modulation vector | R' |.

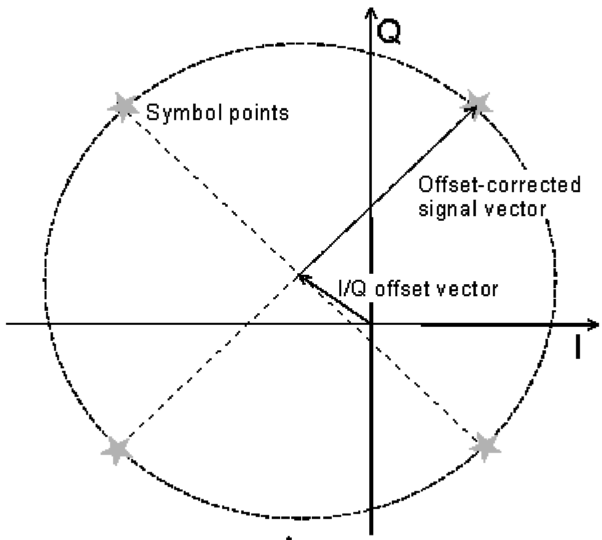
The **Error Vector Magnitude** is calculated as the ratio of the RMS value of E to the RMS value of R' in percent or in dB:

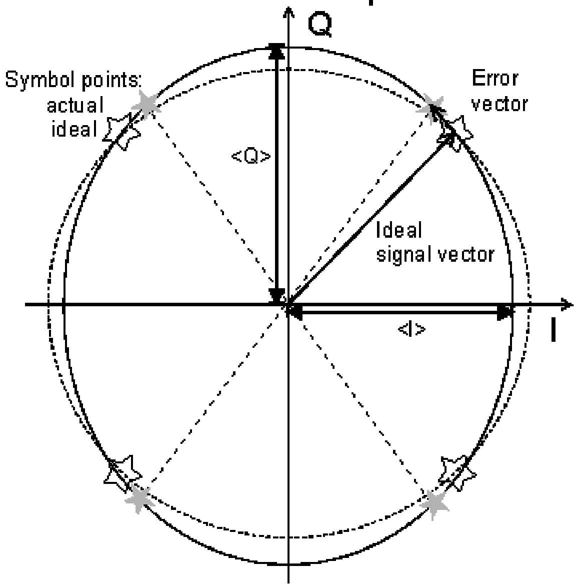
*EVM [%] = RMS (E) / RMS (R') * 100%*

EVM [dB] = 20 log EVM [%]

I/Q Offset, I/Q Imbalance

The following figure is an idealized representation of the modulation errors where the effects of a pure origin offset (first diagram) and of a pure I/Q imbalance (second diagram) are completely disentangled.





The **I/Q offset** in dB is the logarithmic ratio of the I/Q offset vector (i.e. the estimated DC-offset of the measured signal) to the average offset-corrected signal vector:

$$\text{Origin Offset} = 20\log\frac{|\text{I/Q offset vector}|}{|\text{Offset-corrected signal vector}|_{RMS}}$$

In the equation above, $|\text{Offset-corrected signal vector}|_{RMS}$ denotes the magnitude of the offset-corrected signal vector that is RMS-averaged over all samples.

The **I/Q imbalance** in dB is equal to the difference between the estimated I and Q amplitudes of the measured signal, which are normalized and logarithmized as follows:

$$\text{I/Q Imbalance} = 20\log\frac{|\langle I\rangle - \langle Q\rangle|}{|\langle I\rangle + \langle Q\rangle|}$$

Analysis Mode

In some network applications (e.g. WCDMA), it is possible to select different algorithms for the modulation analysis:

- In the analysis "With Origin Offset", the modulation vectors R and Z for the EVM calculation are measured from the origin of the I/Q plane, so the results for the EVM, phase error and magnitude error include a possible origin offset.

- In the analysis "Without Origin Offset", the modulation vectors R and Z for the EVM calculation are measured from the coordinates of the I/Q offset vector, so the origin offset is subtracted out in the EVM, phase error and magnitude error results.

3.2.6.3 Adjacent Channel Power (Spectrum)

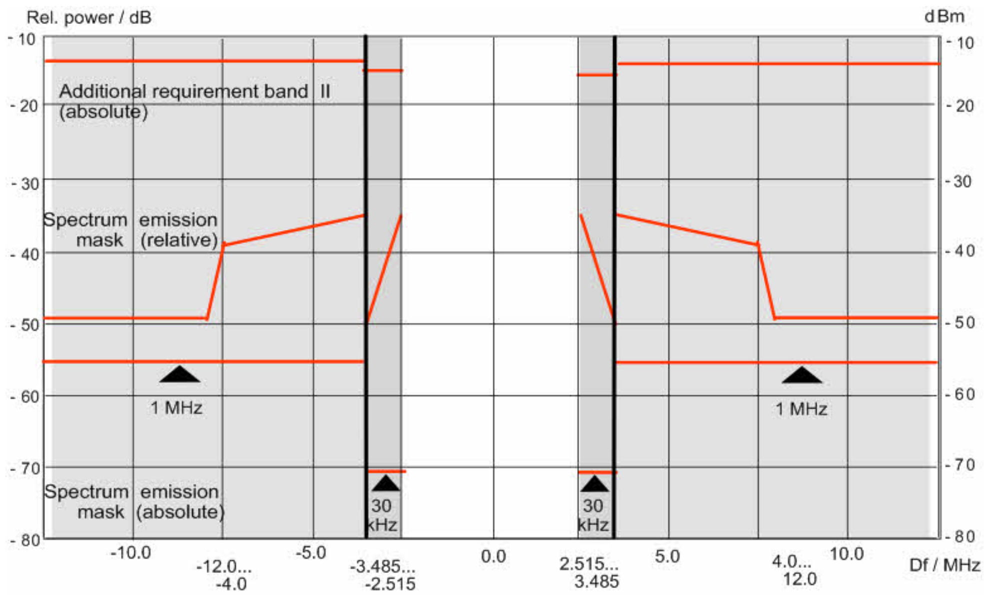
The R&S CMW 500 measures the transmitter output spectrum emissions in a symmetric frequency range centered on the nominal RF carrier frequency. The spectrum emissions are a measure of the amount of energy that spills outside the designated radio channel. An excess amount of off-carrier power increases the interference with adjacent channels and decreases the system capacity.
The off-carrier power can be assessed by several complementary quantities:

- The Adjacent Channel Leakage power Ratio (**ACLR**) is the ratio of the power measured in an adjacent channel (Adjacent Channel Power, ACP) to the transmitted carrier power, expressed in dB.
- In GSM networks, the "ACP Modulation" is measured on a portion of the useful part of the burst, excluding the power ramps and the training sequence. The result is a measure for the part of the spectrum that is due to the modulation of the GSM signal. In contrast, the "ACP" switching" result is the peak power within a minimum number of bursts. This result assesses the switching transients, i.e. the part of the spectrum that is due to the power ramp-up and down of the signal.

Sign conventions
According to the definition above, the sign of the ACLR values is usually negative. This is in line with the ACLR definition for networks like GSM and TDMA but differs from the sign convention for WCDMA (3GPP/FDD); see standard 3GPP TS 34.121. To make results comparable, the R&S CMW 500 uses the GSM sign convention for all network standards.

3.2.6.4 Spectrum Emission Mask

The "Spectrum Emission Mask" is a template to limit the out-of-band emissions in a frequency range around the center carrier frequency. Spectrum emission mask conformance tests are specified for CDMA standards. The spectrum emission mask complements the requirements for the Adjacent Channel Power (ACP).
In the figure below, the red lines represent the spectrum emission mask for UL WCDMA signals (3GPP/FDD 3.85 MHz). The emission mask comprises different sections. In addition to the limit lines the standard specifies IF filter settings for each section.

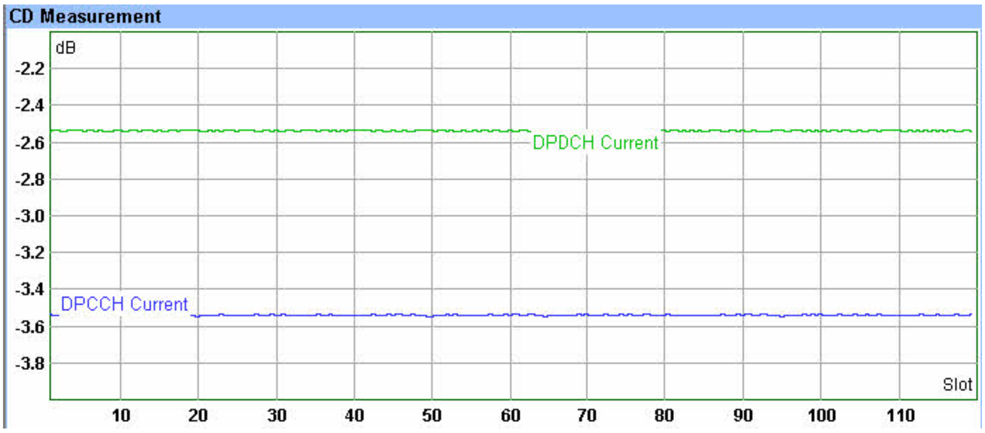


3.2.6.5 Code Domain Power

A Code Domain Power (CDP) measurement provides the power of the individual code channels of a CDMA signal. The power in each code channel is averaged over a suitable time interval (e.g. a slot) and expressed in dB, relative to the power of the total, composite CDMA signal. Typically, the following measurement tasks can be performed:

- Compare different physical channel powers within a CDMA signal
- Monitor active and inactive channels

In the following figure, the CDP of the DPCCH and the DPDCH in an uplink WCDMA signal is displayed over a measurement period of 120 WCDMA slots. The average DPDCH power is approximately 1 dB above the average DPCCH power.



3.2.6.6 Multi-Evaluation Measurements

In a multi-evaluation measurement, the R&S CMW 500 acquires a wide range of measurement results at once. For example, the GSM multi-evaluation measurement provides the most important GSM mobile transmitter test results described in standard 3GPP TS 51.010:

- The transmitter output power versus time
- Results that describe the modulation accuracy: Error vector magnitude (EVM), phase error, frequency error for each symbol, normalized I/Q vector at and between the decision points (I/Q constellation, vector and phase diagrams)
- Results that describe the output RF spectrum: adjacent channel power (ACP) due to modulation and due to switching, ACP versus time

Advantages

Compared to independent TX measurements, multi-evaluation measurements provide several advantages:

- They ensure highest measurement speed.
- They provide a comprehensive picture of the performance of a tested RF transmitter with a minimum of effort for configuring the R&S CMW 500.
- They provide "linked" results: The different measured quantities are all based on the same set of raw measurement data.

In remote control, it is possible to control each multi-evaluation measurement as a whole but retrieve the different types of results separately.

Controlling multi-evaluation measurements

A multi-evaluation measurement is controlled like any other measurement using the measurement control softkey.

In some multi-evaluation measurements, it is possible to disable part of the results; see

"Measurement speed considerations" below.

Measurement results and settings
Multi-evaluation measurement results are displayed in a common measurement dialog which may comprise several diagrams (views) and other output elements. In general, it is possible to modify the display settings, e.g. in order to zoom in on a single diagram. Measurement settings for the different views are also part of a common configuration dialog. Many parameters (e.g. the connection control settings and statistical parameters) affect the entire multi-evaluation measurement.

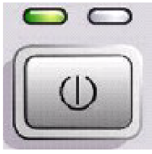
Measurement speed considerations
A multi-evaluation measurement ensures that the entire set of results is acquired and processed as quickly as possible. If only part of the results is needed, it can be preferable to restrict the scope of the measurement in order to gain additional speed.
Example: Disabling the ACLR results in the GSM multi-evaluation measurement speeds up the measurement of the modulation accuracy.

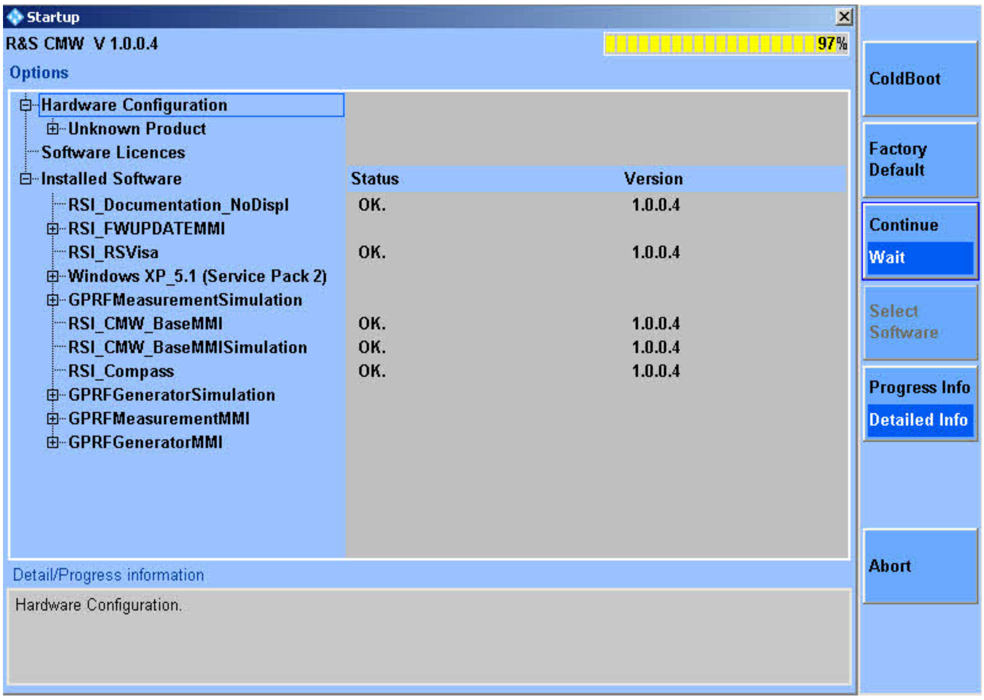
4 Basic Instrument Functions

The following chapter describes dialogs and settings for general use. The dialogs are not related to a particular general purpose or network test application.

4.1.1 Startup Dialog

The "Startup" dialog shows the progress of the startup procedure and the available options. Once the startup procedure has been terminated, it is automatically replaced by the measurement or generator dialog opened in the last session.





Startup dialog

The "Startup" dialog provides control softkeys that you can activate while the startup is in progress.

Cold Boot

Copies new firmware-specific data to the internal hardware of the R&S CMW 500. A cold boot is required to finalize a firmware update.

Continue / Wait

Resume or interrupt the startup procedure. "Wait" is appropriate e.g. for a check of the installed hardware and software options; see "Progress Info / Detailed Info" below.

Progress Info / Detailed Info
Toggles between alternative information types in the "Option/progress information" panel across the bottom of the screen.
- The "Progress Info" is a log of the startup procedure including the loaded firmware components.
- The "Detailed Info" describes the selected hardware or software option. It may contain the name, version, product code and essential technical data of the option.

It is preferable to press "Continue / Wait" in order to view the "Detailed Info". After the startup procedure is finished and the startup menu is closed, the detailed option information is displayed in the "Setup" menu.

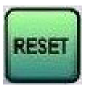
Abort
Aborts the startup procedure. The R&S CMW 500 returns to standby state. Press the standby key on the front panel to re-initialize the startup.

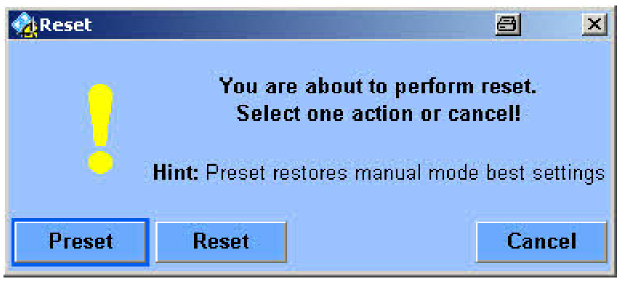
4.2 Utility Dialogs

Utility dialogs are used to perform administrative tasks and to reset the instrument to a definite state. They also provide information on the instrument and assistance.
Most of the utility dialogs are opened using the Utility Keys to the left of the display.

4.2.1 Reset Dialog

The "Reset" dialog forces the instrument to return to a definite reset/preset state.





Reset dialog

The R&S CMW 500 provides three different reset states.

Preset
Sets the instrument parameters to values for good local/manual interaction. In particular, the Preset state comprises the following settings:
- All measurements are repeated continuously ("Repetition: Continuous").
- The R&S CMW 500 uses long statistics cycles (for reliable statistical evaluations).
- The preferred modes and features of the current firmware version are active.

Consequently, the Preset state may change after a firmware upgrade.

In setups comprising several instruments, a Preset only affects the instrument which is currently operated.

Exceptions:

The following R&S CMW 500 settings are not affected by Preset:

- Address information assigned to the instrument (e.g. the GPIB bus address or IP address)
- The instrument setup

GPIB command: `SYSTem:PRESet`

Reset

Sets the instrument parameters to values for good remote operation. In particular, the Reset state comprises the following settings:

- All measurements are performed in Single Shot mode ("Repetition: Single Shot").
- The R&S CMW 500 uses short statistics cycles (for benchmarks).
- The preferred modes and features are the same in all firmware versions. As far as older features are concerned, the Reset state never changes after a firmware upgrade.

In setups comprising several instruments, a Reset only affects the instrument which is currently operated.

Exceptions:

The following R&S CMW 500 settings are not affected by "Reset":

- Address information assigned to the instrument (e.g. the GPIB bus address or IP address)
- The instrument setup
- The contents of the status registers

GPIB command: *RST

4.2.2 Print Dialog

The "Print" dialog prints the current screen contents to a file, to be saved on partition D: of the internal hard disk or a USB memory stick.

Print dialog

The R&S CMW 500 supports the following bitmap data formats for print files.
.bmp, .emf, .jpeg, .pbm, .pgm, .png, .ppm, .wmf, .xbm, .xpm

The default file format (for file names entered without extension) is .jpeg.

4.2.3 Save/Recall Dialog

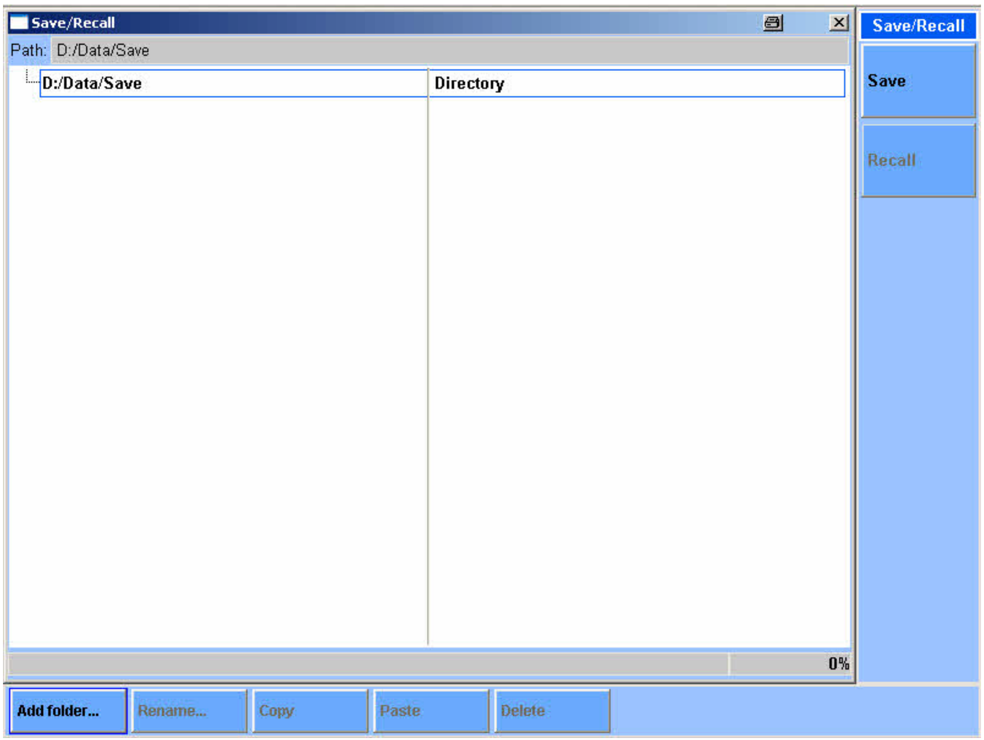
The "Save/Recall" dialog stores the current instrument setup and recalls (and re-activates) setups.

Save files

Save files help you customize the R&S CMW 500 to specific tasks. A setup describes an instrument configuration at a particular time. This comprises:

- The active firmware application and dialog
- The instrument settings of the base system and of all firmware applications
- The display configuration of all measurement dialogs

Save files contain a complete instrument setup. Save files are ASCII files and stored in .xml format.



Save/Recall dialog

The "Save/Recall" dialog provides the following control softkeys and hotkeys.

Save

Saves the current configuration to a file. Save files are stored in a default directory on drive D: of the internal hard disk; see also Firmware Update.

- If a folder is selected, a new save file SaveFile<no>.xml is created. <no> is 01 or the number of the last save file plus one.

- If a save file is selected, this file is overwritten.

Remote control: *SAV<no> – saves the current configuration to a file SaveFile<no>.xml.

Recall

Recalls the selected save file and activates the stored settings.
Remote control: *RCL<no> – recalls the configuration stored in file SaveFile<no>.xml.

Add Folder... / Rename... / Copy / Paste / Delete (hotkeys)

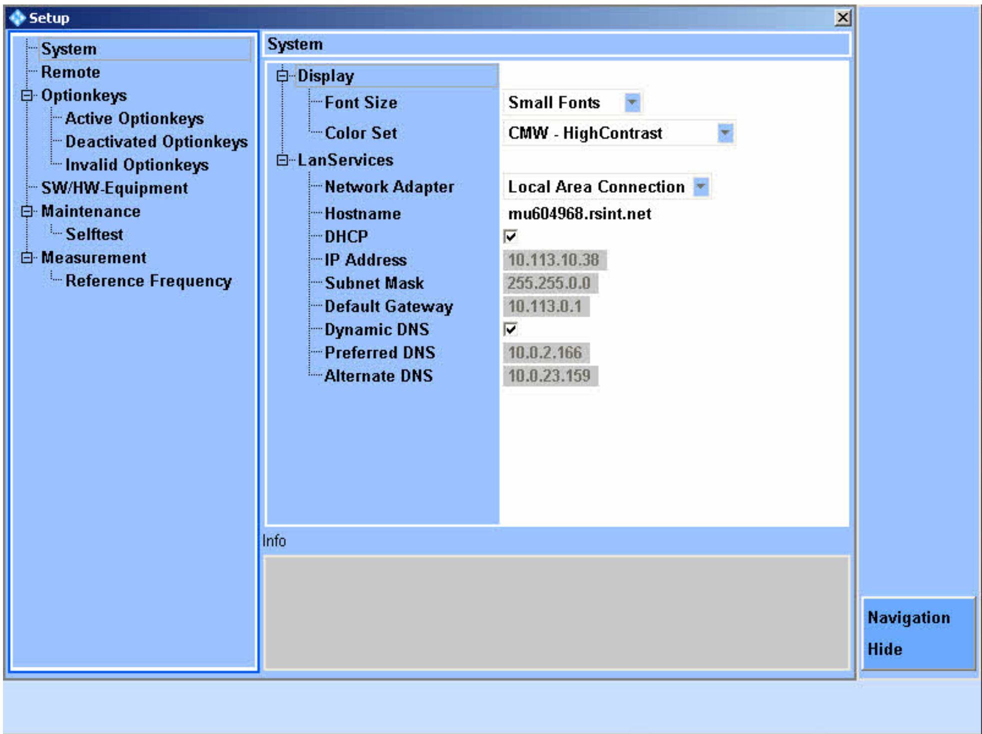
The hotkeys across the bottom of the dialog add, delete and rename folders and save files.
Remote control:

```
MMEMory:MDIRectory '<directory_name>'
MMEMory:COPY '<file_source>'[,'<file_destination>']
MMEMory:MOVE '<file_source>','<file_destination>'
MMEMory:DELete '<file_name>'
MMEMory:RDIRectory '<directory_name>'
```

4.3 Setup Dialog

The "Setup" dialog helps you perform various basic and administrative tasks. The "Setup" dialog is subdivided into the following sections:

- System – defines the overall appearance of the dialogs and address information for remote control.
- Remote – lists all available interface types for remote control and their parameters.
- Option Keys – activates and deactivates options using a key code; see Activating Options.
- SW/HW Equipment – shows the software and hardware equipment of the R&S CMW 500.
- Selftest
- Reference Frequency .
- Info – shows detailed information about the selected item in the "Setup" dialog.



Setup dialog

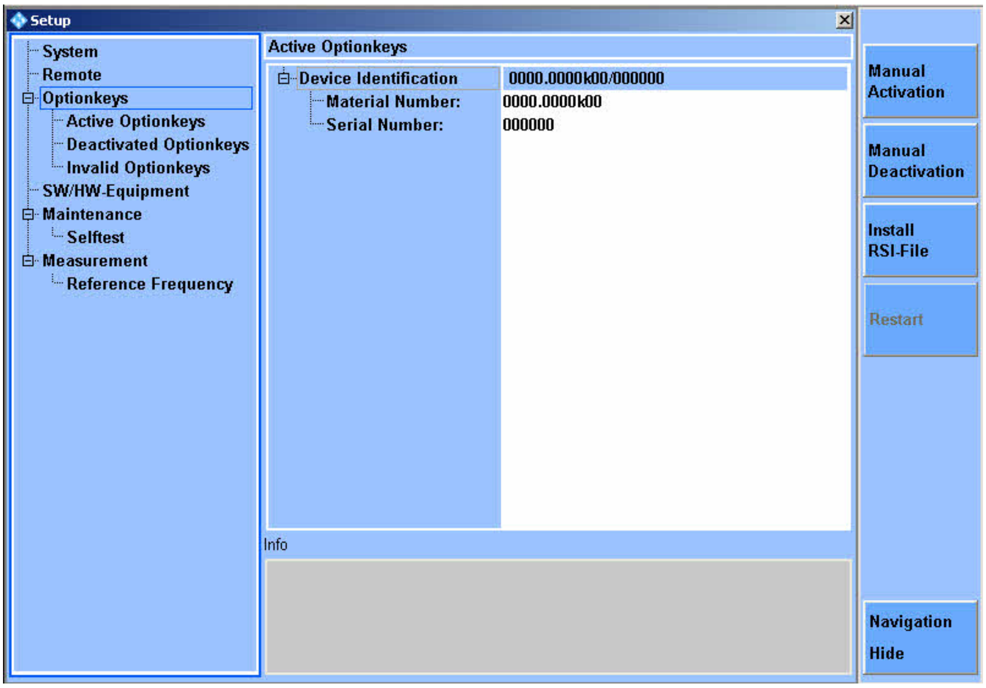
GPIB commands: Most of the commands belong to the `SYSTem...` SCPI subsystem. The LAN services are configured using the `SYSTem:COMMunicate:NET:...` commands.

4.3.1 Activating Options

New R&S CMW 500 options must be enabled using the key code supplied by Rohde & Schwarz. Activating a previously installed option involves the following steps.

1. Open the "Option Keys" section in the "Setup" dialog.
2. Enter the key code using either manual activation, typing in the key code, or an installation file.
3. Restart the R&S CMW 500

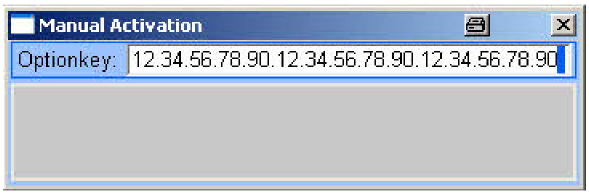
The "Setup" dialog provides all necessary control elements and shows the active, deactivated and invalid option keys.



Setup – Option Keys

Manual Activation

Type in the key code using an input box. The separating dots are entered automatically.



Manual Deactivation

Not needed at present, for future extensions.

Install RSI File

Avoid typing in your key code; use an .rsi (Rohde & Schwarz Installation) file instead. The installation file is supplied with the key code; it can be stored to a directory on drive D: of the internal hard disk or to an external USB memory stick.

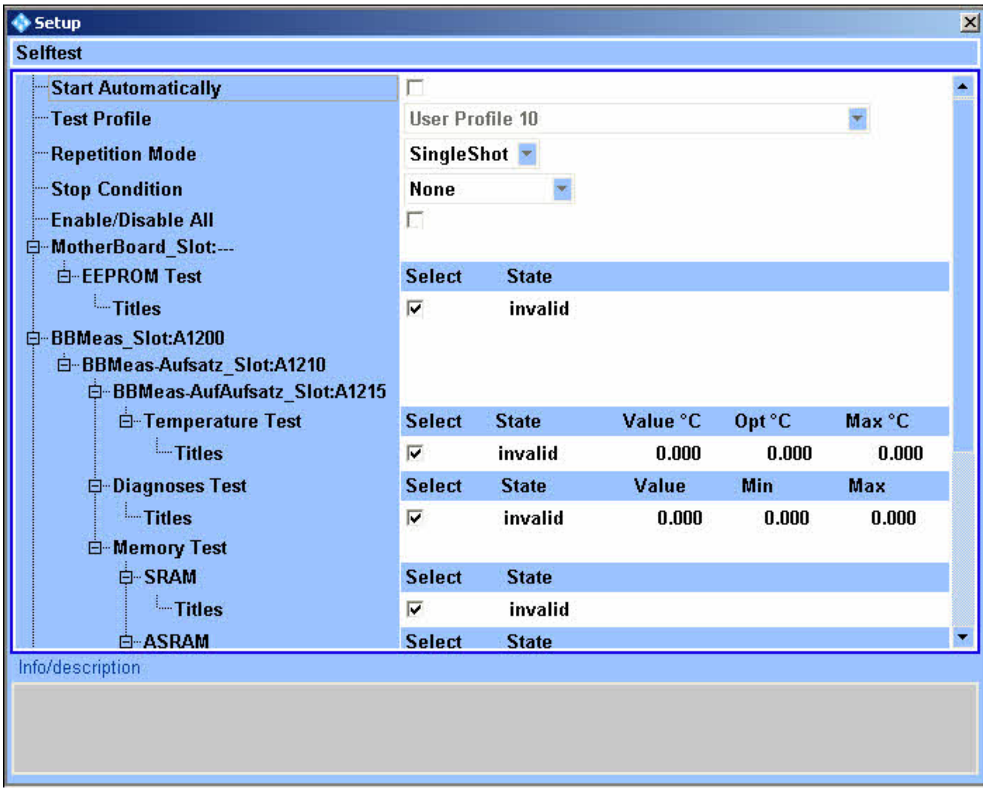
4.3.2 Selftests

The R&S CMW 500 provides extensive selftest procedures on module and system level. The selftests are primarily intended for production and service purposes; they are not needed during normal operation of the instrument. The following description serves as a general overview.

- General test features
- Board Tests
- System Tests
- Application Example
- Selftest Parameters

4.3.2.1 General Test Features

All selftests are arranged in the "Setup" dialog.



Selftest dialog

In the dialog you can select a particular test or a group of related tests (Test Profile). Each selftest may be performed once or continuously. The result of each test (State) is displayed in the individual test section:

- Invalid: No test performed yet, no result available
- In progress: Test running, no result available yet
- Passed: Test passed; all measurements within the factory-set tolerances
- Failed: Test failed, one or more measurements out of tolerances

4.3.2.2 Board Tests

A board test verifies that a particular hardware module works properly. Depending on the board, the R&S CMW 500 may provide different types of board tests:

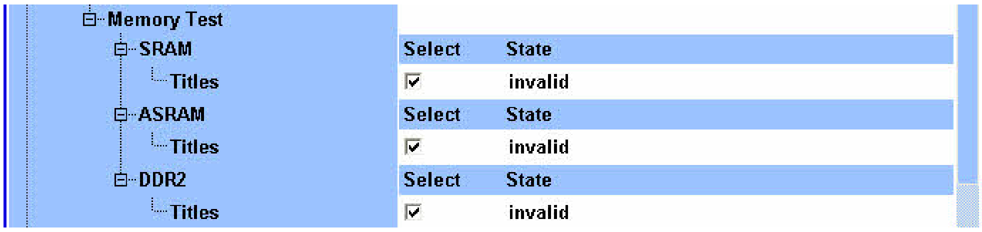
Diagnoses test

The R&S CMW 500 measures a series of selectable diagnostic voltages and checks whether they are within the permitted range. The permitted minimum and maximum voltages are stored in the EEPROM of the tested board.

A diagnoses test is provided for most of the R&S CMW 500 modules.

Memory test

The R&S CMW 500 tests one or more of the memories (SRAM, ASRAM, DDR2) on the board. Two different types of memory tests are provided.



- For an Address Line Test, the individual address lines of the RAM are activated one after another in order to transfer a definite number to the RAM. If the instrument can read the transferred and stored numbers correctly after testing all address lines, the address lines must be independent (not interconnected), as required.
- For a Pseudorandom (RRAN) Test, the R&S CMW 500 generates a pseudo-random bit sequence (PRBS) which is first written to the RAM and then read. The R&S CMW 500 checks whether the read PRBS is equal to the generated PRBS.

An address line test is generally faster than a PRAN test. Notice that a failed address line test does not necessarily prove that two address lines are connected; the problem may be due to one of the other components involved in data transmission and storage.

Download test

The R&S CMW 500 loads program data into a DSP or FGPGA module and verifies that the module responds properly.

EEPROM test

The R&S CMW 500 verifies that the I2C EEPROM data of the board is well-formed (i.e. the syntax is correct, the contents are logically compatible). If no access to the EEPROM data is possible, the board is not displayed in the Selftest dialog.
An EEPROM test is provided for all modules.

4.3.2.3 System Tests

An internal system test verifies that the communication between several internal modules of the instrument is uninterrupted. A passed system test usually proves that several modules (e.g. boards and bus systems connecting these boards) work properly.

System tests and board tests
A system test represents an efficient method for testing the instrument's overall functioning. After a failed system test, you can use one of the module tests to pin down the source of the malfunction.

The R&S CMW 500 provides different types of system tests:

Overall Loop RF1 COM TRX1
A signal generated on the TX1 module is routed to the Frontend (RF1 COM connector path) and back to the RX1 module. The R&S CMW 500 measures the transmission TX1 —> RF1 COM —> RX1 at different frequencies and TX levels.
The header row of the overall loop test shows the output levels in dBm at the RF1 COM connector. The actual levels measured are approx. 6 dB above the equivalent RF1 COM levels.

Sample Bus Test
A pseudo-random bit sequence (PRBS) is transferred over the sample bus between two hardware modules. The R&S CMW 500 compares the transmitted PRBS with the received PRBS and verifies that no bit errors occur in the transmission path.

4.3.2.4 Performing Selftests

Selftests verify the correct operation of hardware modules in the instrument. The selftests are primarily intended for production and service purposes; they are not needed during normal operation of the R&S CMW 500.
Selftests are controlled like any other measurement.

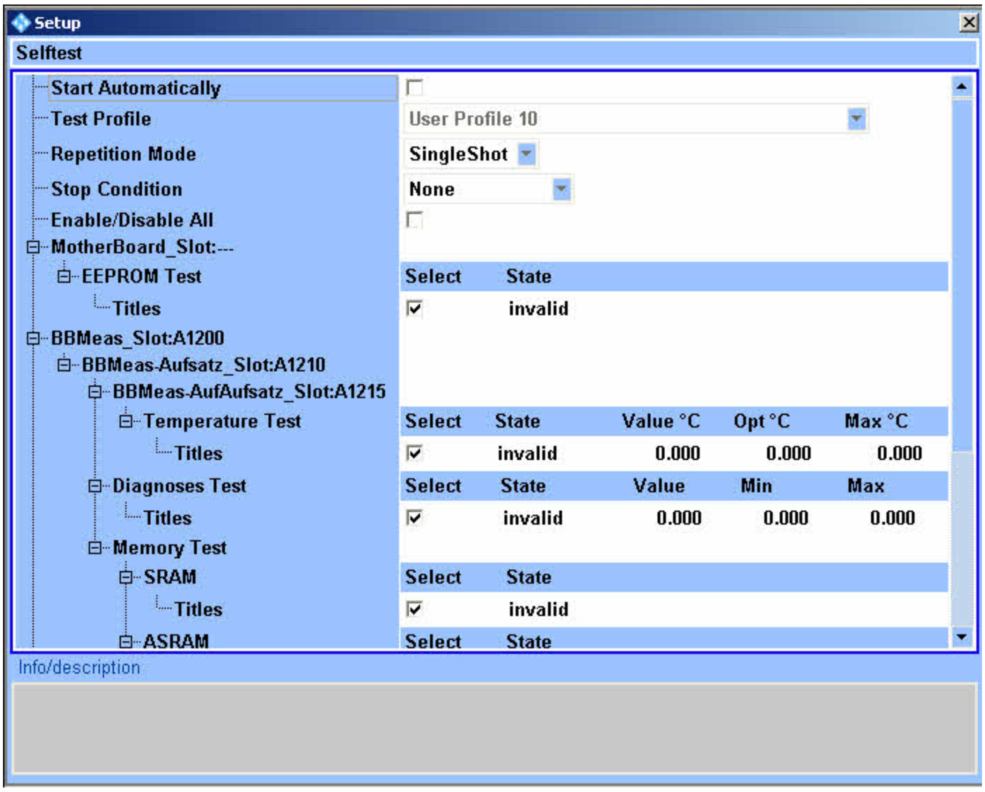
Overall Loop RF1COM – TRX1 Test

The Overall Loop RF1COM – TRX1 test is a special internal system test that measures the entire RF path from the generator (TX1 module) to the Frontend (RF1 COM connector path) and back to the analyzer (RX1 module).

To perform the overall loop test:

1. Press the MEASURE key on the front panel and select Selftest from the "Measurement Controller" dialog. Close the "Measurement Controller".

The Maintenance – Selftest dialog is opened.



Selftest dialog

2. In the measurement dialog, open the "Test Profile" drop-down list and select "Overall Loop RF1COM –TRX1".
3. Select "Repetition: Single Shot" to perform the test only once.
4. Open the "System Test > Internal > Overall Loop RF1COM –TRX1" section and select the RF frequencies you want to measure. Each frequency is measured at different RF output levels.
5. Press the "Selftest Ctrl." hotkey once to start the selftest.

The result of the test at each frequency is shown in the "State" column. The measured levels should be approx. 6 dB above the RF output levels.

4.3.2.5 Selftest Parameters

The "Selftest" dialog provides the following controls and dialogs.

- Measurement Control: Softkey
- Parameters: Selftest Configuration

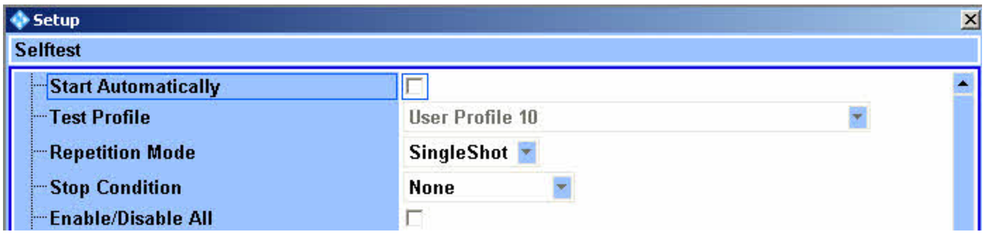
Measurement Control

The measurement is turned on or off using the "Selftest" measurement control softkey and the ON | OFF or RESTART | STOP front panel keys.

Selftest Ctrl. (Softkey)
Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via remote control.

Selftest Configuration

The selftest measurement is configured using the parameters at the beginning of the "Selftest" section in the "Setup" dialog.



Selftest configuration

Start Automatically
Starts the selected selftests.

Test Profile
A test profile is either a single test or a group of related tests to be performed together.

Repetition
Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.
- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.

Stop Condition
At present the selftest measurements are continued according to the repetition mode irrespective of the result (Stop Condition: None).

Enable/Disable All
Selects all selftests for execution or clears the current selection.

4.3.3 Reference Frequency

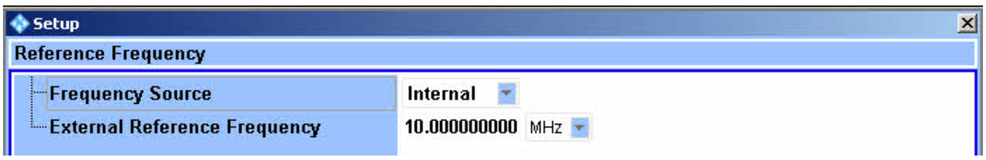
The R&S CMW 500 can be synchronized either to its fixed internal reference frequency or to an external reference. The internal reference frequency is generated using a Temperature Controlled Crystal Oscillator (TCXO) or an optional oven quartz (Timebase OCXO, option R&S CMW-B690A).

Internal Reference
With internal frequency reference, the R&S CMW 500 is synchronized to its internal 800 MHz reference frequency. The internal reference clock signal can be tapped at the output connector REF OUT 1 in order to synchronize other devices. The R&S CMW 500 acts as a master, providing the reference clock for other devices.

External Reference
With external synchronization, the internal reference frequency is not used. Instead, the R&S CMW 500 is synchronized to an external reference signal with variable frequency. The external reference signal is also routed to the output connector REF OUT 1 in order to synchronize other devices. The external reference signal must meet the specifications of the data sheet.

4.3.3.1 Reference Frequency Settings

The reference frequency settings appear in the "Setup" dialog.



Reference frequency settings

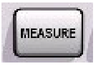
Frequency Source
Sets the R&S CMW 500 to internal or external reference; see above.
GPIB command: `CONFigure:SELFtest:REFerence:FREQuency:SOURce INTernal | EXTernal`

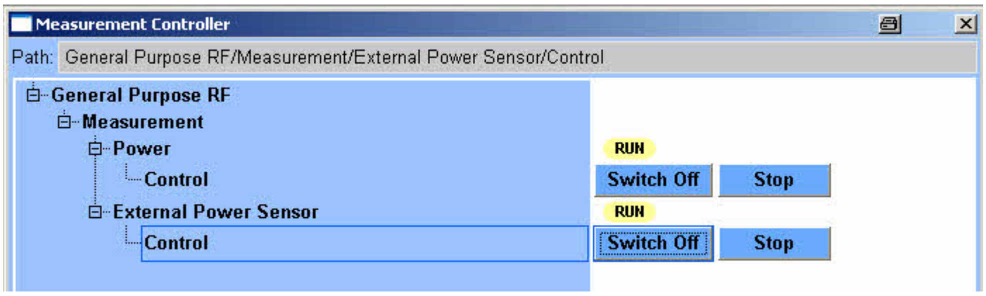
Internal Reference Frequency
Indication of the fixed internal 800 MHz frequency (no setting value).

External Reference Frequency
Value of the external reference frequency. If "Frequency Source: External" is used this value must be equal to the frequency of the signal fed in at the rear panel connector REF IN. Besides the external reference signal must meet the specifications of the data sheet.
GPIB command: `CONFigure:SELFtest:REFerence:FREQuency`

4.3.4 Measurement Controller Dialog

The "Measurement Controller" dialog gives an overview of all available measurement firmware applications, starts or stops measurements.





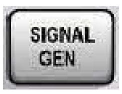
Measurement Controller dialog

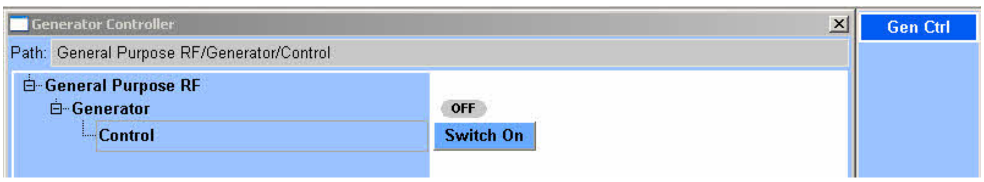
- Use the "Control" buttons in the dialog to switch the selected measurement on or off, stop or restart the measurement (see Measurement Control).
- Alternatively, with a particular measurement selected, use the ON / OFF or RESTART / STOP front panel keys to switch the measurement on or off.

Notice that different measurement and generator firmware applications can be active simultaneously. E.g. all GPRF measurements and the GPRF generator can be active at the same time.

4.3.5 Generator Controller Dialog

The "Generator Controller" dialog gives an overview of all available generator firmware applications, starts or stops generators.





Generator Controller dialog

- Use the "Control" buttons in the dialog to switch the selected generator on or off (see Generator Control).
- Alternatively, with a particular generator selected, use the ON / OFF or RESTART / STOP front panel keys to switch the generator on or off.

Notice that different measurement and generator firmware applications can be active simultaneously. E.g. all GPRF measurements and the GPRF generator can be active at the same time.

5 Remote Control

This chapter provides instructions on how to set up the tester for remote control, a general introduction to remote control of programmable instruments, and the description of the tester's remote control concept. For reference information about all remote control commands implemented by the instrument, complemented by comprehensive program examples, refer to the "Command Reference" and "Programming" chapters.

Programming examples, software tool
The programming examples in the reference chapters have been tested with the aid of a simple software tool which provides an environment for the development and execution of remote tests. Tool-specific program syntax has been omitted, with the exception of some simple program elements for comments:

- REM: Remark, command line not executed
- FPRINT <Text>: Include text in the output file
- WAITKEY <Text>: Display a dialog containing the text and waiting for user interaction before the program is continued
- Remote control operation
- Messages
- CMW Remote Software Structure
- Control of the Instrument
- Instrument Model and Command Processing
- Status Reporting System

5.1 Remote Control Operation

The instrument supports different interfaces for remote control. The following table gives an overview.

Remote control interfaces and protocols

Interface	Protocols, VISA*) resource string	Remarks
Local Area Network (LAN)	VXI-11 protocol TCPIP[board]::host address[::LAN device name][::INSTR]	The LAN REMOTE connector for LAN connection is located on the rear panel. A second, equivalent LAN connector is located on the front panel. For a description of the protocol and the interface commands refer to VXI-11 Protocol.
	VISA socket resource TCPIP[board]::host address::Data Port[::SOCKET]	Refer to your VISA user documentation.

Interface	Protocols, VISA*) resource string	Remarks
USB	USB[board]::2733::87::serial number[::USB interface number][::INSTR]	USB connectors are located on the front and on the rear panel of the instrument. 2733 (0xAAD) is the manufacturer ID of Rohde & Schwarz 87 (0x57) is the R&S CMW 500 model code the serial number is device-specific.
GPIB	GPIB[board]::primary address[::INSTR] (no secondary address)	Two optional GPIB bus interfaces according to standard IEC 625.1/IEEE 488.1 (options R&S CMW-B612A and R&S CMW-B612B). The GPIB bus connectors for connection to a controller are located on the rear panel of the instrument. For a description of the interface and interface commands refer to GPIB Bus Interface.

*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. The I/O channel (LAN or TCP/IP, USB, GPIB, ...) is selected at initialization time by means of the channel–specific resource string (also termed address string) quoted above or by an appropriately defined VISA alias (short name). A VISA installation is a prerequisite for remote control over LAN or USB interface. All VISA address resource strings are displayed and defined in the Setup dialog.
For more information about VISA refer to the user documentation.

LAN Connection
The R&S CMW 500 provides two LAN connectors for direct connection to a Local Area Network. Remote control via LAN requires a VISA installation but no additional hardware at the controller. VISA provides the TCPIP interface type and several protocol types to communicate with LAN-connected devices. For a simple example see Establishing and Testing a LAN Connection.

USB connection
A USB connection requires the VISA library to be installed. VISA will detect and configure the R&S CMW 500 automatically when it is plugged to the computer. No separate driver installation is necessary.

SCPI (Standard Commands for Programmable Instruments) commands – instrument-control commands – are used for remote control.

SCPI Compatibility
The SCPI standard (Standard Commands for Programmable Instruments) is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers. The R&S CMW 500 is compatible to the final SCPI version 1999.0.
SCPI-confirmed commands are explicitly marked in the command reference chapters. Commands without SCPI label are device-specific, however, their syntax follows SCPI

rules. 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.
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.

Manual and remote control
The R&S CMW 500 provides two different reset states for manual an remote control. Remote control programs should always start from a well-defined initial state (e.g. with the command *RST) and then implement the required settings in order keep full control over the instrument.

5.1.1 Establishing and Testing a LAN Connection

In the following example, a direct LAN connection is set up to the R&S CMW 500. The connection is tested using a simple test script.
The steps in detail depend on the test environment in use. The present example is based on a test tool which requires an additional VISA installation.

1. Connect your R&S CMW 500 to the controller or to the home/company network using the LAN REMOTE connector at the rear panel.
2. Switch on the R&S CMW 500, wait until the startup procedure is complete and press the SETUP front panel key.
3. In the Setup dialog opened, look up the "IP Address" assigned to the R&S CMW 500.

In the following, we assume that the instrument has the IP address 10.121.11.192.

4. Start your test tool, define the VISA address string and assign an alias.

In the following example, the VISA address string "TPCIP0::10.121.11.192::inst0::INSTR" is defined; see table in section Remote Control Operation. The VISA alias (short string) is "CMW".

5. Write a test script using the VISA alias and run the script.

Hostname and IP address
The VISA address strings displayed in the Setup dialog contain the hostname of the R&S CMW 500 instead of the IP address. Use the address string type that is most convenient for you.

The following test script queries the identification string of the connected R&S CMW 500 and (after a short pause) returns the contents of the error queue:

```
CMW: *IDN?
PAUSE 100
CMW: system:error?
```

On test script execution, the test tool generates the following result log:

```
: Opening new VISA channel: TCPIP0::10.121.11.192::inst0::INSTR
: [-->TCPIP0::10.121.11.192::inst0::INSTR] Setting timeout to
5000 ms
: Connection to TCPIP0::10.121.11.192::inst0::INSTR established!
: Session handle: 0
: VISA Resource-Identifier: TCPIP0::10.121.11.192::inst0::INSTR
: send_Query(0, "*IDN?")
: [-->TCPIP0::10.121.11.192::inst0::INSTR] *IDN?
: read_Answer(0, ..., False)
: [<--TCPIP0::10.121.11.192::inst0::INSTR]
Rohde&Schwarz,CMW,1201.0002k50/624376,1.0.0.0
: send_Query(0, "system:error?")
: [-->TCPIP0::10.121.11.192::inst0::INSTR] system:error?
: read_Answer(0, ..., False)
: [<--TCPIP0::10.121.11.192::inst0::INSTR] 0,"No error"
```

5.1.2 Switchover to Remote Control

On power-up, the instrument is always in the manual operating state and can be operated via the front panel controls (for instruments equipped with a display), a connected keyboard and mouse or via the Graphical User Interface (GUI) displayed on an external monitor. The instrument is switched to remote control as soon as it receives a command from the controller.
While remote control is active, the instrument settings are optimized for maximum measurement speed; the display is switched off.
The instrument remains in the remote state until it is reset to the manual state via the GUI or via remote control (see section Return to Manual Operation).

5.1.3 Return to Manual Operation

Return to manual operation can be initiated via the front panel or via remote control.

- Manually: Click a front panel key, e.g. TASKS, MEASURE, SIGNAL GEN and select the desired measurement or generator application.
- Via GPIB bus: CALL IBLOC(device%), GTL interface message
- Via VXI-11 protocol: &GTL interface message

Local lockout (GPIB bus, VXI-11)

Before returning to manual control, command processing must be completed. If this is

not the case, the R&S CMW 500 switches back to remote control immediately.
Returning to manual control by pressing a front panel key can be disabled by the Local Lockout Message:

- Via GPIB bus: LLO; see GPIB Bus Interface, Universal Commands
- Via VXI-11 protocol: &LLO interface message
- Many instrument driver commands, e.g. the NI commands SetRWLS (Set Remote With Lockout State) or SendLLO, also contain a local lockout command.

A local lockout prevents unintentional return to manual control by means of a front panel key. Return to manual operation by means of an interface message is still possible.
Returning to manual control via the front panel keys can be enabled again:

- Via GPIB bus: deactivate the REN control line
- Via VXI-11 protocol: &NREN message

5.2 Messages

The messages transferred between the controller and the R&S CMW 500 can be either interface messages or device messages.
Section "SCPI Command Structure and Syntax" describes the structure of the device messages as defined by the SCPI standard. For specific features of the R&S CMW 500 command set refer to section "CMW Remote Software Structure".

5.2.1 VXI-11 Interface Messages

The VXI-11 protocol allows the instrument to be controlled in a Local Area Network. For a short introduction and a list of interface functions refer to the following sections:

- VXI-11 Protocol

5.2.2 GPIB Bus Interface Messages

GPIB interface messages are transferred on the data lines of the GPIB 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 GPIB bus controller.
GPIB interface messages can be further subdivided into:

- Universal commands, act on all devices connected to the GPIB bus without previous addressing.
- Addressed commands, only act on devices previously addressed as listeners.

The interface messages relevant to the instrument are listed in the GPIB bus section.

5.2.3 Device Messages (Commands and Device Responses)

Device messages are transferred via the USB interface, the LAN interface (VXI-11 protocol) or on the data lines of the GPIB bus, the "ATN" control line not being active. The ASCII character set is used. A distinction is made according to the direction in which device messages are transferred:

- **Commands**
  are messages the controller sends to the instrument. They operate the device functions and request information.
- **Device responses**
  are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

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 output level to some value.
- **Queries**
  cause data to be provided for output on the GPIB bus, e.g. for identification of the device or polling the active input.

2. According to their definition in standard IEEE 488.2:

- **Common commands**
  have a function and syntax that is exactly defined in standard IEEE 488.2. Typical tasks are the management of the standardized status registers, reset and selftest.
- **Instrument-control commands**
  are functions that depend on the features of the instrument such as frequency settings. A majority of these commands has also been standardized by the SCPI consortium.

The device messages have a characteristic structure and syntax. In the SCPI reference chapters all commands are listed and explained in detail.

5.2.4 SCPI Command Structure and Syntax

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics which are separated by colons. Queries are formed by appending a question mark to the header.

SCPI defines two command types with different syntax:

- Common commands
- Instrument-control commands

5.2.4.1 Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk "*" and possibly one or more parameters.

Examples:

*RST	RESET, resets the instrument.
*ESE 253	
*IDN?	IDENTIFICATION QUERY, queries the instrument identification string.

5.2.4.2 Instrument-Control Commands

Instrument-control commands are based on a hierarchical structure and can be represented in a command tree. The command headers are built with one or several mnemonics (keywords). The first level (root level) mnemonic identifies a complete command system.

Example:

`SOURce...` This mnemonic identifies the `SOURce` command system which provides generator settings.

For commands of lower levels, the complete path must be specified, starting on the left with the highest level, the individual keywords being separated by a colon ":".

Example:

`SOURce:GPRF:GENerator<i>:STATe ON`

This command is located on the fourth level of the `SOURce` system. It turns on the RF generator signal. The numeric suffix denotes a particular instance of the RF generator; see General Command Structure.

The following rules simplify and abbreviate the command syntax:

Repeated mnemonics with different meaning

The same mnemonics may be used on different command levels, not necessarily with the same meaning. The actual meaning of a mnemonic depends on its position in the command header.

Example:

`SOURce:GPRF:GENerator<i>:RFSettings:FREQuency 1GHZ`

This command contains the mnemonic `SOURce` in the first command level ("define RF generator settings"). The command defines the frequency of the GPRF generator signal.

`CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:SOURce`

This command contains the mnemonic `SOURce` in the sixth command level. It selects the source of the trigger events for the GPRF Power measurement.

Optional mnemonics

Commands may contain optional mnemonics. These mnemonics are marked by square brackets in the command description. 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 mnemonics.

Optional mnemonics with suffixes
An optional mnemonic must not be omitted if its effect is further specified by a numeric suffix.

Long and short form
The key words have a long form and a short form. Either the short form or the long form can be entered; other abbreviations are generally not permitted.
Example:
SOUR:GPRF:GEN<i>:STAT ON
SOURce:GPRF:GENerator<i>:STATe ON

Case insensitivity
The short form is marked by upper case letters, the long form corresponds to the complete word. Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

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 ",". For a description of the parameter types, refer to section SCPI Parameters.
Example:
SOURce:GPRF:GENerator<i>:LIST:SSTop 1,10
This command defines a group of frequency/level combinations that the GPRF generator provides in list mode.

Numeric suffix
If a device provides several functions or features of the same kind, e.g. several signals, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.
Example:
SOURce:GPRF:GENerator:DTONe:OFRequency2 1MHz
This command specifies an offset frequency for the second (Source 2) component of the dual-tone GPRF generator signal. GENerator (without suffix or with suffix 1) denotes the first instance of the GPRF generator.

5.2.4.3 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a `<New Line>`, a `<New Line>` with EOI or an EOI together with the last data byte. Some programming languages automatically produce 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.

Example: `ROUTe:GPRF:GENerator:RFSettings:CONNector RF1C;:SOURce:GPRF:GENerator:RFSettings:FREQuency 1GHZ`

This command line contains two commands. The first command belongs to the `ROUTe` system and selects the output connector for the GPRF generator. The second command belongs to the `SOURce` system and defines the frequency of the GPRF generator signal.

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:GPRF:GENerator:RFSettings:FREQuency 1GHz;:SOURce:GPRF:GENerator:RFSettings:LEVel` -80

This command line is written in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the `SOURce:GPRF:GENerator:RFSettings` command subystem, i.e. they have four levels in common.

When abbreviating the command line, the second command begins with the level below `SOURce:GPRF:GENerator:RFSettings`. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

`SOURce:GPRF:GENerator:RFSettings:FREQuency 1GHz;LEVel -80`

A new command line must always begin with the complete path.

Example: `SOURce:GPRF:GENerator:RFSettings:FREQuency 1GHz`
`SOURce:GPRF:GENerator:RFSettings:LEVel -80`

5.2.4.4 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. The following rules apply to the responses:

- The requested parameter is transmitted without header.
  Example: `ROUTe:GPRF:GENerator:RFSettings:CONNector?`
  Response: `RF1C`
- Maximum values, minimum values and all further quantities which are requested via a special text parameter are returned as numerical values.
  Example: `SOURce:GPRF:GENerator:RFSettings:FREQuency? MAX`
  Response: `3300000000`

- Numerical values are returned without their unit. The default unit for each command is reported in the command reference description.
  Example: `SOURce:GPRF:GENerator:RFSettings:FREQuency? MAX`
  Response: `3300000000` for 3.3 GHz
- Boolean values are returned as 0 (for OFF) and 1 (for ON). Possible exceptions to this rule are reported in the command reference description.
  Example: `SOURce:GPRF:GENerator:STATe?`
  Response: `1`
- Text (character data) is returned in short form (see also next section).
  Example: `SOURce:GPRF:GENerator:BBMode?`
  Response: `DTON` (for `DTONe`, dual tone)

5.2.4.5 SCPI Parameters

Most commands require one or more parameters to specify their function. 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 parameter types and the permissible ranges of values are specified in the command description.

Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the 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. 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 omitted, the default unit is used.
Example:
`SOURce:GPRF:GENerator:RFSettings:FREQuency 1.5GHz` is equivalent to
`SOURce:GPRF:GENerator:RFSettings:FREQuency 1.5E9`

Special numeric values
The texts `MINimum`, `MAXimum`, `DEFault`, `UP` and `DOWN` are interpreted as special numeric values. A query returns the associated numerical value.
Example: Setting command:
`SOURce:GPRF:GENerator:RFSettings:FREQuency MINimum`
The query `SOURce:GPRF:GENerator:RFSettings:FREQuency?` returns
`10000000`.
The following special values can be used on the R&S CMW 500:

- MIN/MAX denote the minimum and maximum value of a range of numeric values.
- DEF denotes the preset value. This value is set by the *RST command.

- NAN represents the value 9.91E37. Not a Number (NAN) is only sent as device response. This value is not defined. Possible causes are division by zero, subtraction or addition of infinite values, or missing values.

Unless it is explicitly stated in the command description you can use the special numeric parameters described above for all commands of the R&S CMW 500. Other special parameters are generally not supported.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON. The OFF state (logically false) is represented by OFFReplacement of ON or OFF by 1 or 0 is not supported.
Example: Setting command:`SOURce:GPRF:GENerator:STATe ON`
Query: `SOURce:GPRF:GENerator:STATe`? returns `ON`

Text Parameters

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:GPRF:GENerator<i>:SSB:MSOurce INTernal`
Query: `SOURce:GPRF:GENerator<i>:SSB:MSOurce?` returns `INT`

Strings

Strings must be entered within single or double quotation marks (' or ").
Example: `MMEMory:SAVE "MyFile"` or `MMEMory:SAVE 'MyFile'`

Block Data Format

Block data is 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: `HEADer:HEADer #45168xxxxxxxx`
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 above 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.
A #0 combination introduces a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

Overview of 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 sign # introduces block data. Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

5.2.4.6 Use of SCPI Subsystems

The structure of the instrument-control commands implemented by the R&S CMW 500 is described in sections General Command Structure and Control of the Instrument. Due to this structure, some SCPI subsystems are used in a specific manner. The following list gives an overview.

ABORt...	Stop measurement, release resources; see ABORt
CONFigure...	Specify measurement settings
FETCh...	Retrieve measurement results (running measurement; see FETCh), measurement or generator states
INITiate...	Start measurement, see INITiate
READ...	Start new single shot measurement and retrieve results; see READ
ROUTe...	Select output connectors and signal paths
SOURce...	Specify generator settings
STOP...	Stop measurement, do not release resources; see STOP

5.3 R&S CMW Software and Command Structure

The syntax of the remote commands for the R&S CMW 500 reflects the instrument's basic software modules. The header of each instrument-control command contains the logical software entity the command is assigned to, eliminating the need of addressing the entities (e.g. firmware applications) separately.
The following topics are relevant for the R&S CMW 500 command structure:

- General command structure

- Firmware applications
- Measurement Contexts and Views
- Comparison with CMU Commands

5.3.1 General Command Structure

The instrument-control command headers for the R&S CMW 500 consist of four parts.

SCPI subsystem (1 mnemonic)	Firmware application (2 mnemonics)	Instance (numeric suffix)	Setting/Result (1 or several mnemonics)
`SOURce`	`:GPRF:GENerator`	`1 | 2 | 3 | 4`	`[:STATe]`

The purpose and format of the four command parts is as follows:

SCPI Subsystem

One of the root mnemonics specified in the SCPI standard, indicating the SCPI subsystem. Commands within the same subsystem serve a similar purpose; see SCPI Subsystems Used. Some root mnemonics may be optional.

Firmware application (FWAs)

Two non-optional mnemonics indicating a combination of network standard or general purpose (GP) measurement and generator/measurement function group; see Firmware Applications.

Instance

Numeric suffix used to distinguish several FWAs of the same type (e.g. several GPRF generators). Values can range from 1 to 4; a suffix 1 can be omitted according to SCPI rules.

Setting/Result

One or several possibly optional mnemonics indicating the purpose of the command.

Extensions for measurement firmware applications

Many of the measurement firmware applications provide several measurement contexts and views. They are identified by fourth- and fifth/sixth-level mnemonics.

Due to the general structure described above, most R&S CMW 500 commands are not SCPI confirmed, however, they follow SCPI syntax rules (see also Remote Control Operation).

5.3.2 Firmware Applications

The R&S CMW 500 supports different network standards and general purpose (GP) applications. A network standard or GP application can be combined with one or two of the following function groups:

GENerator	Generator function group, controls and configures RF generators. **Example:** The RF generator associated with the GPRF application generates a flexible RF signal for test purposes.
MEASurement	Measurement function group, provides all measurements specific to the network standard or GP application. **Example:** The measurement group associated with the GPRF application comprises different measurements, e.g. Power, External Sensor Power.

A combination of application and generator/measurement function group is termed a firmware application (FWA). In the remote control commands, the FWA is addressed using the second and third-level mnemonics; see General Command Structure. A possible numeric suffix <i> (short for <instance>) behind the FWA mnemonics distinguishes several FWAs of the same type. The maximum number of instances is four.

The following list gives an overview of the FWAs of the R&S CMW 500 and their mnemonics:

`WCDMa:MEASurement<i>`	WCDMA network standard, measurements
`GSM:MEASurement<i>`	GSM network standard, measurements
`GPRF:GENerator<i>`	RF general purpose application, generator
`GPRF:MEASurement<i>`	RF general purpose application, measurements

Remote control commands do not differentiate different bands or band classes within a network standard.

5.3.3 Measurement Contexts and Views

Most measurement firmware applications are further subdivided into different measurement contexts. In manual control, a measurement context may consist of several views, providing different types of measurement results. In remote control, measurement contexts and views are identified by the fourth- and fifth/sixth-level mnemonics in the command headers, respectively.

Measurement contexts and views are addressed by different types of commands:

- Measurement control commands affect the entire measurement context. The same holds for most measurement configurations.
- Measurement results are assigned to a particular view. The commands used to define the measurement statistics and to retrieve results are also view-specific, which makes it possible to transfer a subset of results actually needed.

Example for context-specific commands

The following measurement control command affects the `EPSensor` measurement context (external power sensor measurement) in the `GPRF:MEASurement<i>` firmware application:

`INITiate:GPRF:MEASurement<i>:EPSensor`

The `EPSensor` measurement context appears as a fourth-level mnemonic. No view type is specified.

Example for view-specific commands

The following command retrieves the results in the `PVTime` view (Power vs. Time) which is part of the `MEValuation` measurement context in the `GSM:MEASurement<i>` firmware application:

`FETCh:GSM:MEASurement<i>:MEValuation:TRACe:PVTime:CURRent?`

The `PVTime` view appears as a sixth-level mnemonic.

READ...? and FETCh...? queries

The `READ...?` query is view-specific and calculates only the results needed for a particular view. This can result in a performance improvement compared to the context-specific command sequence `INITiate...; FETCh...?`.

5.4 Control of the Instrument

The following sections are devoted to the principles of measurement and generator control.

- Measurement states and measurement control commands
- Statistical Settings
- Retrieving Measurement Results
- Reliability Indicator
- Multi-Evaluation Measurements
- Generator Control
- RF Path Settings
- Resource and Path Management

5.4.1 Measurement Control

The R&S CMW 500 provides a variety of measurements (also termed measurement contexts) for each of the supported network standards or general purpose applications. All measurements are identified by a fourth level mnemonic and controlled in an analogous way. The benefit of this structure lies in the close analogy of all measurements. Commands for the different measurement have a similar structure and syntax.

The following topics describe the principles of measurement control:

- Measurement states and measurement control commands
- INITiate... command
- ABORt... command
- STOP... command
- Measurement substates

Measurement contexts

Measurement control commands affect the entire measurement context, which may include several views (see Measurement Contexts and Views). This means that the measurement states of all views within the same context are always equal. In contrast, the results of each view can be retrieved separately.

5.4.1.1 Measurement States and Measurement Control Commands

Measurement control commands are used to switch over between the following main measurement states:

OFF Measurement switched off, no resources allocated, no results available (when entered after `STOP`...). OFF corresponds to the SCPI trigger state IDLE.

RDY Measurement has been terminated, valid results may be available. RDY corresponds to the SCPI trigger state IDLE.

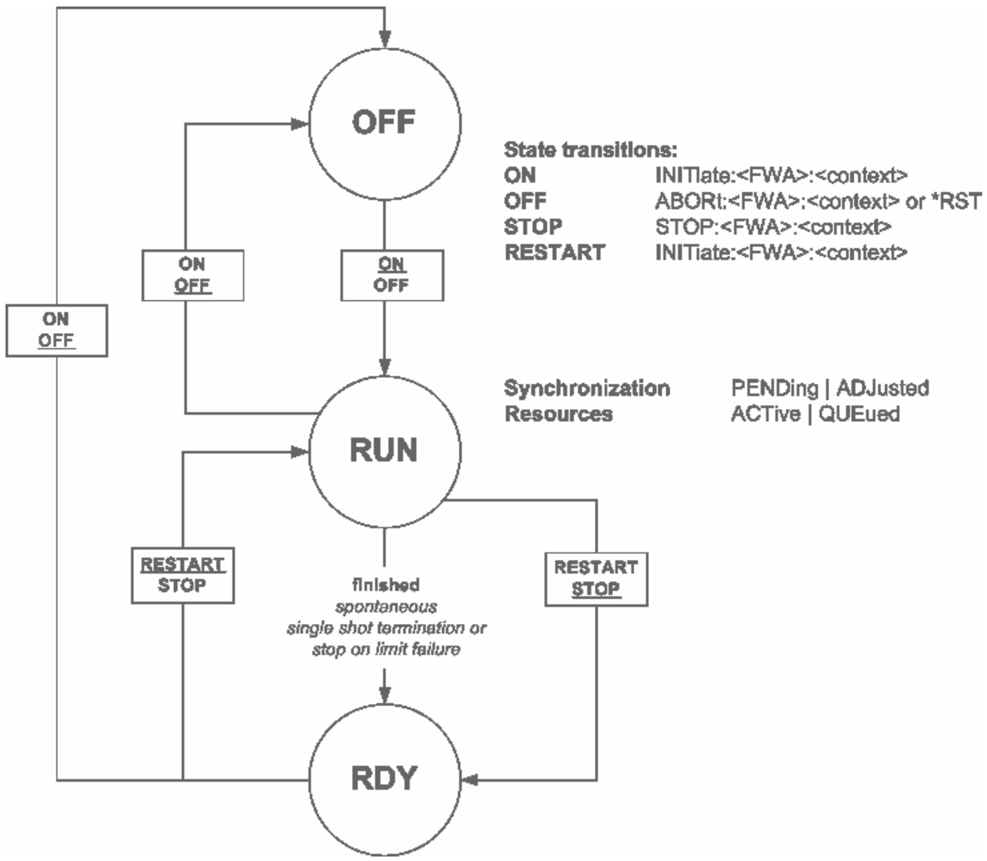
RUN Measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates). RUN corresponds to the SCPI trigger state INITiated.

Querying the main measurement state

The main measurement state can be queried using `FETCh:<FWA>:<context>:STATe?` where <FWA> denotes the firmware application and <context> is to be replaced by the name of the measurement.

Example: `FETCh:GPRF:MEASurement<i>:POWer:STATe?` (possible response: RDY).

The relationship between measurement states and measurement control commands is shown in the following diagram:



Measurement control commands are of the following type (see also Firmware Applications):

SCPI subsystem	<Application>	Measurement instance	Context
INITiate ABORt STOP	:GSM | :WCDMa | :GPRF	:MEASurement<i>	:POWer :EPSensor :MEValuation ... (depending on <Application>)

Example: `INITiate:GPRF:MEASurement:POWer`

5.4.1.2 INITiate:<Application>:MEASurement<i>

Starts the measurement in the repetition mode set via `CONFigure:<Application>:MEASurement<i>:<Context>:REPetition` (single shot or continuous, see Statistical Settings). The command resets the counters for the evaluation period and statistics cycle to zero.

`INITiate...` can be used irrespective of the current measurement state. An initiated measurement reserves all necessary system resources and enters the "RUN" state. If the hardware and system resources are already assigned to another firmware application, this firmware application is released in order to start the measurement; see Resource and Path Management.

If a previously initiated measurement (which may be of the same type) is still running, the new measurement remains in the "PENDing" or "QUEUed" measurement substates (see Queuing of Measurements) and is activated only after the previous measurement has completed the current measurement cycle. After the new measurement has entered the "RUN" state, the previous results are discarded.
If the measurement cannot be started due to an unrecoverable resource conflict (e.g. a missing software option) it remains in the OFF state. The SCPI error "–213, Init ignored, ...", is generated.

Conflicting settings cause restart of the measurement
Many measurement parameters (e.g. RF path settings, filter settings, etc.) have a direct impact on the measurement results. Changing these parameters while the measurement is running results in wrong results.
To avoid misleading results, a running measurement is re-started if a parameter with direct impact on the results is changed. All values acquired so far are discarded; the statistics counters are re-set to zero.

READ...? command
`READ...?` can be used instead of `INITiate...` to start a (single shot) measurement. `READ...?` also returns the results; see Retrieving Measurement Results.

5.4.1.3 ABORt:<Application>:MEASurement<i>

Aborts the current measurement immediately and causes the measurement to enter the OFF state. All measurement values are set invalid (INV or NAV); the hardware resources are released for other measurements.

5.4.1.4 STOP:<Application>:MEASurement<i>

Halts the measurement immediately. The measurement enters the RDY state; the R&S CMW 500 retains all valid measurement results. Moreover, the hardware and system resources continue to be allocated to the measurement.

5.4.1.5 Measurement Substates

Each running measurement can be in one of the following substates:

Substate	For main state	Values	Description
Synchronization	RUN	PENDing	Waiting for resource allocation, adjustment, hardware switching

		ADJusted	All necessary adjustments finished, measurement running
Resources	RUN	QUEued	Measurement without resources, no results available
		ACTive	Resources allocated, acquisition of results in progress but not complete

Querying substates

The main measurement state can be queried using
`FETCh:<FWA>:<context>:STATe:ALL?` where <FWA> denotes the firmware application and <context> is to be replaced by the name of the measurement.
Example: `FETCh:GPRF:MEASurement<i>:POWer:STATe:ALL?` (possible response: RUN, ADJ, ACT).

5.4.2 Statistical Settings

Measurements generally cover a basic time interval and can be repeated periodically. The measurement interval depends on the measurement context.
The number of measurement intervals that the R&S CMW 500 repeats in order to calculate statistical results is termed "statistic count" (multi-measurement count). After one statistic count, the instrument has terminated a basic measurement cycle ("single shot" measurement). Measurement cycles can be repeated for an unlimited number of times, resulting in the "continuous" repetition mode.
Most measurement contexts provide different sets of measurement results (single/scalar values and traces) corresponding to the current measurement interval, and the maximum, minimum, and average over a number of consecutive measurement intervals (see section Statistical Results). In remote control these statistical results can be retrieved independently.

Statistic count

Integer number of measurement intervals per measurement cycle (single shot measurement). The statistic count can be set independently for any measurement context or view; see Measurement Contexts and Views.
`CONFigure:<FWA>:<Context>:SCOunt:<View> <Count>`
e.g. `CONFigure:GSM:MEASurement:MEValuation:SCOunt:PVTime 10`
(sets the statistic count for the PVTime view in the GSM "Multi Evaluation" measurement context).

Repetition mode

Single shot: The measurement is stopped after the number of measurement intervals defined by the "statistic count".
Continuous: The measurement is continued until it is stopped explicitly. Average results are calculated according to the rules given in the Statistical Results topic.

Manual and remote control
In contrast to mode other instrument settings, the repetition modes in manual and remote control are independent and do not overwrite each other. The default repetition mode in manual control is Continuous (observe results over an extended period of time), the default mode in remote control is Single Shot (perform one measurement and retrieve results). See also Reset Dialog.

```
CONFigure:<FWA>:<Context>:REPetition <Count>
e.g.CONFigure:GPRF:MEASurement<i>:POWer:REPetition CONT
```

Statistics type
In general the following types of statistical results are available for scalar results (single values) and traces:
Current: Result of the current measurement interval
Minimum/Maximum: Minimum or maximum of all evaluation periods since the measurement was started
Average: Average referenced to one single shot measurement length.

```
FETCh:<FWA>:<Context>:<View>:CURRent...?
READ:<FWA>:<Context>:<View>:CURRent...?
FETCh:<FWA>:<Context>:<View>:MINimum...?
READ:<FWA>:<Context>:<View>:MINimum...?
FETCh:<FWA>:<Context>:<View>:MAXimum...?
READ:<FWA>:<Context>:<View>:MAXimum...?
FETCh:<FWA>:<Context>:<View>:AVERage...?
READ:<FWA>:<Context>:<View>:AVERage...?
e.g. FETCh:GPRF:MEASurement<i>:POWer:CURRent:RMS
```

Detector
Some measurements provide different detector settings to calculate the returned results from the raw measurement data. An example is the GPRF Power measurement which evaluates the maximum, minimum, and RMS (average) power within the current measurement interval (see Statistical Results). The detector is identified by means of an additional mnemonic preceding the statistics type:

```
FETCh:<FWA>:<Context>:<View>[:RMS[:CURRent?
FETCh:<FWA>:<Context>:<View>:MINimum:CURRent?
FETCh:<FWA>:<Context>:<View>:MAXimum:CURRent?
READ:<FWA>:<Context>:<View>[:RMS]:CURRent?
READ:<FWA>:<Context>:<View>:MINimum:CURRent
READ:<FWA>:<Context>:<View>:MAXimum:CURRent
```

Simplified statistics
Some measurement contexts provide simplified statistical settings. Refer to the measurement and remote control description for details.

5.4.3 Retrieving Measurement Results

The results of a measurement can be retrieved by means of the `FETCh...?` or `READ...?` queries. Both command types have the same structure:
`FETCh:<FWA>:<Context>:<View>:<Statistics>...?`
`READ:<FWA>:<Context>:<View>:<Statistics>...` e.g.
`FETCh:GPRF:MEASurement<i>:POWer:RMS:CURRent?`
The three identifiers `<FWA>`, `<Context>`, `<View>`, and `<Statistics>` denote the firmware application, measurement context and view, and the statistics type, respectively. `<View>` is only required for measurement contexts providing several views.
The number and type of measurement results depends on the measurement context and view; refer to the relevant reference documentation.
For more information refer to the following topics:

- FETCh...? command
- READ...? command
- Retrieving single (scalar) values and traces

5.4.3.1 FETCh...? Command

Waits until the end of the current measurement cycle (if the measurement is running) and returns the results including the reliability indicator. `FETCh...?` is similar to the READ...? command, however, it does not start a new measurement. The measurement must have been started (`INITiate...`; see Measurement Control) before a `FETCh...?` command can be executed.

Measurement states
A `FETCh...?` command can be used in the RUN state as described above or in the RDY state, provided that the R&S CMW 500 has stored valid results. If no valid results are available (e.g. because the measurement has not been configured for the queried result type), the command returns a single NCAP ("Not Captured") reliability indicator.
The following table gives an overview:

State	Valid results?	Effect of FETCh...?

State	Valid results?	Effect of FETCh...?
OFF	No	Returns NCAP. `FETCh...?` should not be used in the OFF state.
RUN	Yes/No	R&S CMW 500 waits until the results of the current measurement cycle have become valid and returns them. In continuous repetition mode the R&S CMW 500 continues acquiring results without reaching the RDY state.
RDY	Yes	Returns the results.
RDY	No	Returns NCAP.

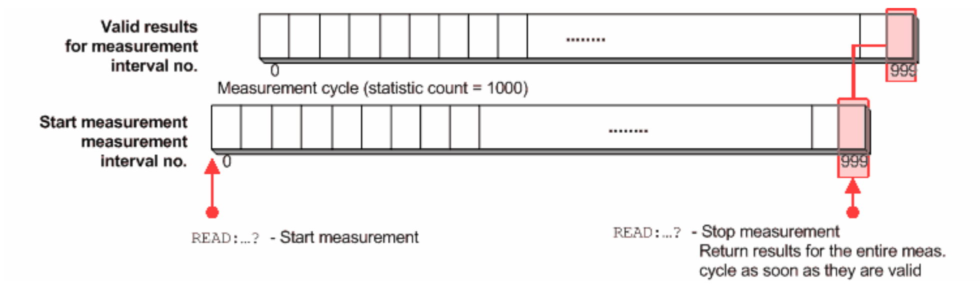
Repeated `FETCh...?` commands

It is possible to use repeated `FETCh...?` commands without re-starting the measurement, e.g. in order to monitor the variation in time of a measured quantity in continuous measurement mode.

- In single-shot mode where the measurement reaches the RDY state and is stopped before the first `FETCh...?` is executed, the results of repeated `FETCh...?` commands will be identical.
- In continuous mode, the first `FETCh...?` is executed after the end of the current measurement cycle. The following `FETCh...?` commands are executed as quickly as possible, no matter whether the R&S CMW 500 has acquired new results.

5.4.3.2 READ...? Command

Aborts the current measurement (if a measurement is running), starts a new measurement in single shot mode, and returns the results including the reliability indicator at the end of the measurement cycle.



`READ...?` does not change any of the measurement control settings. The measurement initiated by `READ...?` is stopped after one single shot (--> measurement state RDY), however, the repetition mode itself is not changed. `READ...?` can be used in all measurement states.

Performance considerations, multi-evaluation measurements

The `READ...?` query is view-specific and calculates only the results needed for a particular view. This can result in a performance improvement compared to the context-specific command sequence `INITiate...; FETCh...?`

In contrast to `FETCh...?` queries, `READ...?` commands also provide valid results for disabled views in multi-evaluation measurements; see Retrieving results for disabled views.

5.4.3.3 Retrieving Single Values and Traces

The R&S CMW 500 provides two different types of measurement results:

- Tables or output fields contain a (usually) small number of single, mostly statistical values.
- Traces in diagrams consist of a larger number of measurement points. They usually depend on a parameter such as the time or frequency.

Single results and traces can be retrieved separately. To distinguish the result type, the mnemonic `:TRACe` is included in the commands headers:

```
FETCh:<FWA>:<Context>:<View>:<Statistics>...?
READ:<FWA>:<Context>:<View>:<Statistics>...?
READ:<FWA>:<Context>:TRACe:<View>:<Statistics>...?
FETCh:<FWA>:<Context>:TRACe:<View>:<Statistics>...?

e.g.
FETCh:GSM:MEASurement:MEValuation:EVMagnitude?
FETCh:GSM:MEASurement:MEValuation:TRACe:EVMagnitude:CURRent?
```

The <View> mnemonic is used in multi-evaluation measurements where it distinguishes different subsets of results. For detailed information about the returned values refer to the command reference description.

5.4.4 Reliability Indicator

The reliability indicator is an information element that describes the validity of the results and the possible source of inaccuracies or errors. The R&S CMW 500 provides common reliability indicators for an entire array of measurement results (retrieved with a single command).

5.4.4.1 Common Reliability Indicator

The common reliability indicator is the first value in the output arrays of the

`FETCh...?` and `READ...?` queries.
e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`
Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement values)
In the present firmware version, the common reliability indicator is always set to zero.

5.4.5 Multi-Evaluation Measurements

In a multi-evaluation measurement, the R&S CMW 500 acquires a wide range of measurement results at once. For example, the GSM multi-evaluation measurement provides the most important GSM mobile transmitter test results described in standard 3GPP TS 51.010:

- The transmitter output power versus time
- Results that describe the modulation accuracy: Error vector magnitude (EVM), phase error, frequency error for each symbol, normalized I/Q vector at and between the decision points (I/Q constellation, vector and phase diagrams)
- Results that describe the output RF spectrum: adjacent channel power (ACP) due to modulation and due to switching, ACP versus time

Multi-evaluation measurements offer maximum speed and performance, even if only a subset of the measurement results is needed. In remote control, it is possible to control each multi-evaluation measurement as a whole but retrieve the different types of results separately.

Controlling multi-evaluation measurements

A multi-evaluation measurement is controlled like any other measurement; see Measurement Control. The following commands start, stop and abort a multi-evaluation measurement within a particular firmware application <FWA>:

```
INITiate:<FWA>:MEValuation
STOP:<FWA>:MEValuation
ABORt:<FWA>:MEValuation
```

The following commands query the measurement state and the substates:

```
FETCh:<FWA>:MEValuation:STATe?
FETCh:<FWA>:MEValuation:STATe:ALL?
```

Example: `INITiate:GSM:MEASurement<i>:MEValuation`

Retrieving measurement results

The commands for retrieving the results of a multi-evaluation measurement follow general syntax rules (see Retrieving Measurement Results). In general it is possible to specify the subset of results needed using an additional <View> mnemonic:

```
READ:<FWA>:MEValuation[:SCALar]:<View>:<Statistics>...?
READ:<FWA>:MEValuation:TRACe:<View>:<Statistics>...?
FETCh:<FWA>:MEValuation[:SCALar]:<View>:<Statistics>...?
FETCh:<FWA>:MEValuation:TRACe:<View>:<Statistics>...?
```

The result subsets are closely related to the different views that the multi-evaluation measurement provides in manual control.

Example: `READ:GSM:MEASurement<i>:MEValuation:TRACe:EVM:AVERage?`

Retrieving results for disabled views

In some measurements (e.g. in the GSM multi-evaluation measurement), it is possible to disable individual views and results in order to gain measurement speed. The `READ...?` and `FETCh...?` queries act differently on disabled views:

- A `FETCh...?` command leaves the view in the unchanged (disabled) state and returns NCAP (not captured) results. The view must be enabled explicitly to obtain valid results.
- A `READ...?` command enables the view implicitly and returns valid results. After program execution, the view returns to the disabled state.

5.4.6 Generator Control

The commands used to control the R&S CMW 500 RF signal generator are analogous to the commands explained in section Measurement Control. The generator is in one of the following generator states:

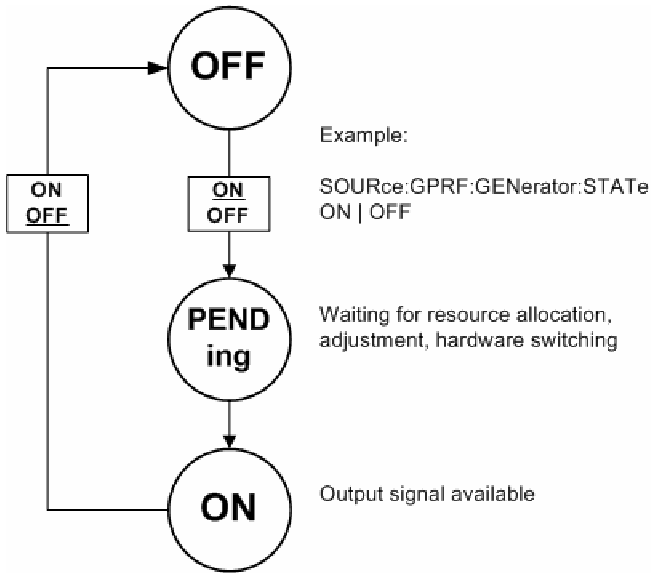
OFF Generator turned off, resources either released or (partially) reserved from the last time the generator was turned on.

PENDing Generator turned on, but still waiting for resource allocation, adjustment, hardware switching. No output signal is applied to the selected output connector.

ON Generator turned on, with all necessary adjustments finished. An output signal according to the R&S CMW 500 specifications is available at the selected output connector.

The OFF and PENDing/ON states correspond to the status indication "Stop" and "Run" in the generator softkeys.

The relationship between generator commands and generator states is shown in the following diagram:



Generator control commands are of the following type (see also *Firmware Applications*):

SCPI subsystem	<Application>	Generator, logical instrument	State
SOURce	:GSM | :WCDMa |:GPRF	:GENerator<i>	:STATe ON | OFF

Example: `SOURCe:GPRF:GENerator[:STATe] ON | OFF`

SOURce:<Application>:GENerator<i>:STATe ON

Starts the generator, reserves all necessary hardware and system resources and changes to the generator state "PENDing", then "ON". If the generator is already turned on the command has no effect.

If the hardware and system resources are already assigned to another firmware application, this firmware application is released in order to start the generator; see Resource and Path Management.

If the generator cannot be started due to an unrecoverable resource conflict (e.g. a missing software option) it remains in the OFF state. The SCPI error "–213, Init ignored, ...", is generated.

Command synchronization

Before you use the generator signal, use the query `SOURce:<Application>:GENerator<i>:STATe?` to ensure that the generator has reached its `ON` state and that the generator signal is available.

SOURce:<Application>:GENerator<i>:STATe OFF

Switches the generator off, releases the hardware resources for other generators, and changes to the generator state "OFF". If the generator is already turned off the command has no effect.

5.4.7 RF Path Settings

The R&S CMW 500 provides a number of settings that are very similar in different applications but can be configured independently. These settings control the routing of input and output signals, the correction of the generator level or input power, the RF analyzer and trigger system.

Input/output connector

`ROUTe:<Application>:GENerator<i>:RFSettings:CONNector`
`ROUTe:<Application>:MEASurement<i>:RFSettings:CONNector`
Selects an output connector for the RF generator signal and an input connector for a TX measurement.

External input/output attenuation

`SOURce:<Application>:GENerator<i>:RFSettings:EATTenuation`
`CONFigure:<Application>:MEASurement<i>:RFSettings:EATTenuation`
Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF output or input connector.

Analyzer settings

`CONFigure:<Application>:MEASurement<i>:RFSettings:ENPower`
`CONFigure:<Application>:MEASurement<i>:RFSettings:UMARgin`
`CONFigure:<Application>:MEASurement<i>:RFSettings:FREQuency`
Defines the expected nominal power of the measured RF signal, an additional, signal-specific (user) margin, and the center frequency of the RF analyzer.

Trigger settings

`CONFigure:<Application>:MEASurement<i>:<Measurement>:TRIGger:SOURce`
Selects the source of the measurement trigger events. In general, this command is complemented by measurement-specific trigger settings. Many measurements implement a trigger slope, threshold, delay, and timeout:
`CONFigure:<Application>:MEASurement<i>:<Meas.>:TRIGger:SLOPe`
`CONFigure:<Application>:MEASurement<i>:<Meas.>:TRIGger:THReshold`
`CONFigure:<Application>:MEASurement<i>:<Meas.>:TRIGger:DELay`
`CONFigure:<Application>:MEASurement<i>:<Meas.>:TRIGger:TOUT`

5.4.8 Resource and Path Management

The R&S CMW 500 is a modular platform supporting a wide range of measurements and generators. For the remainder of this section, measurements and generators are both termed "tasks".
In general, the instrument is capable of running several tasks in parallel. E.g. the

GPRF generator can be used to generate a test signal, while the GPRF Power measurement analyzes the input signal at different powers and frequencies, and the External Power Sensor measurement is used to monitor the signal power at a particular point in the test setup. Conflicts between different tasks may occur if they rely upon the same system resources.
The Resource and Path Management (RPM) of the R&S CMW 500 represents a control mechanism for conflicting tasks, deciding whether and for how long a running task will persist.

Remote and manual control
The RPM principles described below are valid in remote as well as in manual control. In remote control, running different tasks in parallel enhances the speed and performance of the tester. In manual control, it allows you to monitor different measurements simultaneously and compare the results.

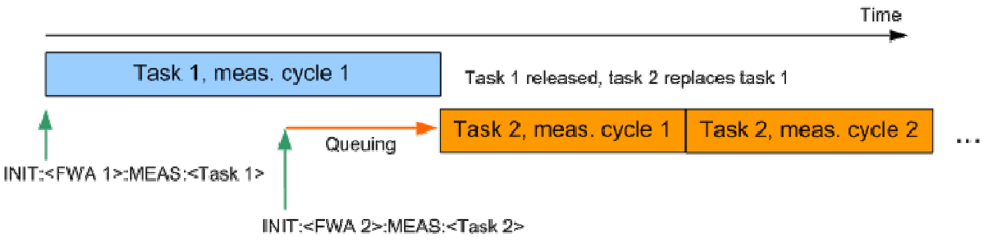
5.4.8.1 Basic RPM Principles

The principles of R&S CMW 500 Resource and Path Management can be summarized very briefly:

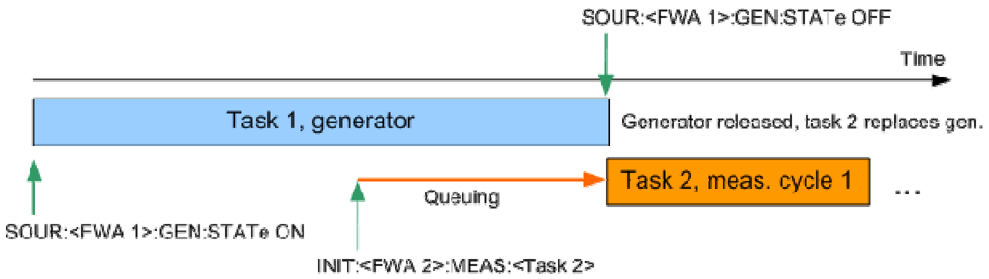
- Non-conflicting tasks can be running in parallel without restriction.
- A new measurement or generator that is in conflict with a running task replaces the running task. Conflicting measurements are blocked until the generators are switched off by other means.
- Generators are released immediately, measurements are released after the current measurement cycle.

According to the last rule, conflicting measurements are queued. A new measurement is started only after all previous measurements have been terminated in a regular way.
The RPM principles can be visualized as follows:

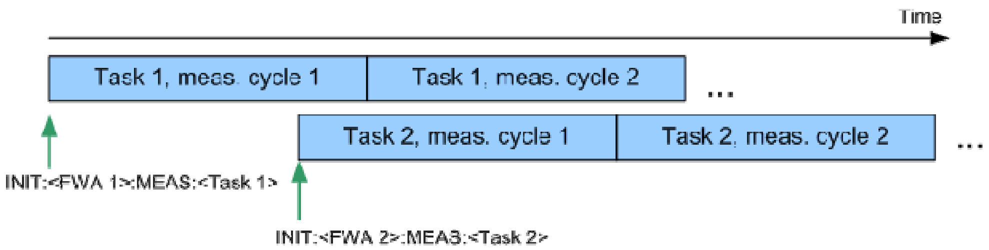
Two measurements in conflict, second measurement queued



Generator and measurement in conflict



Two non-conflicting measurements, executed in parallel



5.4.8.2 Queuing of Measurements

The R&S CMW 500 queues conflicting measurements in order to ensure that no results are lost when a new measurement is started. Adding a new measurement to the queue switches the preceding measurement into single shot mode (if it is a continuous measurement). As a result, the instrument can acquire a valid set of measurement results for every measurement in the queue.

Example for queued conflicting measurements

`*RST` `INITiate:<FWA>:<Meas1>`	Start measurement 1 in single shot mode (default setting for remote control)
`INITiate:<FWA>:<Meas2>`	Start a new measurement 2. The new measurement will be queued.

`FETCh:<FWA>:<Meas1>:STATe:ALL?`	Query the measurement substates of measurement 1. The response (`RUN, ADJ, ACT`) indicates that the measurement is running with all necessary adjustments finished, that the necessary resources are allocated and that results are being acquired.
`FETCh:<FWA>:<Meas2>:STATe:ALL?`	Query the measurement substates of measurement 2. The response (`RUN, PEND, QUE`) indicates that the measurement is running but still queued, waiting for resource allocation.
`FETCh:<FWA>:<Meas1>...CURRent?` (or similar command syntax for reading measurement results)	Wait until the end of the statistics cycle of measurement 1 and retrieve the results.
`FETCh:<FWA>:<Meas2>:STATe:ALL?`	Query the measurement substates of measurement 2. The response (`RUN, ADJ, ACT`) indicates that measurement 2 is now active.

Extension: Queued continuous measurements

`CONFigure:<FWA>:<Meas1>:REPetition CONT` `Initiate:<FWA>:<Meas1>`	Start measurement 1 in continuous mode
`CONFigure:<FWA>:<Meas2>:REPetition CONT` `Initiate:<FWA>:<Meas2>`	Start a new measurement 2 in continuous mode. The new measurement will be queued, the old measurement is set to "single shot mode".
`FETCh:<FWA>:<Meas1>:STATe:ALL?`	Query the measurement substates of measurement 1. The response (`RUN, ADJ, ACT`) indicates that the measurement is running with all necessary adjustments finished, that the necessary resources are allocated and that results are being acquired.
`FETCh:<FWA>:<Meas2>:STATe:ALL?`	Query the measurement substates of measurement 2. The response (`RUN, PEND,`

	QUE) indicates that the measurement is running but still queued, waiting for resource allocation.
FETCh:<FWA>:<Meas1>...CURRent ? (or similar command syntax for reading measurement results)	Wait until the end of the statistics cycle of measurement 1 and retrieve the results.
FETCh:<FWA>:<Meas2>:STATe:ALL ?	Query the measurement substates of measurement 2. The response (RUN, ADJ, ACT) indicates that measurement 2 is now active.
CONFigure:<FWA>:<Meas1>:REPetition? CONFigure:<FWA>:<Meas1>:REPetition?	Query the repetition mode of measurements 1 and 2. Measurement 1 is in single shot mode (SING), measurement 2 is still in continuous mode (CONT).

5.4.8.3 Causes for Task Conflicts

Resource conflicts may arise for the following reasons:

Hardware Resource Conflicts
A generator requires an independent output channel (digital and analog RF transmitter stages). Mobile transmitter measurements (TX measurements) generally require their own input channel (analog and digital RF receiver stages).
The number of tasks that the instrument can service in parallel depends on the number of independent channels. The R&S CMW 500 can be equipped with up to 4 independent input/output channels.

System Resource Conflicts
In addition to the hardware resources required for TX and RX channels, other system resources may cause limitations: memory size, possible connections between modules (e.g. trigger lines, I/Q data lines etc.)

Software Option Conflicts
Many R&S CMW 500 features must be enabled using a firmware option key. To be run in parallel, several measurements of the same type may require several enabled software options. A resource conflict arises whenever the required number of software options is not available.
The RPM principles are not valid for tasks which cause a software option conflict.

These tasks are rejected.

5.4.8.4 Monitoring Measurement and Generator States

The state of each measurement and generator can be queried with commands of the following types:

```
FETCh:<Meas_FWA>:<Measurement>:STATe?
FETCh:<Meas_FWA>:<Measurement>:STATe:ALL?
SOURce:<Gen_FWA>[:STATe]?
```

For a detailed description see Measurement Substates and Generator Control.

Example 1: Conflicting generators

`SOURce:<Gen_FWA 1> ON` `SOURce:<Gen_FWA 1>?`	Switch on the first generator and query its state. After hardware adjustment, the response is `ON`, i.e. the generator is running and an output signal is available.
`SOURce:<Gen_FWA 2> ON` `SOURce:<Gen_FWA 2>?`	Switch on the second generator and query its state. Again, the response is `ON`, i.e. the generator is running.
`SOURce:<Gen_FWA 1>?`	Check the state of the first generator. The generator state should be `OFF`, i.e. the second generator has replaced the first generator.

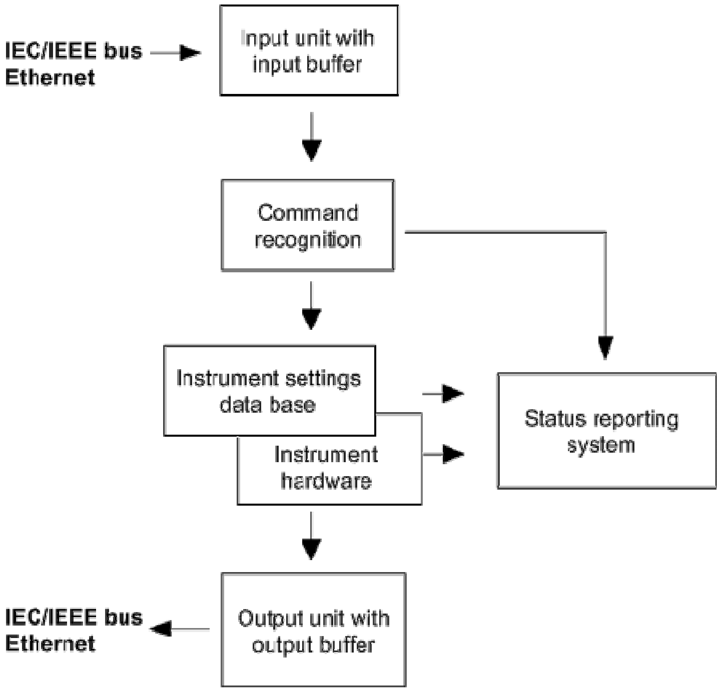
Example 3: Conflicting measurements
Two conflicting measurements will be queued; the first one is set to single shot mode; see examples in section Queuing of Measurements.

5.5 Command Processing

The block diagram below shows how GPIB bus commands are serviced in the instrument. The instrument model consists of the following components:

- Input Unit
- Command Recognition
- Data Base and Instrument Hardware
- Status Reporting System
- Output Unit

The individual components work independently and simultaneously. They communicate with each other by means of so-called "messages".



5.5.1 Input Unit

The input unit receives commands character by character from the controller 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 message data 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.

5.5.2 Command Recognition

The command recognition stage analyzes 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, e.g. a `GET` (Group Execute Trigger) is only executed after the commands received before. Each recognized command is immediately transferred 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 still

executed, if possible. After the syntax check, the range of the numerical parameters 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").

5.5.3 Data Base and Instrument Hardware

The expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function – signal generation, measurement etc. The controller is not included. The data base manages all the parameters and associated settings required for the instrument hardware.
Setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. frequency) into the data set, however, it only passes them on to the hardware when requested by the command recognition. This can only occur at the end of a command line, therefore the order of the setting commands in the command line is not relevant.
The commands 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 instrument detects 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 (example: simultaneous routing of the same generator signal to different output connectors). At the end of the command line, however, a permissible instrument state must have been reached again.
Before passing on the data to the hardware, the settling bit in the `STATus:OPERation` register is set (cf. section STATus:OPERation Register). The hardware executes the settings and resets the bit again as soon as the new state has settled. This fact can be used to synchronize command servicing.
Queries induce the data set management to send the desired data to the output unit.

5.5.4 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.

5.5.5 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 information requested is longer, it is made available "in portions" without this being recognized by the controller.
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 is sent on the GPIB bus or via the Ethernet, the controller waits until it has reached its time limit. This behavior is specified by SCPI.

5.6 Status Reporting System

The status reporting system stores all information on the present operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue. Both can be queried via GPIB bus or Ethernet (STATus Commands).

Hierarchy of status registers

As shown in the graphical overview, The status information is of hierarchical structure.

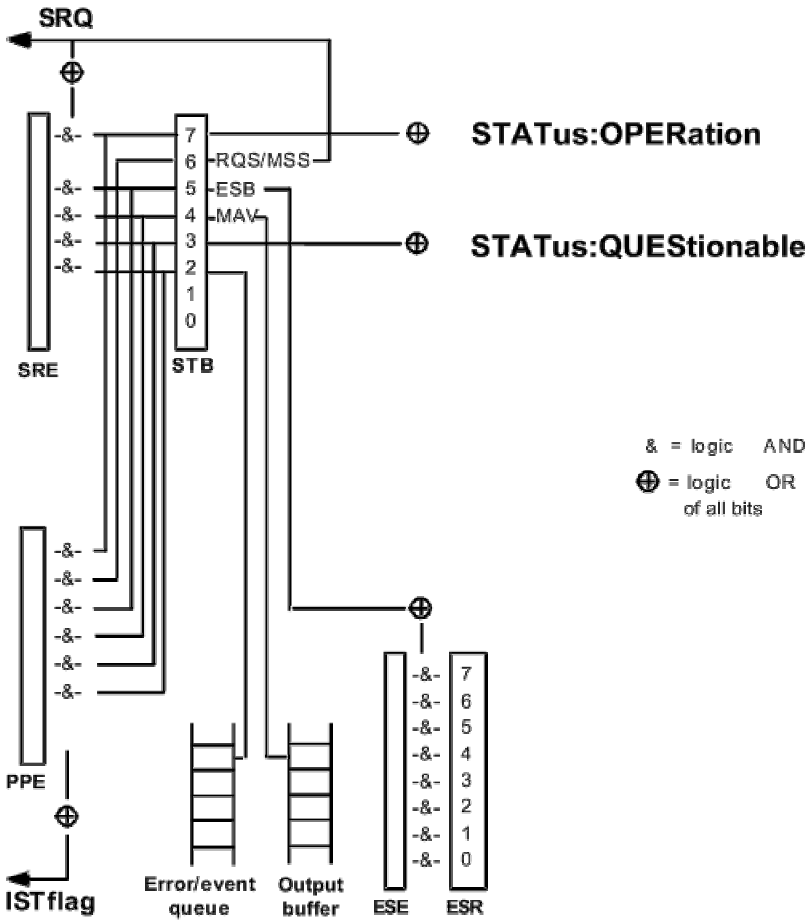
- STB, SRE
  The STatus Byte (STB) register and its associated mask register Service Request Enable (SRE) form the highest level of the status reporting system. The STB provides a rough overview of the instrument status, collecting the information of the lower-level registers.
- ESR, SCPI registers
  The STB receives its information from the following registers:
  The Event Status Register (ESR) with the associated mask register standard event status enable (ESE).
  The STATus:OPERation and STATus:QUEStionable registers which are defined by SCPI and contain detailed information on the instrument.
- IST, PPE
  The IST flag ("Individual STatus"), like the SRQ, combines the entire instrument status in a single bit. The PPE is associated to the IST flag. It fulfills an analogous function for the IST flag as the SRE does for the service request.
- 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.

All status registers have the same internal structure.

SRE register
The service request enable register SRE can be used as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be used as the ENABle part of the ESR.

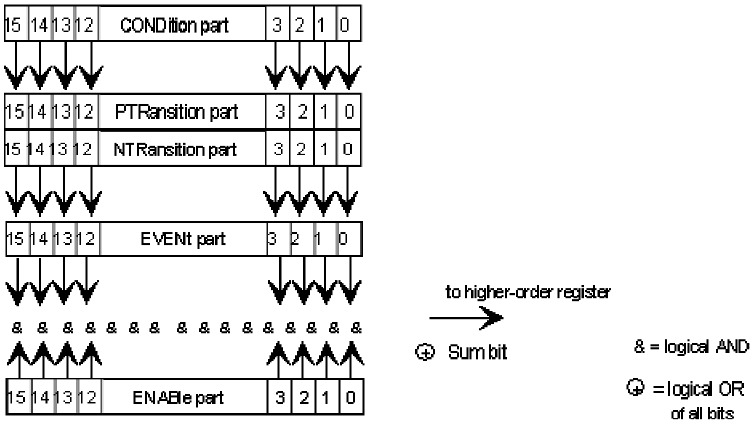
5.6.1 Overview of Status Registers

The status registers of the R&S CMW 500 are implemented as shown below.



5.6.2 Structure of an SCPI Status Register

Each standard SCPI register consists of 5 parts which each have a width of 16 bits and have different functions. The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.



5.6.2.1 Description of the five status register parts

The five parts of an SCPI register have different properties and function:

CONDition

The CONDition part is permanently overwritten by the hardware or the sum bit of the next lower register. Its contents always reflect the current instrument state.
This register part can only be read, but not overwritten or cleared. Reading the CONDition register is nondestructive.

PTRansition

The two transition register parts define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.
The Positive TRansition part acts as a transition filter. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1:

- PTR bit =1: the EVENt bit is set
- PTR bit =0: the EVENt bit is not set

This status register part can be overwritten and read at will. Reading the PTRansition register is nondestructive.

NTRansition

The Negative TRansition part also acts as a transition filter. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.

- NTR bit =1: the EVENt bit is set.
- NTR bit =0: the EVENt bit is not set.

This part can be overwritten and read at will. Reading the PTRansition register is nondestructive.

EVENt

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument. This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.

ENABle

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').

- ENAB bit =0: The associated EVENt bit does not contribute to the sum bit.
- ENAB bit =1: If the associated EVENT bit is "1", the sum bit is set to "1" as well.

This part can be overwritten and read by the user at will. Its contents are not affected by reading.

The sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.

The instrument automatically generates the sum bit for each register. Thus an event can lead to a service request throughout all levels of the hierarchy.

5.6.3 Contents of the Status Registers

The individual status registers are used to report different classes of instrument states or errors. The following status registers belong to the general model described in IEEE 488.2:

- The STatus Byte (STB) gives a rough overview of the instrument status.
- The IST flag combines the entire status information into a single bit that can be queried in a parallel poll.
- The Event Status Register (ESR) indicates general instrument states.

The status registers below belong to the device-dependent SCPI register model:

- The STATus:OPERation register contains conditions which are part of the instrument's normal operation.
- The STATus:QUEStionable register indicates whether the data currently being acquired is of questionable quality.

5.6.3.1 STB and SRE

The STatus Byte (STB) provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. The STB represents the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the summary bit of the remaining bits of the status byte.

SRE and Service Request

The STatus Byte (STB) is linked to the Service Request Enable (SRE) register on a bit-by-bit basis.

- The STB corresponds to the CONDition part of an SCPI register, indicating the current instrument state.
- The SRE corresponds to the ENABle part of an SCPI register. 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 GPIB bus.

Bit 6 of the SRE is ignored, because it corresponds to the summary bit of the STB.

Related common commands

The STB is read out using the command *STB? or a serial poll.
The SRE can be set using command *SRE and read using *SRE?.
The bits in the STB are defined as follows:

Bit No.	Meaning
2	**Error Queue not empty** This bit is set when an entry is made in the error queue.
3	**QUEStionable status summary bit** The bit indicates a questionable instrument status, which can be further pinned down by polling the QUEStionable register.
4	**MAV bit**(message available) This bit is set if a message is available and can be read from the output buffer. This bit can be used to automatically transfer data 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 implies an error or an event which can be further pinned down by polling the event status register.
6	**MSS bit** (master status summary bit) This bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register summary bit** This bit is set if an EVENt bit is set in the OPERation-Status register and the associated ENABle bit is set to 1.

5.6.3.2 IST Flag and PPE

In analogy to the Service Request (SRQ), the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll.
The Parallel Poll Enable (PPE) register 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.

Related common commands

The IST flag is queried using the command *IST?.
The PPE can be set using *PRE and read using command *PRE?.

5.6.3.3 ESR and ESE

The Event Status Register (ESR) indicates general instrument states. It is linked to the Event Status Enable (ESE) register on a bit-by-bit basis.

- The ESR corresponds to the CONDition part of an SCPI register, indicating the current instrument state.
- The ESE corresponds to the ENABle part of an SCPI register.If a bit is set in the ESE and the associated bit in the ESR changes from 0 to 1, the ESB bit in the STatus Byte is set.

Related common commands

The Event Status Register (ESR) can be queried using ESR?.
The Event Status Enable (ESE) register can be set using the command *ESE and read using *ESE?.
The bits in the ESR are defined as follows:

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC after all previous commands have been executed.
1	**Request Control** This bit is set if the instrument requests the controller function. This is the case when a hardcopy is sent to a printer or a plotter via the IEC-bus.
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 describes the error in greater detail, is entered into the error queue (see).
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 describes the error in greater detail, is entered into the error queue (see).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error

Bit No.	Meaning
	message with a number between -100 and -200, which describes the error in greater detail, is entered into the error queue (see).
6	**User Request** This bit is set on pressing the *LOCAL* key, i. e. when the instrument is switched over to manual control.
7	**Power On**(supply voltage on) This bit is set when the instrument is switched on.

5.6.3.4 STATus:OPERation

The STATus:OPERation register contains conditions which are part of the instrument's normal operation.
The R&S CMW 500 does not use the STATus:OPERation register:

5.6.3.5 STATus:QUEStionable

The STATus:QUEStionable register indicates whether the data currently being acquired is of questionable quality.
The R&S CMW 500 does not use the STATus:QUEStionable register:

5.6.4 Application of the Status Reporting System

The purpose of the status reporting system is to monitor the status of one or several devices in a measuring system. To do this and react appropriately, the controller must receive and evaluate the information of all devices. The following standard methods are used:

- Service request (SRQ) initiated by the measuring device
- Serial poll of all devices in the bus system, initiated by the controller in order to find out who sent a SRQ and why
- Parallel poll of all devices
- Query of a specific instrument status by means of commands
- Query of the error queue

5.6.4.1 Service Request

The measuring device can send a service request (SRQ) to the controller. Usually this service request causes an interrupt, to which the control program can react appropriately.

Initiating an SRQ

As shown in the graphical overview, an SRQ is initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits summarizes the information of a further register, the error queue or the output buffer. The ENABle parts of the status registers can be set such that arbitrary bits in an arbitrary status register initiate an SRQ. To use the possibilities of the service request effectively, all bits in the enable registers SRE and ESE should be set to "1".

Example: Use `*OPC` to generate an SRQ

1. Set bit 0 in the ESE (Operation Complete).
2. Set bit 5 in the SRE (ESB).
3. Insert `*OPC` in the command sequence.

As soon as all commands preceding `*OPC` 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.

5.6.4.2 Serial Poll

In a serial poll, the controller queries the STatus Bytes of the devices in the bus system one after another. The query is made via interface messages, so it is faster than a poll by means of *STB?.

Serial poll procedure

The serial poll method is defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.
The 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 controller.

5.6.4.3 Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 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".

Parallel poll procedure

In addition to the SRE register, which determines the conditions under which an SRQ is generated, there is a Parallel Poll Enable register (PPE) which is ANDed with the STB bit by bit, considering bit 6 – AND as well. 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 controller has sent a service request. To this effect, SRE and PPE must be set to the same value.

5.6.4.4 Query of an Instrument Status

Each part of any status register can be read by means of queries. There are two types of commands:

- The common commands `*ESR?`, `*IDN?`, `*IST?`, `*STB?` query the higher-level registers.
- The commands of the STATus system query the SCPI registers (`STATus:QUEStionable...`)

All queries return a decimal number which represents the bit pattern of the status register. This number is evaluated by the controller program.

Decimal representation of a bit pattern

The STB and ESR registers contain 8 bits, the SCPI registers 16 bits. The contents of a status register is keyed and transferred as a single decimal number. To make this possible, each bit is assigned a weighted value. The decimal number is calculated as the sum of the weighted values of all bits in the register that are set to 1.

Bits	0	1	2	3	4	5	6	7	...
Weight	1	2	4	8	16	32	64	128	...

Example: The decimal value 40 = 32 + 8 indicates that bits no. 3 and 5 in the status register (e.g. the QUEStionable status summary bit and the ESB bit in the STatus Byte) are set.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

5.6.4.5 Error Queue

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain text error messages that can be queried via remote control using `SYSTem:ERRor[:NEXT]?` or `SYSTem:ERRor:ALL?`. Each call of `SYSTem:ERRor[:NEXT]?` provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with `0, "No error"`. The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

5.6.5 Reset Values of the Status Reporting System

The table below indicates the effects of various commands upon the status reporting system of the R&S CMW 500.

Event	**Switching on supply voltagePower-On-Status-Clear**		**DCL,SDC(Device Clear, Selected Device Clear)**	***RST or SYSTem:PRESet**	**STATus:PRESet**	***CLS**
Effect	0	1				
Clear STB,ESR		yes				yes
Clear SRE,ESE		yes				
Clear PPE		yes				
Clear EVENt parts of the registers		yes				yes
Clear ENABle parts of all OPERation-and QUESTionable registers, Fill ENABle parts of all other registers with "1".		yes			yes	
Fill PTRansition parts with „1" Clear NTRansition parts		yes			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.

6 Command Reference

This chapter lists all common commands and instrument-control commands for the R&S CMW 500 platform.

- Common Commands
- Instrument-Control Commands

For an overview of these commands refer to the Alphabetical List of Commands.
The softkey or menu command corresponding to each remote control command is indicated in the command description.

Contents of this chapter
The commands listed in this chapter control the R&S CMW 500 platform. Application-specific commands (e.g. GPRF commands) are listed in the relevant sections.

6.1 Special Terms and Notation

This section explains the meaning of special syntax elements used in the SCPI command reference sections. A general description of the SCPI command syntax can be found in section SCPI Command Structure and Syntax in the "Remote Control" chapter.

Information in the command tables
All commands are described according to the same scheme. The following information is provided:

- Complete command syntax and parameter list
- Description of the command and its relationship with other commands
- List and description of the parameters with their numerical ranges, default values and default units
- SCPI conformance information, supported command types (setting command, query)
- Program example (optional)

Order of commands
The commands are arranged according to the order of parameters in the corresponding dialogs of the Graphical User Interface. This means that related commands are generally grouped together. Groups of commands with similar function (e.g. several `READ...?` and `FETCh...?` queries for a single measurement application) are listed with a common command description. Refer to the index for an alphabetical list of all commands.

Parameters

Many commands are supplemented by a parameter or a list of parameters. Parameters either provide alternative options (setting a or setting b or setting c ..., see special character "|"), or they form a list separated by commas (setting x,y).

- **<Par_Name>** In the command tables and lists, parameters are generally described by a name (literal) written in angle brackets (<>). This literal merely serves as a parameters description; in an application program it must be replaced by one of the possible settings reported in the detailed parameter description.

Example: `SOURce:GPRF:GENerator:STATe <Boolean>`
with <Boolean> = ON | OFF
possible command syntax: `SOURce:GPRF:GENerator:STATe ON`

- **NAN** (Not A Number) is generally used to represent missing data, e.g. if a portion of a trace has not been acquired yet. It is also returned after invalid mathematical operations such as division by zero. As defined in the SCPI standard, NAN is represented as 9.91 E 37.
- **INV** (invalid) is returned e.g. if a limit check is performed without defining the appropriate tolerance values.

Upper / lower case

Upper/lower case characters characterize the long and short form of the mnemonics in a command. The short form consists of all upper-case characters, the long form of all upper case plus all lower case characters. On the R&S CMW 500, either the short form or the long form are allowed; mixed forms will generally not be recognized. Either the short form or the long form are permissible. The instrument itself does not distinguish upper case and lower case characters.

Special characters

- **|** A vertical stroke in the parameter list characterizes alternative parameter settings. Only one of the parameters separated by | must be selected.
  Example: The following command has three alternative settings:
  `SOURce:GPRF:GENerator<i>:OUTPut:CONNector RF1O | RF1C | RF2C`
- **[ ]** in square brackets can be omitted when composing the command header (see SCPI Command Structure and Syntax). The complete command must be recognized by the instrument for reasons of compatibility with the SCPI standard. Parameters in square brackets are optional as well. They may be entered in the command or omitted.
- **{ }** Braces or curly brackets enclose one or more parameters that may be included zero or more times.

Numeric suffixes

Symbols in angular brackets (<Ch>, <Chn>, <Mk>,...) denote numeric suffixes. Numeric suffixes are replaced by integer numbers to distinguish various items of the same type. The R&S CMW 500 provides numeric suffixes for . If unspecified, a numeric suffix is replaced by 1.

Numeric suffixes are in the range between 1 and the maximum value listed in the reference description of the command.

6.2 Common Commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the status reporting system.
Some of the commands in the following list are R&S CMW 500-specific but use the same syntax as common commands. They are marked "not IEEE 488.2-confirmed".

Command	Parameters/Remarks	Short Description
***CLS** – CLear Status	– no query	Sets the status byte (STB), the standard event register (ESR) and the EVENt part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.
***DEV?** – DEVice	–	Sets or queries the R&S CMW 500 device number. The device number appears in the VISA address string. The command accepts t "DEFault"he parameter. The default device number is shown in the Setup dialog ("Assigned Instrument").
***ESE** – Event Status Enable	0 to 255	Sets the event status enable register to the value indicated. The query *ESE? returns the contents of the event status enable register in decimal form.
***ESR?** – Event Status Read	– query only	Returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.
***IDN?** – IDentification Query	– query only	Queries the instrument identification string of the R&S CMW 500.
***IST?** – Individual STatus query	– query only	Returns the contents of the IST flag in decimal form (0 | 1). The IST-flag is the status bit which is sent during a parallel poll.
***LLO** – Local LOckout	– no query, not IEEE 488.2-confirmed	Locks the front panel keys to prevent an inadvertent switchover to manual control. If TRUE is set, the hotkeys to control the remote screen are still active. The parameter FALSe reactivates all front panel keys for switchover to manual control.
***OPC** – OPeration Complete	–	Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query form writes a "1" into the output buffer as soon as all preceding commands have been executed. This is used for command synchronization.
***OPT?** –	–	Queries the options included in the instrument and returns a list of the

Command	Parameters/Remarks	Short Description
OPTion identification query	query only	options installed. The response consists of arbitrary ASCII response data according to IEEE 488.2. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.
***PRE** – Parallel poll Register Enable	0...255	Sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.
***PSC** – Power on Status Clear	0 | 1	Determines whether the contents of the ENABle registers is maintained or reset when the instrument is switched on. *PSC = 0 causes the contents of the status registers to be maintained. Thus a service request can be triggered on switching on in the case of a corresponding configuration of status registers ESE and SRE. *PSC =0 resets the registers. Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.
***RCL** – ReCaLl	0 to 99 no query, not IEEE 488.2-confirmed	Recalls a previously stored device state from a file with the specified number (see also *SAV and section Save/Recall Dialog in chapter "Basic Instrument Funtions").
***RST** – ReSeT	– no query	Sets the instrument parameters to values for good remote operation. The command corresponds to the Reset button in the Reset dialog.
***SAV** – SAVe	0 to 99 no query, not IEEE 488.2-confirmed	Stores the current device state to a file with the specified number (see also *RCL and section Save/Recall Dialog in chapter "Basic Instrument Funtions").
***SRE** – Service Request Enable	0...255	Sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. The query *SRE? returns the contents of the service request enable register in decimal form. Bit 6 is always 0.
***STB?** – STatus Byte query	– query only	Reads the contents of the status byte in decimal form.
***TRG** – TRiGger	– no query	
***TST?** – self TeST query	– query only	
***WAI** – WAIt to continue	– no query	Prevents servicing of the subsequent commands until all preceding commands have been executed and all signals have settled (see also command synchronization and *OPC).

Common commands

6.3 Instrument-Control Commands

The instrument-control commands for the R&S CMW 500 platform give access to the mass memory, control the status structures, and perform various administrative tasks. The platform commands are listed in alphabetical order. They belong to the following SCPI subsystems:

- CONFigure (reference frequency settings)
- MMEMory
- STATus
- SYSTem

6.3.1 MMEMory Commands

The MMEMory system provides mass storage capabilities for the R&S CMW 500.

File and directory names

The <file_name> and <directory_name> parameters are strings. Some commands use a fixed directory; for others the <file_name> can contain the complete path including the drive name and all subdirectories, e.g. 'C:\TEMP\TRASH\test.txt' for the file named test.txt in the TEMP\TRASH subdirectory of the internal hard disk drive C:\. If no complete path is specified, the file location is relative to the current directory (queried with `MMEMory:CDIRectory?`). The file name itself may contain the period as a separator for extensions.
File and directory names can be chosen according to Windows™ conventions; the restrictions placed on file names known from DOS systems do not apply. All letters and numbers are allowed, as well as the special characters "_", "^", "$", "~", "!", "#", "%", "&", "-", "{", "}", "(", ")", "@" and "`". Reserved file names are CON, AUX, COM1, ..., COM4, LPT1, ..., LPT3, NUL and PRN.
The use of wildcards ? and * is not allowed.

MMEMory:CATalog? [<directory_name>]

Returns the contents of the current or of a specified directory.

'<directory_name>' String parameter to specify the directory. If the directory is omitted, the command queries the contents of the current directory, to be queried with `MMEMory:CDIRectory?`

Response — Directory information in the following format:
<used_size>,<free_disk_space>
{,<parent_directory>}{,<file_name>,<format>,<file_size>}
The first two numeric parameters denote the total amount of storage currently used in the directory and the total amount of storage available, both expressed in bytes. All files are returned with their file name and their size in bytes.

Example

```
MMEM:CAT?
Response:
235009,5195137024,".,DIR,0","..,DIR,0","SaveFile001.xml,BIN,78335","SaveFile002.xml,BIN,78338"
```

Characteristics — Firmware version V1.00
SCPI-confirmed, query only

MMEMory:CDIRectory '<directory_name>'

Changes the default directory for mass memory storage.

'<directory_name>' — String parameter to specify the directory.
Def. value: – (A *RST does not change the current directory)

Example

```
MMEM:CDIR 'C:\Temp\Setups\CMW_Setups'
```

Change to the specified directory

Characteristics — Firmware version V1.00
SCPI-confirmed, command or query (returns the current directory)

MMEMory:COPY '<file_source>'[,'<file_destination>']

Copies an existing file to a new file.

'<file_source>', '<file_destination>' — String parameters to specify the name of the file to be copied and the name of the new file.
If no file destination is specified the source file is written to the current directory, to be queried with `MMEMory:CDIRectory?`.
Def. value: –

Example

```
MMEM:COPY
'C:\USER\DATA\CMW_quickstart.pdf','A:'
```

Copy file CMW_quickstart.pdf in directory C:\USER\DATA to an external storage medium, mapped to drive A:\.

Characteristics — Firmware version V1.00
SCPI-confirmed, no query

MMEMory:DATA '<file_name>', <data>

Loads <data> into the file <file_name>.

'<file_name>'	String parameter to specify the name of the file.
<data>	Data in 488.2 block data format. The delimiter EOI must be selected to achieve correct data transfer. Def. value: –
Example	`MMEM:DATA? 'C:\TEMP\TEST01.HCP` Query the block data contained in file TEST01.HCP
Characteristics	Firmware version V1.00 SCPI-confirmed, with query. The query form is `MMEMory:DATA? <file_name>`; it returns the associated <data> in block format.

MMEMory:DELete '<file_name>'

Removes a file from the specified directory.

'<file_name>'	String parameter to specify the name and directory of the file to be removed. Def. value: –
Example	`MMEM:DEL 'C:\TEMP\TEST01.HCP'` Remove file TEST01.HCP from the current directory.
Characteristics	Firmware version V1.5 SCPI-confirmed, no query.

MMEMory:MDIRectory '<directory_name>'

Creates a new directory for mass memory storage.

'<directory_name>'	String parameter to specify the directory. Def. value: –
Example	`MMEM:MDIR 'C:\Documents and Settings\NetworkService\Application Data'` Create the specified directory.
Characteristics	Firmware version V1.5 Device-specific, no query.

MMEMory:MOVE '<file_source>','<file_destination>'

Copies an existing file to a new file.

'<file_source>', '<file_destination>'	String parameters to specify the name of the file to be copied and the name of the new file. Def. value: –

Example `MMEM:COPY 'C:\USER\DATA\SETUP.CFG','A:'`
Copy file `Setup.cfg` in directory `C:\USER\DATA` to the external storage medium, mapped to drive `A:\`.

Characteristics Firmware version V1.5
SCPI-confirmed, no query.

MMEMory:RDIRectory '<directory_name>'

Removes an existing directory from the mass memory storage system.

'<directory_name>' String parameter to specify the directory.
Def. value: –

Example `MMEM:RDIR 'C:\Documents and Settings\NetworkService\Application Data'`
Remove the specified directory.

Characteristics Firmware version V1.5
Device-specific, no query.

6.3.2 Ref Frequency Commands

The following commands control the reference frequency settings.

CONFigure:SELFtest:REFerence:FREQuency:SOURce <Frequency Source>

Sets the R&S CMW 500 to internal or external reference.

<Frequency Source> **INTernal:** Internal reference frequency
EXTernal: External reference frequency
Def. value: INTernal

Example `CONF:SELF:REF:FREQ:SOUR EXT`
Set the R&S CMW 500 to an external reference frequency.
`CONF:SELF:REF:FREQ 1.000000E+007`
Define an external reference frequency of 10 MHz.

Characteristics Firmware version V1.00

CONFigure:SELFtest:REFerence:FREQuency <Ext. Ref. Frequency>

Sets the R&S CMW 500 external reference frequency.

<Ext. Ref. Frequency> Range: 1 MHz to 800 MHz
Def. value: 10 MHz
Unit: Hz

Example See
CONFigure:SELFtest:REFerence:FREQuency:SOURce

Characteristics Firmware version V1.00

6.3.3 STATus Commands

The STATus subsystem controls the SCPI-defined status reporting structures. The purpose and definition of status registers is given in Chapter 5, section Status Reporting System. Unless otherwise stated, all of the following commands are SCPI-confirmed.
Note that *RST does not influence the status registers.

STATus:OPERation:CONDition?

Returns the contents of the CONDition part of the status register. Reading the CONDition registers is nondestructive.

SCPI Confirmed, query only

Example `STAT:OPER:COND?`
Query the CONDition part of the OPERation register to check for states which are part of the instrument's normal operation.

Characteristics Firmware version V1.00
*RST value: –

STATus:OPERation:ENABle <NRf>

Sets the enable mask which allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit (bit 3 of the STatus Byte).

SCPI Confirmed, command or query

<NRf> 0 to 65535 (decimal representation)
Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)

Example `STAT:QUES:ENAB 1536`
Set bits no. 9 and 10 of the OPERation:ENABle register (see decimal representation of a bit pattern).

Characteristics Firmware version V1.00

STATus:OPERation[:EVENt]?

Returns the contents of the EVENt part of the status register. Reading an EVENt register clears it.

SCPI	Confirmed, query only
Example	`STAT:QUES?` Query the EVENt part of the OPERation register to check whether an event has occurred since the last reading.
Characteristics	Firmware version V1.00 *RST value: –

STATus:OPERation:NTRansition <NRf>

Sets the negative transition filter. If a bit is set, a 1 to 0 transition in the corresponding bit of the associated condition register causes a 1 to be written in the associated bit of the corresponding event register.

SCPI	Confirmed, command or query
<NRf>	0 to 65535 (decimal representation) Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)
Example	`STAT:QUES:NTR 1536` Set bits no. 9 and 10 of the OPERation:NTRansition register (see decimal representation of a bit pattern).
Characteristics	Firmware version V1.00

STATus:OPERation:PTRansition? <NRf>

Sets the positive transition filter. If a bit is set, a 0 to 1 transition in the corresponding bit of the associated condition register causes a 1 to be written in the associated bit of the corresponding event register.

SCPI	Confirmed, command or query
<NRf>	0 to 65535 (decimal representation) Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)
Example	`STAT:QUES:PTR 1536` Set bits no. 9 and 10 of the OPERation:PTRansition register (see decimal representation of a bit pattern).
Characteristics	Firmware version V1.00

STATus:PRESet

Configures the status reporting system such that device-dependent events are reported at a higher level.
The command affects only the transition filter registers, the ENABle registers, and queue enabling:

- The ENABle parts of the STATus:OPERation and STATus:QUEStionable... registers are set to all 1's.
- The PTRansition parts are set all 1's, the NTRansition parts are set to all 0's, so that only positive transitions in the CONDition part are recognized.

The status reporting system is also affected by other commands, see Reset Values at the end of the "Remote Control" chapter.

SCPI Confirmed, no query

Example `STAT:PRES`
Preset the status registers.

Characteristics Firmware version V1.00
*RST value: –

STATus:QUEStionable:CONDition?

Returns the contents of the CONDition part of the status register. Reading the CONDition registers is nondestructive.

SCPI Confirmed, query only

Example `STAT:QUES:COND?`
Query the CONDition part of the QUEStionable register to check for questionable instrument states.

Characteristics Firmware version V1.00
*RST value: –

STATus:QUEStionable:ENABle <NRf>

Sets the enable mask which allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit (bit 3 of the STatus Byte).

SCPI Confirmed, command or query

<NRf> 0 to 65535 (decimal representation)
Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)

Example `STAT:QUES:ENAB 1536`

Set bits no. 9 and 10 of the QUEStionable:ENABle register (see decimal representation of a bit pattern).

Characteristics Firmware version V1.00

STATus:QUEStionable[:EVENt]?

Returns the contents of the EVENt part of the status register. Reading an EVENt register clears it.

SCPI Confirmed, query only

Example `STAT:QUES?`
Query the EVENt part of the QUEStionable register to check whether an event has occurred since the last reading.

Characteristics Firmware version V1.00
*RST value: –

STATus:QUEStionable:NTRansition <NRf>

Sets the negative transition filter. If a bit is set, a 1 to 0 transition in the corresponding bit of the associated condition register causes a 1 to be written in the associated bit of the corresponding event register.

SCPI Confirmed, command or query

<NRf> 0 to 65535 (decimal representation)
Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)

Example `STAT:QUES:NTR 1536`
Set bits no. 9 and 10 of the QUEStionable:NTRansition register (see decimal representation of a bit pattern).

Characteristics Firmware version V1.00

STATus:QUEStionable:PTRansition? <NRf>

Sets the positive transition filter. If a bit is set, a 0 to 1 transition in the corresponding bit of the associated condition register causes a 1 to be written in the associated bit of the corresponding event register.

SCPI Confirmed, command or query

<NRf> 0 to 65535 (decimal representation)
Def. value: – (See also Reset Values at the end of the "Remote Control" chapter)

Example	`STAT:QUES:PTR 1536` Set bits no. 9 and 10 of the QUEStionable:PTRansition register (see decimal representation of a bit pattern).
Characteristics	Firmware version V1.00

STATus:QUEue[:NEXT]?

Queries and at the same time deletes the oldest entry in the error queue. Operation is identical to that of SYSTem:ERRor[:NEXT]?
The entry consists of an error number and a short description of the error. Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

SCPI	Confirmed, query only
Example	`STAT:QUE?` Query the oldest entry in the error queue. 0,"No error" is returned if the error queue is empty.
Characteristics	Firmware version V1.00 *RST value: –

6.3.4 SYSTem Commands

The SYSTem subsystem contains functions that are not related to instrument performance. Most of the commands are SCPI-confirmed.

- LAN Services
- Miscellaneous Instrument Settings

6.3.5 LAN Services

The following commands define the parameters for LAN connection of the R&S CMW 500. .

SYSTem:COMMunicate:NET:ADAPter '<Adapter>'

Selects the network adapter and thus the connection type. At present ,
LAN connections are supported.

'<Adapter>'	String parameter, see example below. Def. value: – (a *RST does not affect the LAN service settings)
Example	`SYSTem:COMMunicate:NET:ADAPter "Local Area Connection"` Select a local area (LAN) connection.

Characteristics Firmware version V1.00

SYSTem:COMMunicate:NET:HOSTname '<Host>'

Selects the host name (computer name) of the R&S CMW 500. The host name (without the domain) is part of the VISA address string for LAN-based connections.

'<Host>' String parameter, see example below.
Def. value: – (a *RST does not affect the LAN service settings)

Example `SYSTem:COMMunicate:NET:HOSTname 'hh303132.company.net'`
Define the host name.

Characteristics Firmware version V1.00

SYSTem:COMMunicate:NET:DHCP <Boolean>

Enables or disables Dynamic Host Configuration Protocol (DHCP).

<Boolean> **ON:** DHCP enabled, automatic TCP/IP address setting
OFF: DHCP disabled, manual address setting
Def. value: ON (a *RST does not affect the LAN service settings)

Example `SYSTem:COMMunicate:NET:DHCP OFF`
Disable DHCP, enable manual setting of the IP address information

Characteristics Firmware version V1.00

SYSTem:COMMunicate:NET:IPADdress '<Address>'

Defines the IP address of the R&S CMW 500. This address is valid if DHCP is disabled (`SYSTem:COMMunicate:NET:DHCP OFF`).

'<Address>' String parameter, IP address consisting of four blocks (octets) separated by dots.
Def. value: – (a *RST does not affect the LAN service settings)

Example `SYSTem:COMMunicate:NET:IPADdress '10.113.10.38'`
Select a private IP address (characterized by 10 in the first octet).

Characteristics Firmware version V1.00

SYSTem:COMMunicate:NET:SUBNet:MASK '<Address>'

Defines the subnet mask address of the R&S CMW 500. This address is valid if DHCP is disabled (`SYSTem:COMMunicate:NET:DHCP OFF`).

'<Address>'	String parameter, subnet mask consisting of four blocks separated by dots. Def. value: – (a *RST does not affect the LAN service settings)
Example	`SYSTem:COMMunicate:NET:SUBNet:MASK '255.255.0.0'` Select a subnet mask. With this subnet mask, the first two octets
Characteristics	Firmware version V1.00

SYSTem:COMMunicate:NET:GATeway '<Address>'

Defines the default gateway of the R&S CMW 500. This address is valid if DHCP is disabled (`SYSTem:COMMunicate:NET:DHCP OFF`).

'<Address>'	String parameter, gateway consisting of four blocks separated by dots. Def. value: – (a *RST does not affect the LAN service settings)
Example	`SYSTem:COMMunicate:NET:GATeway '10.113.0.1'` Select the default gateway.
Characteristics	Firmware version V1.00

SYSTem:COMMunicate:NET:DNS:ENABle <Boolean>

Enables or disables dynamic DNS address configuration.

<Boolean>	**ON:** Dynamic DNS enabled, automatic DNS address setting **OFF:** Dynamic DNS disabled, manual address setting Def. value: ON (a *RST does not affect the LAN service settings)
Example	`SYSTem:COMMunicate:NET:DNS:ENABle OFF` Disable dynamic DNS address configuration, enable manual address setting.
Characteristics	Firmware version V1.00

SYSTem:COMMunicate:NET:DNS '<Preferred>', <Alternate>'

Defines the preferred and the alternate DNS addresses of the R&S CMW 500. The addresses are valid if dynamic DNS address configuration is disabled (`SYSTem:COMMunicate:NET:DNS:ENABle OFF`).

'<Preferred>', '<Alternate>'	String parameters, DNS addresses consisting of four blocks separated by dots. Def. value: – (a *RST does not affect the LAN service settings)
Example	`SYSTem:COMMunicate:NET:DNS '10.0.2.166', '10.0.23.159'` Select the DNS addresses.

Characteristics Firmware version V1.00

6.3.6 Miscellaneous Instrument Settings

The SYSTem subsystem contains functions that are not related to instrument performance. Most of the commands are SCPI-confirmed.

SYSTem:DATE <Year>, <Month>, <Day>

Sets the date of the internal calendar.

<Year> Year, to be entered as a four-digit number (including the century and millenium information)

<Month> Month, 1 (for January) to 12 (for December)

<Day> Day, 1 to the number of days in the month from the previous parameter.

Numbers entered are rounded to the closest integer value.

Def. value: – (a *RST does not affect the date setting)

Example `SYSTem:DATE?`

Query the current date. Possible response: 2007, 09, 20

Characteristics Firmware version V1.00

SCPI-confirmed

SYSTem:ERRor:ALL?

Queries and at the same time deletes all entries in the error queue.

The entry consists of an error number and a short description of the error. Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example `SYSTem:ERRor:ALL?`

Query all entries in the error queue. 0,"No error" is returned if the error queue is empty.

Characteristics Firmware version V1.00

SCPI-confirmed, query only

SYSTem:ERRor:CODE:ALL?

Queries and at the same time deletes all entries in the error queue.

The command returns the error numbers without any description of the errors. Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example `SYSTem:ERRor:CODE:ALL?`

Query all entries in the error queue. "0" is returned if the error queue is empty.

Characteristics Firmware version V1.00
SCPI-confirmed, query only

SYSTem:ERRor:CODE[:NEXT]?

Queries and at the same time deletes the oldest entry in the error queue.
The command returns the error number without any description of the error. Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example `SYSTem:ERRor:CODE?`
Query the oldest entry in the error queue. "0" is returned if the error queue is empty.

Characteristics Firmware version V1.00
SCPI-confirmed, query only

SYSTem:ERRor[:NEXT]?

Queries and at the same time deletes the oldest entry in the error queue. Operation is identical to that of `STATus:QUEue[:NEXT]?`
The entry consists of an error number and a short description of the error. Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example `SYSTem:ERRor?`
Query the oldest entry in the error queue. 0,"No error" is returned if the error queue is empty.

Characteristics Firmware version V1.00
SCPI-confirmed, query only

SYSTem:HELP:SYNTax? '<Header>'

Returns the full syntax and all parameters of the specified command.

'<Header>' String containing any implemented command header. Optional nodes and suffixes may appear in the header.

Example `SYSTem:HELP:SYNTax? "SYSTem:ERRor?"`
Query the full syntax of the specified command. The response is "`SYSTem:ERRor:[NEXT]`".

Characteristics Firmware version V1.00
SCPI-confirmed, query only

SYSTem:KLOCk <Enable>

Locks or unlocks the local controls of the instrument. This includes the front panel keys, the keyboard, or other local interfaces.

<Enable>	**ON:** Local key locked (key lock enabled) **OFF:** Local keys unlocked Def. value: OFF
Example	`SYSTem:KLOCk ON` Lock the local keys.
Characteristics	Firmware version V1.00 SCPI-confirmed

SYSTem:PRESet

Sets the instrument parameters to values for good local/manual interaction. The command corresponds to the Preset button in the Reset dialog.

Example	`SYSTem:PRESet`
	Force the R&S CMW 500 to a reset state that is optimized for manual operation.
	`*RST`
	Optimize the R&S CMW 500 for remote operation.

Characteristics	Firmware version V1.00 SCPI-confirmed, no query

SYSTem:TIME <Hour>, <Minute>, <Second>

Sets the time of the internal clock.

<Hour>	Hour, 0 to 23
<Minute>	Minute, 0 to 59
<Second>	Second, 0 to 59 (60 due to rounding) Numbers entered are rounded to the closest integer value. Def. value: – (a *RST does not affect the time setting)
Example	`SYSTem:TIME?` Query the current time. Possible response: 15, 09, 20
Characteristics	Firmware version V1.00 SCPI-confirmed

SYSTem:VERSion?

Returns the SCPI version number to which the instrument complies. The instrument complies to the final SCPI version 1999.0.

Example
`SYSTem:VERSion?`
Query the SCPI version.

Characteristics
Firmware version V1.00
SCPI-confirmed, query only

6.4 Alphabetical List of Commands (System)

Command **Page**

7 GPRF Applications

The General Purpose RF (GPRF) firmware applications provide an RF test and measurement functionality that is not related to a particular network standard. The R&S CMW 500 provides the following GPRF firmware applications:

- GPRF Generator
- GPRF Measurements

7.1 GPRF Measurements and Generators

General Purpose RF (GPRF) measurements determine the properties of an arbitrary RF signal. The R&S CMW 500 provides the following GPRF measurements:

- Power
- External Power Sensor

In addition the R&S CMW 500 can generate an RF signal for test purposes.

- GPRF RF Generator

7.1.1 General Purpose RF Generator

The General Purpose RF (GPRF) generator provides a flexible RF signal for test purposes. The R&S CMW 500 provides several independent RF generator modes:

- In constant-frequency mode the RF generator provides a single or dual-tone RF signal at constant frequency.
- In arbitrary mode, the RF signal is based on an arbitrary baseband signal defined by a waveform file (*.wv, ARB File).
- In list mode, the RF generator steps through a list of configurable frequencies and levels.

The RF generator signal can be routed to any of the RF connectors at the front panel of the instrument. Moreover, it is possible to take into account a constant external output attenuation for the RF generator signal in order to compensate for a known loss or gain in the test setup.

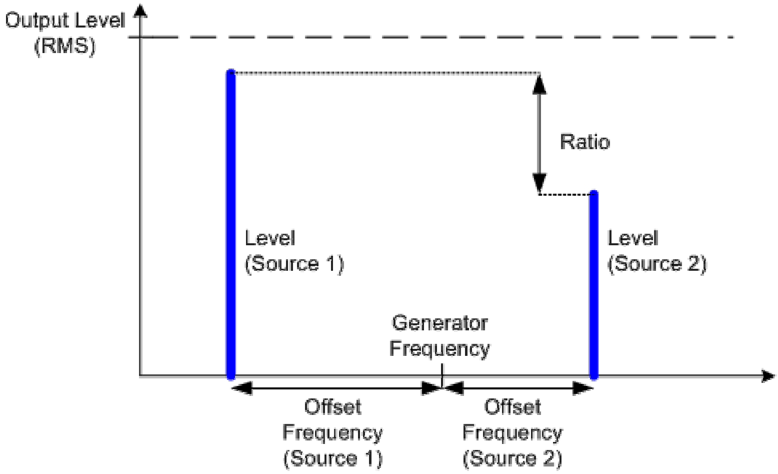
7.1.1.1 GPRF Generator (Constant Frequency)

In constant-frequency mode the RF generator provides a single or dual-tone RF signal at constant frequency and output level.

- The single-tone (CW) signal is configured with its level and frequency. No further signal settings are needed.
- The two sources of the dual-tone signal can be configured separately; see below.

Dual-tone signal

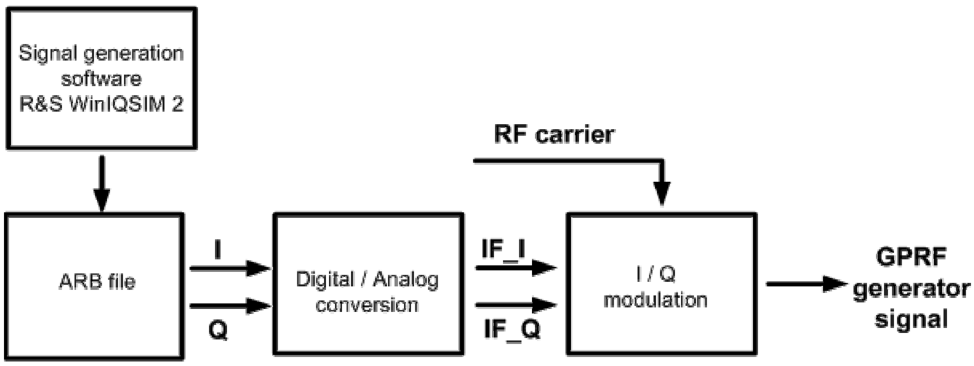
The dual-tone signal is a superposition of two CW signals Source 1 and Source 2 at the output connector. The R&S CMW 500 provides two independent parameter sets for the two signals. The level of the signals is set implicitly by means of the sum level ("Output Level (RMS)" and the "Ratio".



Dual-tone signal

7.1.1.2 Arbitrary RF Generator (Option R&S CMW-B110 A)

In arbitrary (ARB) baseband mode the R&S CMW 500 uses a waveform file (*.wv, ARB File) to generate the GPRF generator signal. Waveform files define digital baseband signals. The R&S CMW 500 converts the digital waveform into anlog I/Q signals and modulates them onto the RF carrier. The modulated RF signal is fed to the selected RF connector.



ARB generator

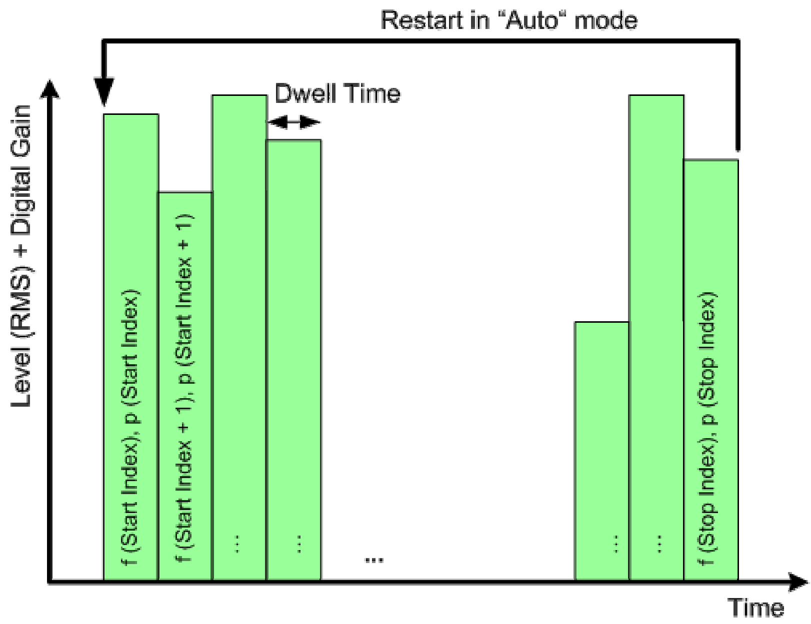
The R&S CMW 500 supports waveform files (.wv) generated with the Signal Generation Software R&S WinIQSIM 2.

In arbitrary mode, the GPRF generator provides a wide range of modulated RF signals:

- RF signals in accordance with different digital network standards
- Customized RF signals using with various modulation schemes

7.1.1.3 List Mode

In list mode, the RF generator steps through a list of configurable frequencies and levels.



GPRF generator settings (list mode)

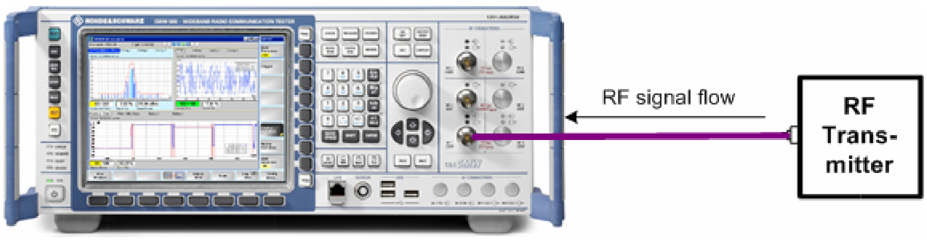
It is possible to cycle through the list, to pass through the list once, or select a single frequency and level. The transmission time ("Dwell Time") is variable but equal for all frequency/level steps.
The test signal that the R&S CMW 500 provides in list mode can be used e.g. for fast receiver or power meter adjustments over a wide range of channels and powers.

7.1.2 Power Measurement

The "Power" measurement measures a series of power steps at (possibly) different powers and frequencies and performs a statistical evaluation. The measurement is a flexible tool for power measurements on an arbitrary RF signal. In particular it can be used for fast transmitter adjustments over a wide range of channels and output powers.

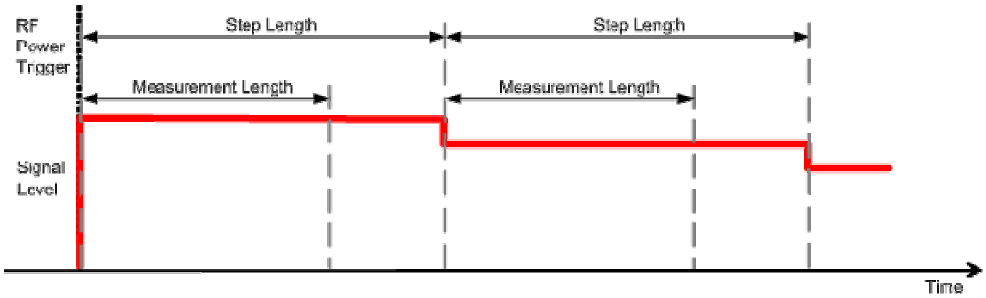
7.1.2.1 Test Setup

The external RF signal source (mobile phone transmitter, signal generator etc.) is connected to one of the RF input connectors RF 1 COM or RF 2 COM at the front panel of the R&S CMW 500. The input level ranges of the connectors are identical; see RF Connectors. No additional cabling and no external trigger is needed.

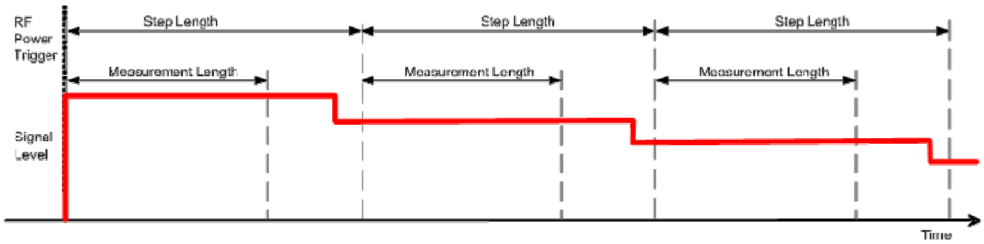


7.1.2.2 Single Power Steps and List Mode

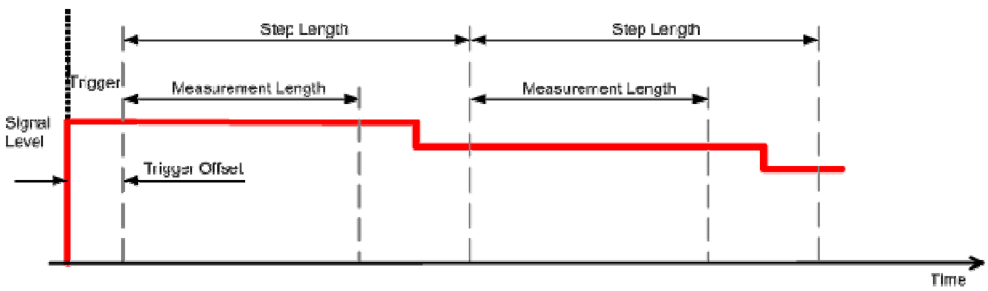
In its simplest configuration the "Power" measurement provides the average power in a measurement interval of configurable length("Measurement Length"): The instrument behaves like a power meter.
The measurement interval can be repeated periodically over a sequence of power steps ("List Mode"). A single step sequence is termed a "sweep".



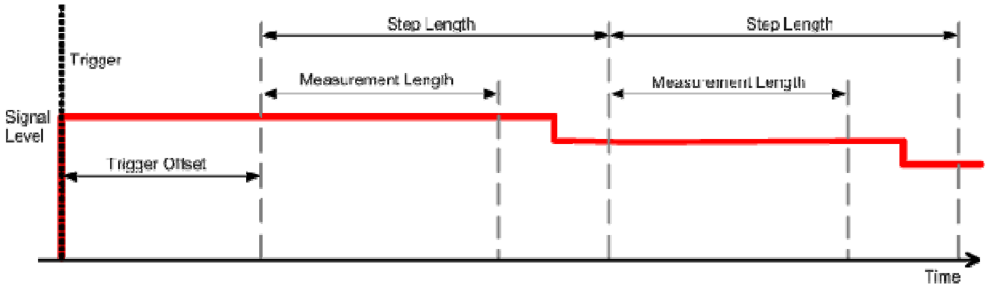
The measurement interval is moved with respect to the power steps, if the first step that the DUT generates is shortened. This can be suitable to avoid the switching transients due to the power steps.



Alternatively it is possible to introduce a trigger offset in order to move the measurement interval relative to the steps.



A trigger offset is also suitable if the first power step is longer than the following steps.

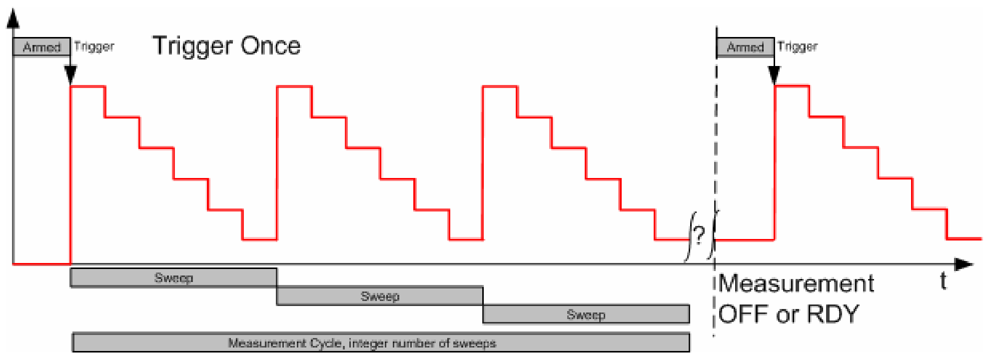


The entire sweep can be repeated several times to perform statistical evaluations; see Statistical Results.

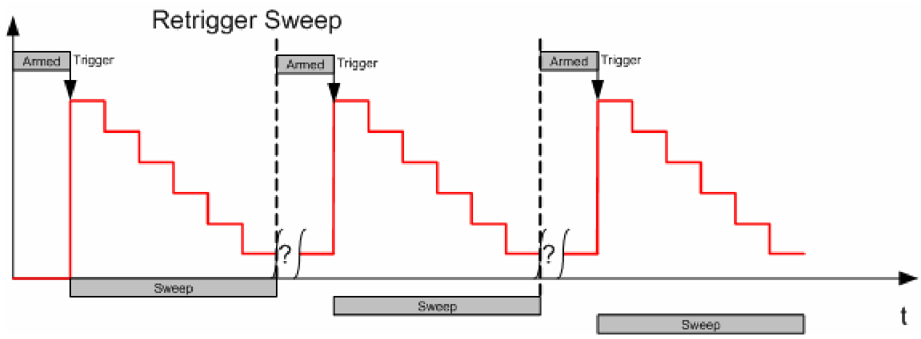
7.1.2.3 Trigger Modes

The "Power" measurement can be performed in "Free Run" (untriggered) mode, however, an RF power trigger is suitable, in particular if the measurement has to be synchronized to a sequence of power steps. The R&S CMW 500 provides several alternative trigger modes for RF input signals with different characteristics.

Trigger Once
The measurement is triggered once; all the following evaluation intervals are calculated according to the "Step Length" and the "Measurement Length" settings. The trigger is re-armed only after the measurement is stopped and re-started.
This mode is recommended for signals where all steps (including possible repetitions for statistics) are within the "Step Length".



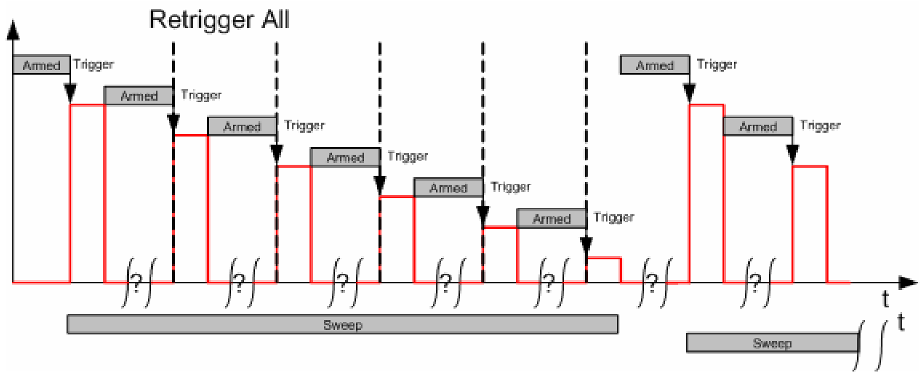
Retrigger Sweep
The measurement starts after the first trigger event and continues according to the "Step Length" and the "Measurement Length" settings until a sweep (a sequence of power steps) is completed. After the sweep is completed, a new trigger event can re-synchronize the measurement.
This mode is recommended for signals where all steps within one sweep are within the "Step Length" but the time gap between the sweeps is not very precise. Furthermore this mode is recommended for very high statistic counts where re-triggering can compensate for a possible time drift of the DUT.



Retrigger All

Like "Retrigger Sweep", however, the trigger is re-armed after each power/frequency step.

This mode is recommended if for steps with unknown or irregular distances.



7.1.2.4 Measurement Settings

The parameters for the "Power" measurement are accessible from the "Power Configuration" dialog; see Power Parameters. In the measurement menu, various softkey with associated hotkeys provide fast access to the most important power parameters.

The "Power" measurement can be performed with a wide range of IF filters of various shapes and bandwidths. In addition to Gaussian and bandpass filters, the measurement provides special filter types for WCDMA and CDMA200 measurements.

7.1.2.5 Power: Results

The basic "Power" measurement result is the power of the RF input signal averaged over the "Measurement Length". All power results of the sweep can be displayed in a bar graph or in tables. Moreover, the measurement provides a statistical evaluation at a particular power step; see Statistical Results.

The statistical evaluation includes the calculation of the "Standard Deviation". This quantity shows how widely spread the power values are at each power step.

- Diagram View
- Table View

Diagram View

The measured power values appear in a bar graph, the numerical results at a particular power step are displayed in a table below.

Power measurement results: Diagram View

- Use the List Configuration parameters to control the number of measured steps.
- Use the Display parameters to control the number of superimposed bars with different colors.
- Use the checkboxes in the result section below the diagrams to display or hide the results.

Result panels

A statistical evaluation of the power values at the current marker position is displayed below the diagram; see Statistical Results.

- Use the checkboxes to display or hide the results in the upper and lower diagram.

Settings panels

An overview of the essential current settings of the "Power" measurement is displayed to the right of the result panels.

- Use "Display > Hide Settings" to hide the settings panels.

Table View

The results in the bar graphs of the Diagram View is also displayed in a table with numeric values.

Power [Seq.]	Current-RMS	Current-Min.	Current-Max.	Average-RMS	Minimum-Min.	Maximum-Max.
Power [0]	-16.986 dBm	-17.101 dBm	-16.872 dBm	-16.127 dBm	-116.786 dBm	-14.353
Power [1]	-15.897 dBm	-15.980 dBm	-15.818 dBm	-15.468 dBm	-107.843 dBm	-14.342
Power [2]	-15.240 dBm	-15.288 dBm	-15.196 dBm	-15.215 dBm	-121.223 dBm	-14.344
Power [3]	-15.047 dBm	-15.052 dBm	-15.044 dBm	-15.364 dBm	-118.724 dBm	-14.349
Power [4]	-15.295 dBm	-15.344 dBm	-15.250 dBm	-15.926 dBm	-118.724 dBm	-14.341
Power [5]	-15.984 dBm	-16.079 dBm	-15.901 dBm	-16.924 dBm	-116.786 dBm	-14.353
Power [6]	-17.120 dBm	-17.254 dBm	-17.000 dBm	-18.408 dBm	-110.765 dBm	-14.348
Power [7]	-18.810 dBm	-19.006 dBm	-18.621 dBm	-20.469 dBm	-116.786 dBm	-14.344
Power [8]	-21.145 dBm	-21.393 dBm	-20.910 dBm	-23.247 dBm	-113.863 dBm	-14.339
Power [9]	-24.393 dBm	-24.777 dBm	-24.051 dBm	-27.078 dBm	-130.765 dBm	-14.345
Power [10]	-28.831 dBm	-29.322 dBm	-28.404 dBm	-32.235 dBm	-113.863 dBm	-14.343
Power [11]	-35.444 dBm	-36.276 dBm	-34.733 dBm	-38.658 dBm	-110.765 dBm	-14.336
Power [12]	-46.680 dBm	-48.105 dBm	-45.502 dBm	-39.543 dBm	-115.202 dBm	-14.290
Power [13]	-70.200 dBm	-73.679 dBm	-67.586 dBm	-35.382 dBm	-116.786 dBm	-14.339
Power [14]	-48.319 dBm	-49.900 dBm	-46.922 dBm	-31.084 dBm	-113.863 dBm	-14.343
Power [15]	-36.378 dBm	-37.182 dBm	-35.604 dBm	-27.062 dBm	-118.724 dBm	-14.347
Power [16]	-29.602 dBm	-30.054 dBm	-29.143 dBm	-23.651 dBm	-109.182 dBm	-14.350
Power [17]	-25.102 dBm	-25.474 dBm	-24.730 dBm	-20.915 dBm	-111.680 dBm	-14.339
Power [18]	-21.856 dBm	-22.094 dBm	-21.617 dBm	-18.800 dBm	-112.703 dBm	-14.350
Power [19]	-19.495 dBm	-19.682 dBm	-19.306 dBm	-17.228 dBm	-111.680 dBm	-14.345
Power [20]						

Power measurement results: Table View

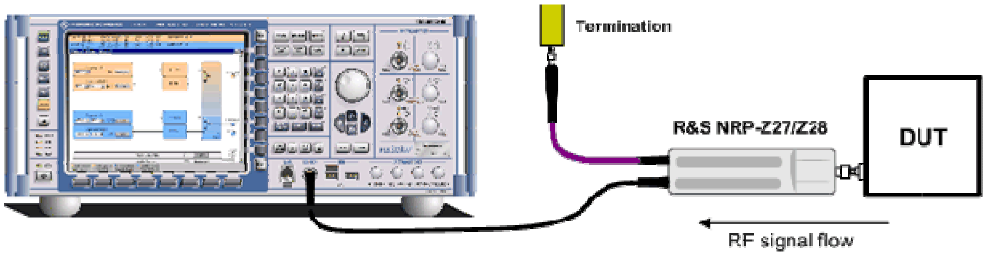
7.1.3 External Power Sensor Measurement

The External Power Sensor measurement records the power values measured by an external R&S NRP power sensor and performs a statistical evaluation.

- Sensor connection and test setup
- Measurement settings
- Zeroing
- Measurement results

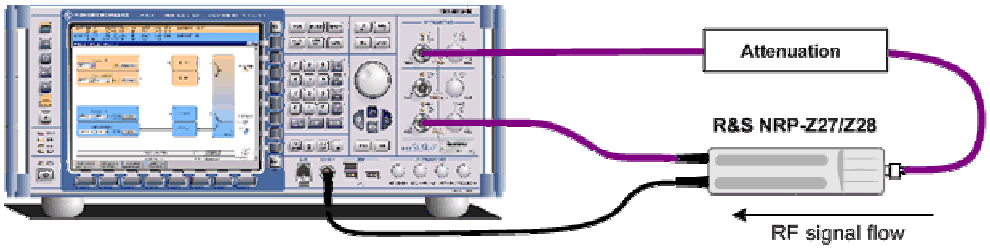
7.1.3.1 Sensor Connection and Test Setup

The external power sensor is connected to the SENSOR connector at the front panel of the R&S CMW 500. If the sensor measures an external signal, no extra RF connection with the R&S CMW 500 is needed.



Test setup for external power sensor measurement on a DUT

An external power sensor can be used also to monitor the RF power at a particular point in the test setup. e.g. in order to determine an attenuation in the test setup and "calibrate" the RF source. Moreover it is possible to feed the sensor output signal back to the R&S CMW 500, e.g. in order to perform an additional "Power" measurement.



Test setup for external power sensor measurement power calibration

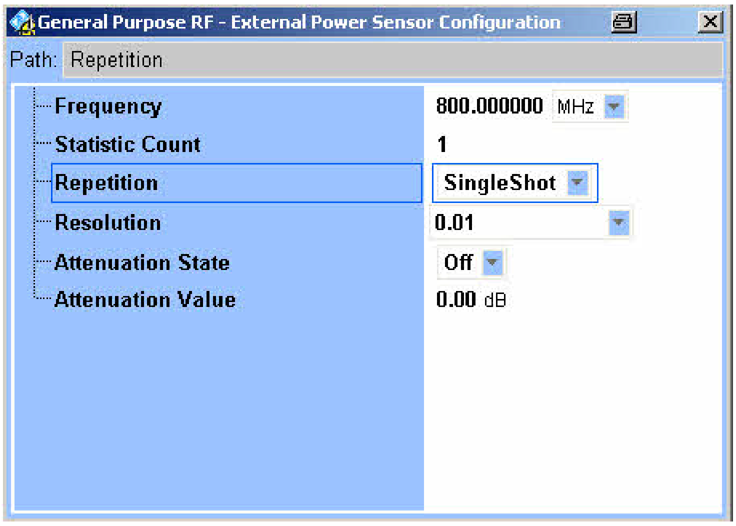
The R&S CMW 500 supports the following sensor types:

- R&S NRP-Z27
- R&S NRP-Z28

Refer to the relevant documentation for information about the sensor properties.

7.1.3.2 Measurement Settings

The sensor is controlled via the SENSOR connection. All control parameters are accessible from the "External Power Sensor Configuration" dialog; see External Power Sensor Parameters.



External Power Sensor Configuration

The statistical settings (Control) define the number of power results requested from the power sensor. An attenuation value corrects the power reading of the external power sensor.

7.1.3.3 Zeroing

Zeroing calibrates the external power sensor by adjusting its reading at zero signal power. For this purpose, the RF power source must be switched off or disconnected from the sensor (see tips below!). R&S power sensors automatically detect the presence of any significant input power. This aborts zeroing and generates an error message. Zeroing can take a few seconds, depending on the sensor model; refer to the documentation of your external power sensor for more information.

Tips for zeroing

Repeat zeroing

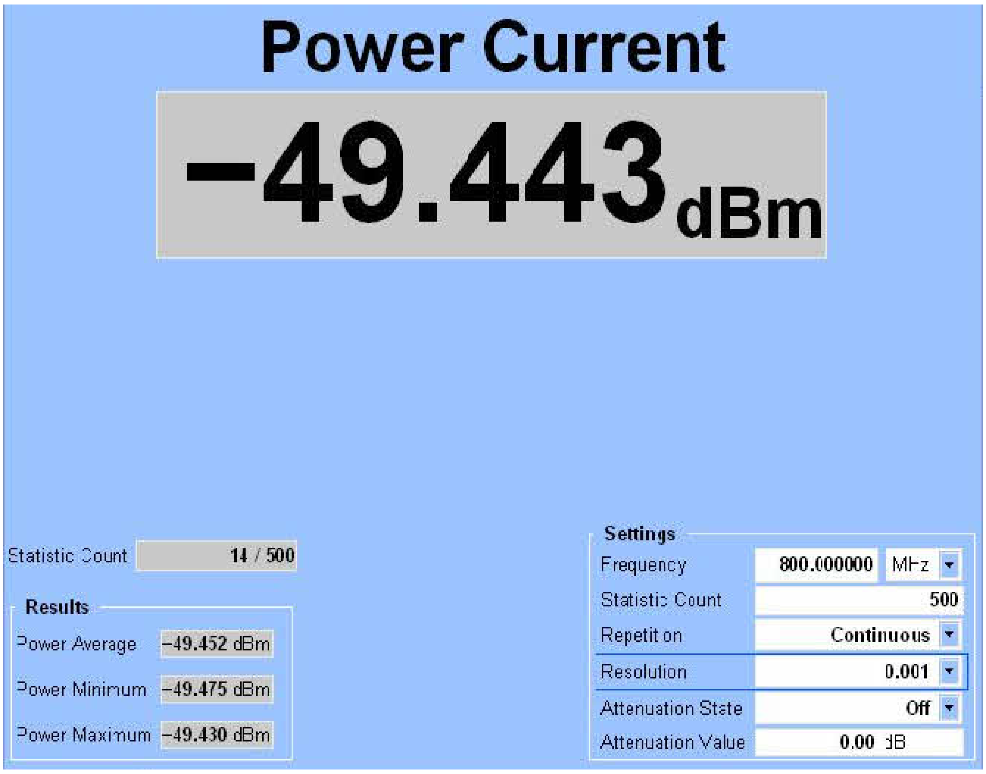
- During warm-up after switching on or connecting the instrument
- After a substantial change of the ambient temperature
- After fastening the power sensor module to an RF connector at high temperature
- After several hours of operation
- When very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.

Switch off the RF power source for zeroing; do not disconnect it from the power sensor. In this way you will maintain the thermal equilibrium, and zeroing will also compensate for the noise superimposed on the measured signal (e.g. from a broadband amplifier).

A reset of the R&S CMW 500 does not affect the last zeroing result.

7.1.3.4 External Power Sensor: Results

The basic "External Power Sensor" result is the sensor power at the selected frequency. Moreover, the measurement provides a statistical evaluation of the sensor power results; see Statistical Results. Note that the "Power Current" result is the result that the sensor obtained in the measurement interval indicated under "Statistic Count".The R&S NRP-Z27/-Z28 power sensors provide a broadband power result.
All results are displayed in the measurement diagram.



External Power Sensor measurement results

The progress of the measurement is shown as a numeric value ("Statistic Count").

Settings panel
An overview of the essential current settings of the "Power" measurement is displayed to the right of the result panels.

- Use "Display > Hide Settings" to hide the settings panels.

7.2 GPRF GUI Reference

The following sections provide detailed reference information on the parameters of the General Purpose RF application. The R&S CMW 500 provides the following GPRF measurements:

- Power
- External Power Sensor

In addition the R&S CMW 500 can generate an RF signal for test purposes:

- RF Generator

7.2.1 General Purpose RF Generator

The General Purpose RF (GPRF) Generator is configured using the parameters listed below.

- Generator control and signal routing
- Constant-frequency settings
- Baseband configuration
- ARB generator
- List mode

7.2.1.1 Generator Control and Signal Routing

The GPRF generator is turned on or off using the "GPRF Generator" softkey and the ON | OFF front panel key.

GPRF Generator (control softkey)

Turns the RF generator on or off, see Generator Control. The generator state is shown in the hotkey.

GPIB command:

`SOURce:GPRF:GENerator<i>:STATe ON | OFF`

The following parameters are valid irrespective of the generator mode.

GPRF generator settings (general)

Routing

Selects the output connector for the RF generator signal.

GPIB command:

`ROUTe:GPRF:GENerator<i>:RFSettings:CONNector`

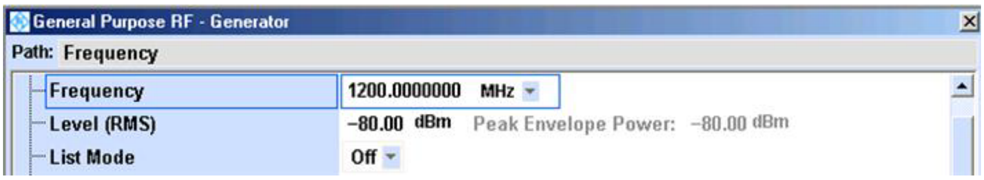
External Attenuation (Output)

Defines the value of an external attenuation (or gain, if the value is negative) in the

output path. With an external attenuation of x dB, the generator power is increased by x dB so that the actual generator power differs from the output power shown in the dialog.
The actual generator output level is equal to the indicated Peak Envelope Power plus the external attenuation.
GPIB command:
SOURce:GPRF:GENerator<i>:RFSettings:EATTenuation

7.2.1.2 GPRF Generator (Constant Frequency)

Constant-frequency mode is active as long as the list mode is switched off (List Mode > State > Off).



GPRF generator settings (constant-frequency signal)

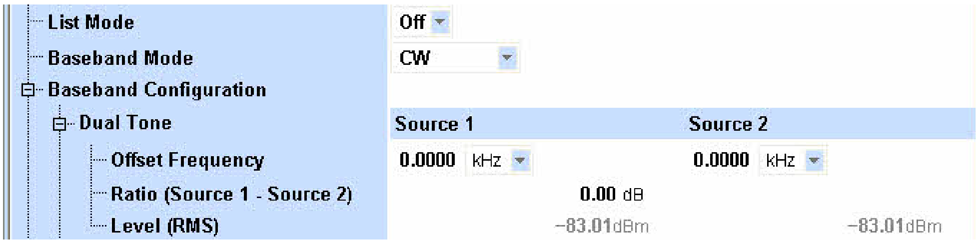
Frequency
Sets the frequency of the RF generator. Some of the baseband modes modify the generator frequency.
GPIB command: SOURce:GPRF:GENerator<i>:RFSettings:FREQuency

Level (RMS)
Sets the base level of the constant-frequency RF generator. In list mode, this base level can be modified using a gain. The resulting actual "Peak Envelope Power" (PEP) is displayed for information.
The indicated PEP corresponds to the actual peak output level at the output connector, assuming the External Attenuation (Output) is zero. In list mode, the PEP at each step is equal to the "Level (RMS)" plus the "Digital Gain". For the Dual Tone signal the PEP is equal to the "'Level (RMS)"; the total signal power is distributed between the Source 1 and the Source 2 contributions according to the selected "Ratio".
GPIB command:
SOURce:GPRF:GENerator<i>:RFSettings:LEVel

List Mode
Enables or disables the list mode. "Off" means that the RF generator generates a constant-frequency signal. The List Mode is further specified in the parameter section below.
GPIB command:
SOURce:GPRF:GENerator<i>:LIST

7.2.1.3 Baseband Configuration

If the list mode is off, the generator signal is modified according to the selected "Baseband Mode".



GPRF generator settings (baseband)

Baseband Mode

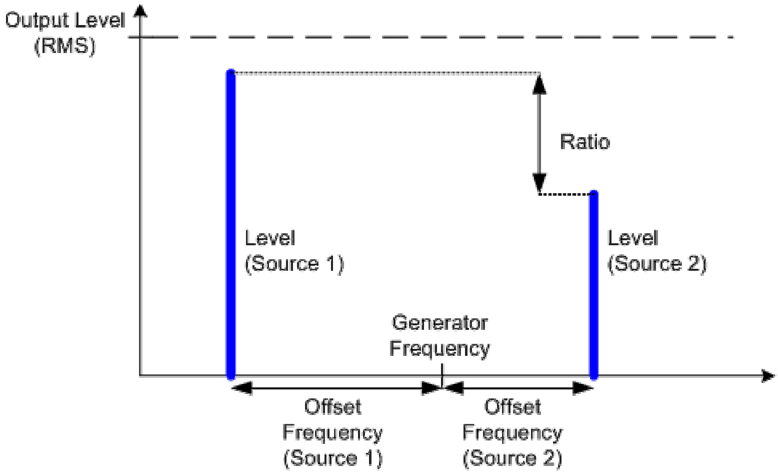
Defines the baseband settings for the RF generator. These settings define a possible modulation of the RF signal.

CW	The RF signal is a CW signal, i.e. a signal at constant "Frequency" and "Level (RMS)". No further signal settings are required.
Dual Tone	The RF signal is a superposition of two CW signals with individual offset frequencies and a definite ratio; see "Dual Tone" parameters below.
ARB	The RF signal is based on an arbitrary baseband signal defined by a waveform file (*.wv, ARB File); see ARB Generator.

GPIB command:
`SOURce:GPRF:GENerator<i>:BBMode`

Baseband > Dual Tone

The Baseband > Dual Tone section provides parameters for the two generator signals "Source 1" and "Source 2". The two signals are superimposed at the selected output connector if "Dual Tone" baseband mode is active.



Modulation > Dual Tone > Offset Frequency
Positive or negative offset frequency. The frequency of the modulated signal is equal to the Generator Frequency plus the "Offset Frequency".
GPIB command:
SOURce:GPRF:GENerator<i>:DTONe:OFRequency

Modulation > Dual Tone > Ratio
Ratio in dB between the RMS levels of the "Source 1" and "Source 2" signals (Ratio = $\text{Level}_{\text{Source 1}} - \text{Level}_{\text{Source 2}}$). The individual levels are calculated from the total generator level "Level (RMS)" and the ratio.
GPIB commands:
SOURce:GPRF:GENerator<i>:DTONe:RATio
SOURce:GPRF:GENerator<i>:DTONe:LEVel<source>?

7.2.1.4 ARB Generator (Option R&S CMW-B110 A)

In the arbitrary (ARB) baseband mode (with disabled list mode), the RF signal is based on a baseband signal defined by a waveform file (*.wv, ARB File).

Baseband > ARB > ARB File
Selects the waveform file for defining the baseband signal. The R&S CMW 500 supports waveform files (.wv) generated with the Signal Generation Software R&S WinIQSIM 2. A progress bar shows that the selected file is loaded:

WinIQSIM 2 is installed on an external PC and does not require any additional hardware to generate the waveform files. Transmission of the files to the R&S CMW 500 is menu-guided; refer to the WiNIQSIM2 manual. Preferably, a LAN connection is used, and the waveform files are stored under D\:Waveform.

Available waveforms and options

The R&S CMW 500 supports "Custom Digital Modulation" signals generated by WinIQSIM2. Network-specific signals (uplink and downlink) can be downloaded with the following options:

- GSM, GSM + (E)GPRS: Option R&S CMW-KW200, GSM WINIQSIM2
- WCDMA (3GPP FDD): Option R&S CMW-KW400 WCDMA WINIQSIM2
- WCDMA (3GPP FDD) + HSDPA: Option R&S CMW-KW401 WCDMA HSDPA WINIQSIM2
- WCDMA (3GPP FDD) + HSUPA:Option R&S CMW-KW402 WCDMA HSUPA WINIQSIM2
- WiMAX (IEEE 802.16): Option R&S CMW-KW700 WIMAX WINIQSIM2

GPIB command:
SOURce:GPRF:GENerator<i>:ARB:FILE

7.2.1.5 List Mode

In list mode, the RF generator steps through a list of configurable frequencies and powers.

List Configuration > List Section

Definition of the step range to be used in all list modes except "Step". The generator steps through all list entries between the "Start Index" and the "Stop Index" in the "Frequency / Level List". The total number of generated steps *(Result Count = Stop Index – Start Index + 1)* is displayed for information.

GPIB command:
SOURce:GPRF:GENerator<i>:LIST:SSTopSOURce:GPRF:GENerator<i>:LIST:COUNt?

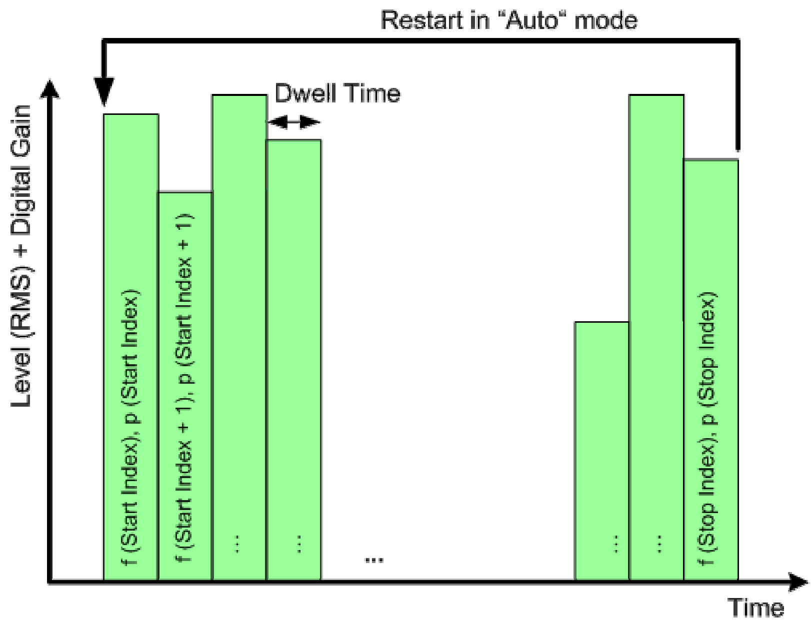
List Configuration > Current Index
Number of frequency/level step in the sequence list. This parameter is available in "Step" mode only.
GPIB command:
`SOURce:GPRF:GENerator<i>:LIST:CINDex`

List Configuration > Mode
Defines how the RF generator runs through the list (or through the list section between the "Start Index" and the "Stop Index").

Auto The generator cycles through the list section between the "Start Index" and the "Stop Index", transmitting at each frequency/level step for the selected "Dwell Time". The cycle is re-started automatically from the beginning of the list.

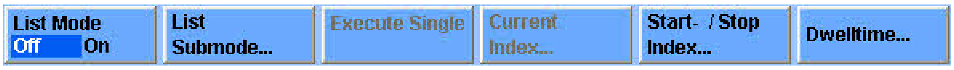
Single The generator runs through the list section between the "Start Index" and the "Stop Index" for a single time. Transmission at the start frequency/level step must be initiated using the "Execute Single" hotkey.

Step Manual selection of a single frequency/level step. The RF generator transmits at the frequency/level with the "Current Index" until a new current index is selected. The dwell time is ignored.



List Mode Settings

List mode configuration and operation
Use the hotkeys associated with the Sequence Config. softkey to operate the GPRF generator in list mode.



GPIB command:
SOURce:GPRF:GENerator<i>:LIST:MODE

List Configuration > Dwell Time
Transmission time on each frequency/level step in "Auto or Single" mode. The value is not used in the other list modes.
The total time for the generator to step through a single cycle is the dwell time times the number of steps *(Stop Index – Start Index + 1)*.
GPIB command:
SOURce:GPRF:GENerator<i>:LIST:DTIMe

List Configuration > Frequency / Level List
Definition of 2000 not necessarily different pairs of frequencies and levels. The actual RF generator level at each frequency (Peak Envelope Power) is equal to the "Level (RMS)" plus the "Digital Gain". The value range for the frequency covers the entire configurable value range of the instrument, the level range depends on the selected RF connector.

Digital Gain
The Digital Gain parameter provides direct access to the IF levels, while the RF Level parameter controls the level in the RF path. The Digital Gain parameter can be used for fine-tuning of the list mode signal (IF hopping).

GPIB command:
SOURce:GPRF:GENerator<i>:LMODe:FREQuency
SOURce:GPRF:GENerator<i>:LMODe:RFLevel
SOURce:GPRF:GENerator<i>:LIST:DGAin

7.2.2 Power: Parameters and Settings

The "Power" measurement is configured using the following groups of settings:
- Measurement Control Settings
- Signal Routing and Analyzer Settings
- Measurement Control Parameters

- List Configuration
- Trigger
- Display Configuration

The most important measurement settings are also displayed in the measurement dialog. The measurement dialog provides all Measurement Results.

7.2.2.1 Measurement Control

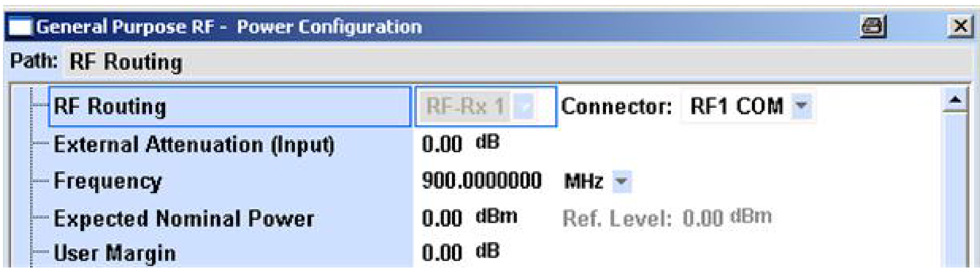
The measurement is turned on or off using the "Power" measurement control softkey.

Power (Softkey)

Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via remote control.
GPIB command:
`INITiate:GPRF:MEASurement<i>:POWer` etc.
`FETCh:GPRF:MEASurement<i>:POWer:STATe?`
`FETCh:GPRF:MEASurement<i>:POWer:STATe:ALL?`

7.2.2.2 Power Configuration: Signal Routing and Analyzer Settings

The "Power" measurement is configured using the parameters in the "Power Configuration" dialog. The following parameters configure the RF input path.



Power configuration: Signal routing and analyzer settings

RF Routing

Selects the input connector for the measured RF signal; see connector selection.
GPIB command:
`ROUTe:GPRF:MEASurement<i>:RFSettings:CONNector`

External Attenuation (Input)
Defines the value of an external attenuation (or gain, if the value is negative) in the input path.
The external attenuation also enters into the internal calculation of the maximum input power that the R&S CMW 500 can measure (see "Expected Nominal Power" below).
GPIB command:
`CONFigure:GPRF:MEASurement<i>:RFSettings:EATTenuation`

Frequency
Center frequency of the RF analyzer. Set this frequency to the frequency of the measured RF signal to obtain a meaningful measurement result.
GPIB command: `CONFigure:GPRF:MEASurement<i>:RFSettings:FREQuency`

Expected Nominal Power
Defines the nominal power of the RF signal to be measured. The nominal power is the average output power at the DUT during the measurement intervals where the RF transmitter is on. The "Ref. Level" is calculated as the expected peak power at the output of the DUT:
Reference power = Expected Nominal Power + User Margin

Maximum input power
The actual input power at the connectors (i.e. the "Reference Level" minus the "External Attenuation (Input)" value, if all power settings are configured correctly) must be within the level range of the selected RF input connector; refer to the "Specifications".

GPIB command: `CONFigure:GPRF:MEASurement<i>:RFSettings:ENPower`

User Margin
Margin that the R&S CMW 500 adds to the "Expected Nominal Power" in order to determine its reference power; see above. The "User Margin" is typically used to account for the known variations of the RF input signal power, e.g. the variations due to a specific channel configuration.
The appropriate values depends on the signal properties, e.g. on the modulation scheme.
GPIB command: `CONFigure:GPRF:MEASurement<i>:RFSettings:UMARgin`

7.2.2.3 Power Configuration: Measurement Control

The "Measurement Control" parameters define how the R&S CMW 500 acquires measurement data.

Power Configuration: Measurement Control

Control – Statistic Count

Defines the number of measurement intervals per measurement cycle (single shot measurement); see Statistical Settings. This value is also relevant for continuous measurements, because the averaging procedures depend on the statistic count; see Statistical Results.

In the "Power" measurement, the length of a measurement cycle depends on the "List Mode":

- If the list mode is switched off, a measurement cycle is completed after a single power step.
- If the list mode is on, the measurement cycle comprises the entire sequence of power steps (sweep).

GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:SCOunt`

Step Length

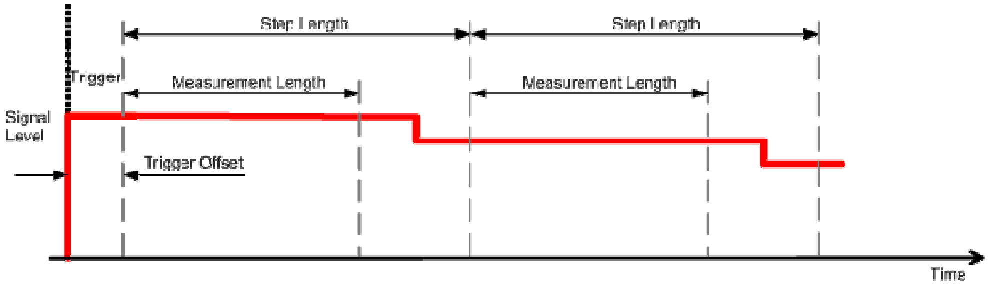
Sets the time between the beginning of two consecutive measured power steps. If no gaps occur between the steps the step length should be simply set to the length of each step. Together with the "Measurement Length", the step length determines the time intervals where the R&S CMW 500 evaluates the acquired data; see below.

The step length must be set precisely in accordance with the properties of the input signal, especially if the R&S CMW 500 measures many steps without a new trigger event (e.g. large "Statistic Count" and "Sub Trigger Mode: Trigger Once"). Inaccurate settings result in a drift of the evaluation intervals with respect to the power steps of the input signal, so that eventually the power is measured across subsequent steps.

GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:SLENgth`

Measurement Length

Sets the length of the averaging intervals that the R&S CMW 500 uses to calculate the "Power" results for each measurement step. The measurement data is acquired continuously, however, data outside the measurement length is discarded. The first evaluation interval starts immediately after the trigger event plus a possible "Trigger Offset" (for "Power Meas. Trigger") or after the measurement is started ("Free Run" measurement).



Measurement Length, Step Length and Trigger Offset

Avoid switching transients
Select your measurement length smaller than the actual width of the power steps to avoid the transients caused by the power steps of your input signal. A shortened first step or a trigger offset can shift the "Measurement Length" relative to the power steps; see Single Power Steps and Sequence Mode.

GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:MLENgth`

Control – Repetition
Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.
- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.
GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:REPetition`

Filter
Sets the type and bandwidth of the measurement filter (IF filter). The R&S CMW 500 provides filters of Gaussian shape with 3-dB bandwidths between 1 kHz and 10 MHz and bandpass filters with 3-dB bandwidths between 1 kHz and 40 MHz.
The bandpass filters are designed as root-raised cosine (RRC) filters with a roll-off of 0.1. This ensures steep filter edges with a wide, flat passsband (90 % of the filter bandwidth). Compared to Gaussian filters, the bandpass filters require longer settling times and therefore increase the measurement duration.
In addition to the Gaussian and bandpass filters with selectable bandwidth, the R&S

CMW 500 provides the following filters of fixed shape:

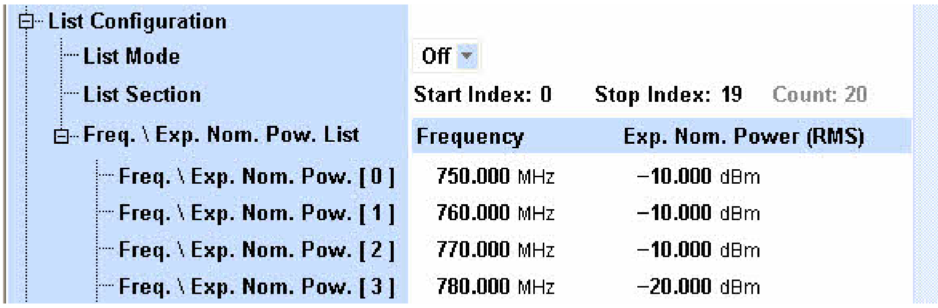
- The RRC filter with a roll-off = 0.22 and a 3.84 MHz bandwidth specified for WCDMA TX tests ("WCDMA" filter, see standard 3GPP 34.121).
- The 1.4 MHz-wide baseband receiver filter specified for CDMA 2000 TX tests ("CDMA" filter; see standard TIA/EIA/IS-2000.2-A).

GPIB command:

CONFigure:GPRF:MEASurement<i>:POWer:FILTer:TYPE
CONFigure:GPRF:MEASurement<i>:POWer:FILTer:GAUSs:BWIDth
CONFigure:GPRF:MEASurement<i>:POWer:FILTer:BANDpass:BWIDth

7.2.2.4 Power Configuration: List Configuration

The "List Configuration" parameters activate and configure the list mode of the GPRF "Power" measurement.



Power Configuration: List Configuration

List Mode

Selects the list mode. "Off" means that the "Power" measurement yields results at a single power/frequency step. If the "List Mode" is switched on, the R&S CMW 500 measures a list of power steps in accordance with the "List Mode" settings.

GPIB command:

CONFigure:GPRF:MEASurement<i>:POWer:LIST

List Section

Defines the step range to be used in list mode. The R&S CMW 500 measures all steps between the Start Index and the Stop Index in the List; the number of steps measured *(Count = Stop Index – Start Index + 1)* is displayed for information.

GPIB command:

CONFigure:GPRF:MEASurement<i>:POWer:LIST:STARt
CONFigure:GPRF:MEASurement<i>:POWer:LIST:STOP
CONFigure:GPRF:MEASurement<i>:POWer:LIST:COUNt?

Freq. / Exp. Nom. Pow. List

Definition of 500 not necessarily different pairs of frequencies and levels. The value range for the frequency covers the entire configurable value range of the instrument, the level range depends on the selected RF connector.

Expected Nominal Power
The power values in the list configure the analyzer of the R&S CMW 500 in accordance with the input power of the measured RF signal. Selecting (approximately) correct values can improve the accuracy of the "Power" measurement. To avoid an overload of the input path, the "User Margin" should account for possible power variations of the input signal (crest factor).

GPIB command:
`CONFigure:GPRF:MEASurement<i>:POWer:LIST:FREQuency`
`CONFigure:GPRF:MEASurement<i>:POWer:LIST:ENPower`

7.2.2.5 Power Configuration: Trigger Settings

The "Trigger" parameters configure the trigger system for the "Power" measurement.

Power Configuration: Trigger

Trigger Source
Selects the source of the trigger event.

Free Run The measurement starts immediately after it is initiated; no trigger is used. The remaining trigger settings are not relevant for "Free Run" measurements.

IF Power The measurement is triggered by the measured power steps. The trigger event is generated after down-conversion of the measured RF signal to the IF band. The "Trigger Slope", "Trigger Threshold", "Trigger Offset", and "Sub Trigger Mode" settings are valid for this trigger mode; they should be adjusted to the measured power steps.

GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:SOURce`

Trigger Slope
Qualifies whether the trigger event is generated at the rising or at the falling edge of

the trigger pulse. This setting has no influence on "Free Run" measurements.
GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:SLOPe`

Trigger Threshold
Defines the trigger threshold for the power trigger modes relative to the "Expected Nominal Power". The trigger threshold defines the measured input signal power where the trigger condition is satisfied and a trigger event is generated.
This setting has no influence on "Free Run" measurements.
GPIB command:
`CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:THREshold`

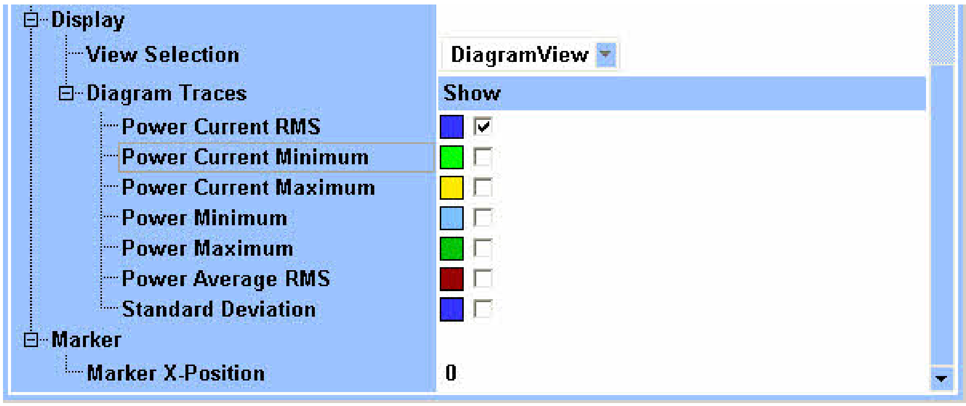
Trigger Offset
Defines a delay time for the power trigger modes. The trigger offset delays the start of the measurement relative to the trigger event. This setting has no influence on "Free Run" measurements.
See also "Measurement Length".
GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:OFFSet`

Trigger Timeout
Sets a time after which the initiated measurement is automatically stopped if it does not receive a trigger event. This setting has no influence on "Free Run" measurements.
GPIB command: `CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:TOUT`

Trigger Mode
Defines the trigger scheme for the measured step sequence. Each trigger event (derived from the RF input power ramp) can trigger a single measurement step or a series of consecutive measurement steps. This setting has no impact on "Free Run" measurements.
For details on the "Trigger Mode" refer to Trigger Modes.
GPIB command:
`CONFigure:GPRF:MEASurement<i>:POWer:TRIGger:MODE`

7.2.2.6 Power Configuration: Display Parameters

The "Display" parameters configure the appearance of the measurement menu and select the displayed results.



Power Configuration: Display Parameters

Display – View Selection

Selects the diagram view or the table view to display the measurement results.

GPIB command: no equivalent command

Display – Diagram View

The parameters in this section select the statistical results to be shown in the diagram view and the marker position. The Table View displays the results at the marker position.

GPIB command: Measurement results are selected by means of the `CURRent`, `AVERage`, `MINimum`, `MAXimum` mnemonics in the command headers; see Retrieving Measurement Results and Power measurement: Measurement Results.

7.2.2.7 Measurement Results

The "Power" measurement dialog shows all results in two alternative views; see detailed description in section Power: Results.

The diagram view shows a bar graph for the measured power values and tables with the numerical results at a particular power step and the essential measurement settings.

Power measurement results: Diagram View

Diagram

Power results at all measured power/frequency steps in dBm.

GPIB command:

`FETCh:GPRF:MEASurement<i>:POWer[:RMS]:CURRent?` etc.

`READ:GPRF:MEASurement<i>:POWer[:RMS]:CURRent?` etc.

Result panels

Statistical evaluation of the power values at the current marker position; see Statistical Results.

GPIB command:

`FETCh:GPRF:MEASurement<i>:POWer[:RMS]:CURRent?` etc.

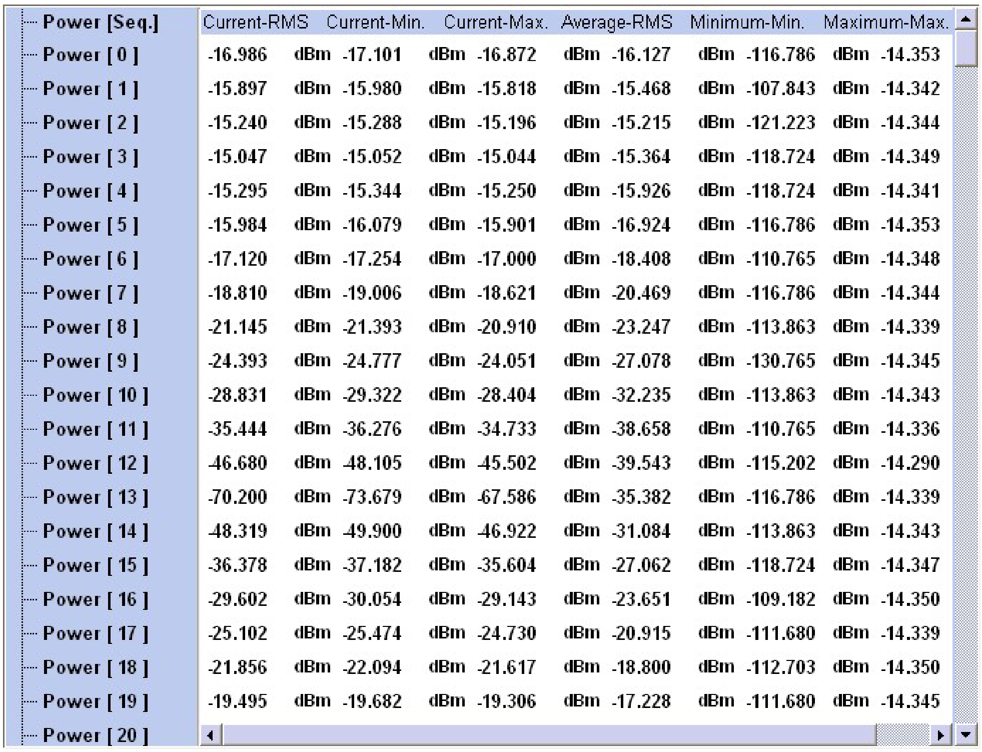
`READ:GPRF:MEASurement<i>:POWer[:RMS]:CURRent?` etc.

Settings panels

Overview of the essential current settings of the "Power" measurement.

GPIB command: The commands are listed with the description of the settings; see Power: Commands.

The table view shows the results in the bar graphs of the Diagram View as a table with numeric values.



Power [Seq.]	Current-RMS	Current-Min.	Current-Max.	Average-RMS	Minimum-Min.	Maximum-Max.
Power [0]	-16.986 dBm	-17.101 dBm	-16.872 dBm	-16.127 dBm	-116.786 dBm	-14.353
Power [1]	-15.897 dBm	-15.980 dBm	-15.818 dBm	-15.468 dBm	-107.843 dBm	-14.342
Power [2]	-15.240 dBm	-15.288 dBm	-15.196 dBm	-15.215 dBm	-121.223 dBm	-14.344
Power [3]	-15.047 dBm	-15.052 dBm	-15.044 dBm	-15.364 dBm	-118.724 dBm	-14.349
Power [4]	-15.295 dBm	-15.344 dBm	-15.250 dBm	-15.926 dBm	-118.724 dBm	-14.341
Power [5]	-15.984 dBm	-16.079 dBm	-15.901 dBm	-16.924 dBm	-116.786 dBm	-14.353
Power [6]	-17.120 dBm	-17.254 dBm	-17.000 dBm	-18.408 dBm	-110.765 dBm	-14.348
Power [7]	-18.810 dBm	-19.006 dBm	-18.621 dBm	-20.469 dBm	-116.786 dBm	-14.344
Power [8]	-21.145 dBm	-21.393 dBm	-20.910 dBm	-23.247 dBm	-113.863 dBm	-14.339
Power [9]	-24.393 dBm	-24.777 dBm	-24.051 dBm	-27.078 dBm	-130.765 dBm	-14.345
Power [10]	-28.831 dBm	-29.322 dBm	-28.404 dBm	-32.235 dBm	-113.863 dBm	-14.343
Power [11]	-35.444 dBm	-36.276 dBm	-34.733 dBm	-38.658 dBm	-110.765 dBm	-14.336
Power [12]	-46.680 dBm	-48.105 dBm	-45.502 dBm	-39.543 dBm	-115.202 dBm	-14.290
Power [13]	-70.200 dBm	-73.679 dBm	-67.586 dBm	-35.382 dBm	-116.786 dBm	-14.339
Power [14]	-48.319 dBm	-49.900 dBm	-46.922 dBm	-31.084 dBm	-113.863 dBm	-14.343
Power [15]	-36.378 dBm	-37.182 dBm	-35.604 dBm	-27.062 dBm	-118.724 dBm	-14.347
Power [16]	-29.602 dBm	-30.054 dBm	-29.143 dBm	-23.651 dBm	-109.182 dBm	-14.350
Power [17]	-25.102 dBm	-25.474 dBm	-24.730 dBm	-20.915 dBm	-111.680 dBm	-14.339
Power [18]	-21.856 dBm	-22.094 dBm	-21.617 dBm	-18.800 dBm	-112.703 dBm	-14.350
Power [19]	-19.495 dBm	-19.682 dBm	-19.306 dBm	-17.228 dBm	-111.680 dBm	-14.345
Power [20]						

Power measurement results: Table View

7.2.3 External Power Sensor: Parameters and Settings

The External Power Sensor measurement is configured using the following groups of settings:

- Measurement Control
- External Power Sensor Configuration

The most important measurement settings are also displayed in the measurement dialog. The measurement dialog provides all Measurement Results.

7.2.3.1 Measurement Control

The measurement is turned on or off using the "EPS" measurement control softkey and the ON | OFF or RESTART | STOP front panel keys.

EPS (Softkey)

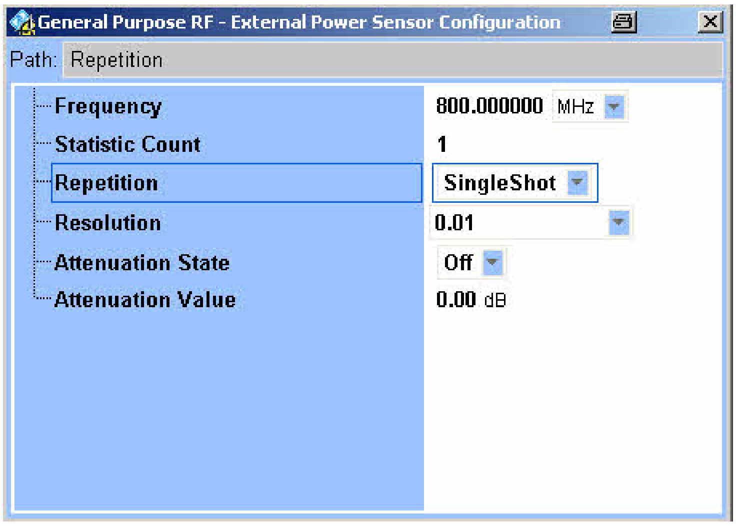
Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via

remote control.
GPIB command:
`INITiate:GPRF:MEASurement<i>:EPSensor` etc.
`FETCh:GPRF:MEASurement<i>:EPSensor:STATe?`
`FETCh:GPRF:MEASurement<i>:EPSensor:STATe:ALL?`

Start Zeroing
Initiates zeroing of the external power sensor. The "Start Zeroing" hotkey is associated with the "EPS" measurement control softkey.
GPIB command:
`CALibration:GPRF:MEASurement<i>:EPSensor:ZERO`

7.2.3.2 External Power Sensor Configuration

The External Power Sensor measurement is configured using the parameters in the External Power Sensor Configuration dialog described below.



External Power Sensor configuration

Frequency
Specifies the input frequency at the power sensor. The value is used for the frequency-response correction of the sensor measurement result.
Although R&S NRP sensors measure the RF power over a wide bandwidth, the correct frequency of the RF signal should be entered for maximum accuracy.
GPIB command: `CONFigure:GPRF:MEASurement<i>:EPSensor:FREQuency`

Statistic Count
Defines the number of measurement intervals per measurement cycle (single shot measurement); see Statistical Settings. This value is also relevant for continuous measurements, because the averaging procedures depend on the statistic count; see

Statistical Results.
In the External Power Sensor measurement, the statistic count corresponds to the number of power results requested from the power sensor.
GPIB command: `CONFigure:GPRF:MEASurement<i>:EPSensor:SCOunt`

Repetition
Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.
- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

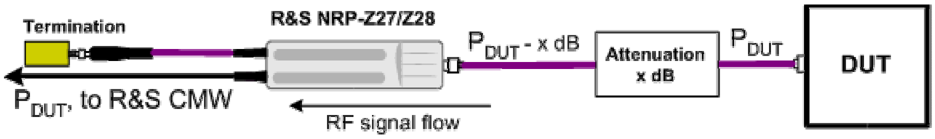
Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.
GPIB command: `CONFigure:GPRF:MEASurement<i>:EPSensor:REPetition`

Resolution
Defines the number of digits of the power results in the measurement dialog.
GPIB command: `CONFigure:GPRF:MEASurement<i>:EPSensor:RESolution`

Attenuation State
Enable or disables an external input "Attenuation Value" for the external power sensor measurement; see below.
GPIB command:
`CONFigure:GPRF:MEASurement<i>:EPSensor:ATTenuation:STATe`

Attenuation Value
If it is enabled ("Attenuation State: ON"), the attenuation factor corrects the power reading of the external power sensor.
An external attenuation is suitable if the test setup contains attenuation pads or amplifiers, e.g. to adjust the output power of the DUT to the input power range of the sensor. An appropriate attenuation value ensures that the measured powers are referenced to the output of the DUT.

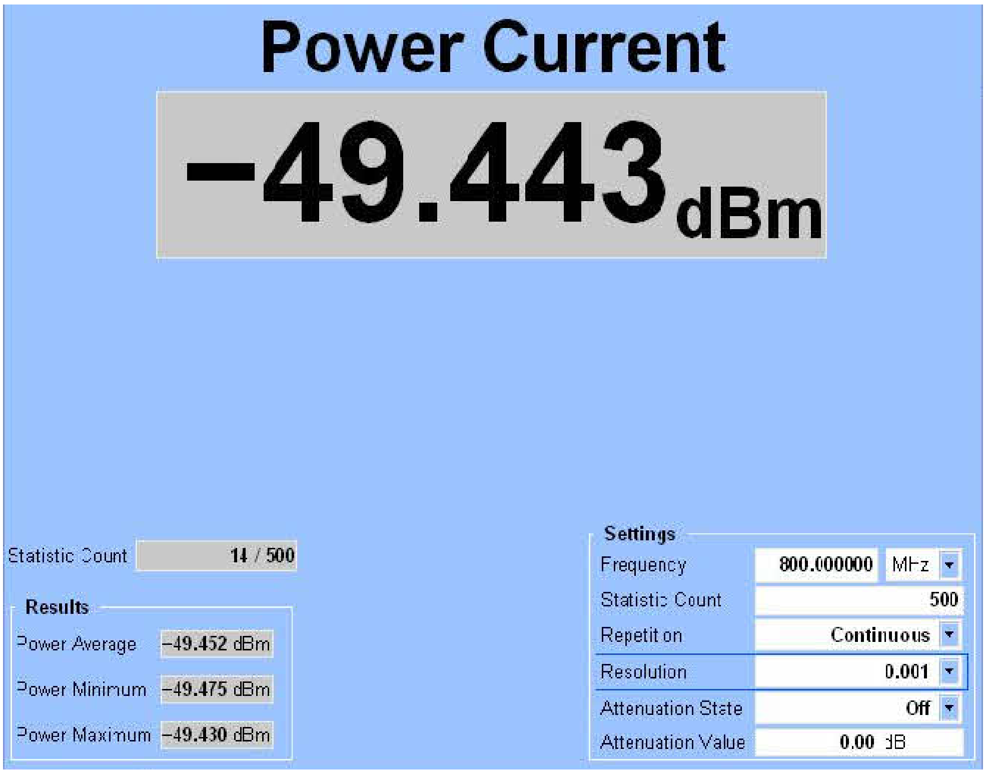
- Positive values increase the power reading, compensating for an attenuation.
- Negative values reduce the power reading, compensating for an amplification factor.



GPIB command: CONFigure:GPRF:MEASurement<i>:EPSensor:ATTENuation

7.2.3.3 Measurement Results

The "External Power Sensor" measurement dialog shows all results; see detailed description in section External Power Sensor: Results.



External Power Sensor: Measurement results

Statistic Count and Power Results

Statistical evaluation of the sensor power results at the selected frequency; see Statistical Results.

GPIB command:

FETCh:GPRF:MEASurement<i>:EPSensor?
READ:GPRF:MEASurement<i>:EPSensor?

Settings panels

Overview of the essential current settings of the "External Power Sensor" measurement.

GPIB command: The commands are listed with the description of the settings; see

External Power Sensor: Commands.

7.3 GPRF Programming

The following sections provide programming examples for the General Purpose RF (GPRF) firmware applications.

- GPRF Generator
- Power
- External Power Sensor

The examples have been tested with the aid of a simple software tool.

7.3.1 Programming the GPRF Generator

The following examples show how to control and configure the GPRF generator via a remote-control program.

- Key Features
- Generating a CW Signal
- Generating a Dual-Tone Signal
- Using the Generator List Mode

For an introduction to instrument programming refer to the "Remote Control" chapter, in particular to section Generator Control.

7.3.1.1 Key Features

The GPRF generator is programmed as follows:

- The generator is controlled by SCPI commands with the following syntax:
  `...GPRF:GENerator:...`
- After a *RST, the generator must be switched on:
  `SOURce:GPRF:GENerator:STATe ON`. *OPC? ensures that the RF generator signal is actually available at the selected RF output before the next command line is executed.

Advanced settings

An RF signal is available at the selected RF output as soon as the RF generator has reached the ADJusted substate. Use `SOURce:GPRF:GENerator<i>:STATe:ALL?` to query the generator substate.

7.3.1.2 Generating a CW Signal

```
FPRINT **********************************************************
FPRINT System-Reset
FPRINT **********************************************************
*RST;*OPC?
*CLS; *OPC?

FPRINT **********************************************************
FPRINT Route output signal, define external attenuation
FPRINT **********************************************************
ROUTe:GPRF:GENerator:RFSettings:CONNector RF1C
SOURce:GPRF:GENerator:RFSettings:EATTenuation 2

FPRINT **********************************************************
FPRINT Set frequency and level, activate CW mode
FPRINT **********************************************************
SOURce:GPRF:GENerator:RFSettings:FREQuency 1.000000E+009
SOURce:GPRF:GENerator:RFSettings:LEVel -70
SOURce:GPRF:GENerator:BBMode CW

FPRINT **********************************************************
FPRINT Switch on generator. With command synchronization, the queried
FPRINT generator state is "ON".
FPRINT **********************************************************
SOURce:GPRF:GENerator:STATe ON; *OPC?
SOURce:GPRF:GENerator:STATe?
```

7.3.1.3 Generating a Dual-Tone Signal

```
FPRINT **********************************************************
FPRINT System-Reset
FPRINT **********************************************************
*RST;*OPC?

FPRINT **********************************************************
FPRINT Activate dual-tone mode, set frequencies and levels
FPRINT **********************************************************
SOURce:GPRF:GENerator:BBMode DTON
SOURce:GPRF:GENerator:RFSettings:FREQuency 1.000000E+009
SOURce:GPRF:GENerator:DTONe:OFRequency1 1000
SOURce:GPRF:GENerator:DTONe:OFRequency2 2000
SOURce:GPRF:GENerator:DTONe:Ratio 10
```

FPRINT **
FPRINT Query levels of source 1 and source 2
FPRINT **

```
SOURce:GPRF:GENerator:DTONe:LEVel1?
SOURce:GPRF:GENerator:DTONe:LEVel2?
```

FPRINT **
FPRINT Switch on generator
FPRINT **

```
SOURce:GPRF:GENerator:STATe ON; *OPC?
```

7.3.1.4 Using the Generator List Mode

FPRINT **
FPRINT System-Reset
FPRINT **

```
*RST;*OPC?
```

FPRINT **
FPRINT Activate list mode, set frequencies and levels for 5 steps
FPRINT **

```
SOURce:GPRF:GENerator:LIST ON
SOURce:GPRF:GENerator:LIST:SSTop 0, 4

SOURce:GPRF:GENerator:LIST:FREQuency 0, 1.9224E+009
SOURce:GPRF:GENerator:LIST:FREQuency 1, 1.9224E+009
SOURce:GPRF:GENerator:LIST:FREQuency 2, 1.9224E+009
SOURce:GPRF:GENerator:LIST:FREQuency 3, 1.9224E+009
SOURce:GPRF:GENerator:LIST:FREQuency 4, 1.9224E+009

SOURce:GPRF:GENerator:LIST:RFLevel 0, -20
SOURce:GPRF:GENerator:LIST:RFLevel 1, -23
SOURce:GPRF:GENerator:LIST:RFLevel 2, -26
SOURce:GPRF:GENerator:LIST:RFLevel 3, -29
SOURce:GPRF:GENerator:LIST:RFLevel 4, -32

SOURce:GPRF:GENerator:LIST:DGAin 0, -2
SOURce:GPRF:GENerator:LIST:DGAin 1, -2
SOURce:GPRF:GENerator:LIST:DGAin 2, -2
SOURce:GPRF:GENerator:LIST:DGAin 3, -2
SOURce:GPRF:GENerator:LIST:DGAin 4, -2
```

FPRINT **
FPRINT Set dwell time equal to the duration of a WCDMA slot,

```
FPRINT let the generator cycle through the list.
FPRINT ************************************************************
SOURce:GPRF:GENerator:LIST:DTIMe 666.67E-6
SOURce:GPRF:GENerator:LIST:MODE AUTO

FPRINT ************************************************************
FPRINT Switch on generator
FPRINT ************************************************************
SOURce:GPRF:GENerator:STATe ON: *OPC?

FPRINT ************************************************************
FPRINT Change the list mode to step, transmit at constant frequency
FPRINT ************************************************************
SOURce:GPRF:GENerator:LIST:MODE STEP
SOURce:GPRF:GENerator:LIST:CINDex 0

WAITKEY >Step no. 0 active, press OK to change to next step<

SOURce:GPRF:GENerator:LIST:CINDex 1

WAITKEY >Step no. 1 active, press OK to terminate program<
```

7.3.2 Programming the Power Measurement

The following examples show how to configure the Power measurement via a remote-control program and retrieve measurement results.

- Key Features
- Specifying General Measurement Settings
- Specifying Measurement-Specific Settings
- Performing a Single-Shot Measurement
- Configuring the List Mode
- Single Shot and Continuous Power Measurements

For an introduction to instrument programming refer to the "Remote Control" chapter, in particular to section Measurement Control.

7.3.2.1 Key Features

The Power measurement is programmed as follows:

- The measurement is controlled by SCPI commands with the following syntax: `...GPRF:MEASurement:POWer...`
- Use general commands of the type `...:GPRF:MEASurement...` (no `:POWer` mnemonic) to define the signal routing and perform RF and analyzer settings.

- After a `*RST`, the measurement is switched off. Use `READ:GPRF:MEASurement:POWer?` to initiate a single-shot measurement and retrieve the results.

Advanced settings

You can also run the measurement in continuous mode and retrieve the results using `FETCh:GPRF:MEASurement:POWer...?` (see Measurement Control). A reliability indicator is returned with each measurement result.

7.3.2.2 Specifying General Measurement Settings

```
FPRINT ***************************************************************
FPRINT System-Reset
FPRINT ***************************************************************
*RST;*OPC?
*CLS; *OPC?

FPRINT ***************************************************************
FPRINT Define signal routing, perform RF and analyzer settings
FPRINT for a 20 dBm GSM signal at a GSM900-specific frequency (channel no. 1)
FPRINT ***************************************************************
ROUTe:GPRF:MEASurement:RFSettings:CONNector RF1C
CONFigure:GPRF:MEASurement:RFSettings:EATTenuation 2
CONFigure:GPRF:MEASurement:RFSettings:ENPower 20
CONFigure:GPRF:MEASurement:RFSettings:UMARgin 5
CONFigure:GPRF:MEASurement:RFSettings:FREQuency 890.2E+6
```

7.3.2.3 Specifying Measurement-Specific Settings

```
FPRINT ***************************************************************
FPRINT Define step in accordance with GSM timeslot
FPRINT and measurement length
FPRINT ***************************************************************
CONFigure:GPRF:MEASurement:POWer:SLENgth 577.9230769E-6
CONFigure:GPRF:MEASurement:POWer:MLENgth 400E-6
FPRINT ***************************************************************
FPRINT Define measurement statistics (5 GSM timeslots)
FPRINT ***************************************************************
CONFigure:GPRF:MEASurement:POWer:SCOunt 5
FPRINT ***************************************************************
FPRINT Select 30 kHz Gauss measurement filter
FPRINT ***************************************************************
CONFigure:GPRF:MEASurement:POWer:FILTer:TYPE GAUSs
```

```
CONFigure:GPRF:MEASurement:POWer:FILTer:GAUSs:BWIDth 30E+3
```

FPRINT ***
FPRINT Configure power measurement trigger
FPRINT ***

```
CONFigure:GPRF:MEASurement:POWer:TRIGger:SOURce IFPower
CONFigure:GPRF:MEASurement:POWer:TRIGger:SLOPe REDGe
CONFigure:GPRF:MEASurement:POWer:TRIGger:THReshold -25
CONFigure:GPRF:MEASurement:POWer:TRIGger:OFFSet 50E-6
CONFigure:GPRF:MEASurement:POWer:TRIGger:TOUT 2
CONFigure:GPRF:MEASurement:POWer:TRIGger:MODE ONCE
WAITKEY >Configuration completed, press "OK" to start
measurement<
```

7.3.2.4 Performing a Single Shot Measurement

FPRINT ***
FPRINT Start single-shot measurement, return RMS-averaged power in last measured timeslot.
FPRINT Repeat measurement, return average power over the entire
FPRINT statistics cycle of 5 slots. Query the measurement state (should be "RDY").
FPRINT ***

```
READ:GPRF:MEASurement:POWer:RMS:CURRent?
READ:GPRF:MEASurement:POWer:RMS:AVERage?
FETCh:GPRF:MEASurement:POWer:STATe?

WAITKEY >Single-slot measurement completed, press "OK" to
configure list mode<
```

7.3.2.5 Configuring the List Mode

FPRINT ***
FPRINT Set up a measurement in list mode and over 8 slots (1 GSM frame).
FPRINT Query no.of measured slots (8), Query and modify the frequency and expected
FPRINT nominal power of the first slot.
FPRINT ***

```
CONFigure:GPRF:MEASurement:POWer:LIST ON
CONFigure:GPRF:MEASurement:POWer:LIST:STARt 0
CONFigure:GPRF:MEASurement:POWer:LIST:STOP 7

CONFigure:GPRF:MEASurement:POWer:LIST:COUNt?
```

```
CONFigure:GPRF:MEASurement:POWer:LIST:FREQuency? 0
CONFigure:GPRF:MEASurement:POWer:LIST:FREQuency 0, 7.55E+8
CONFigure:GPRF:MEASurement:POWer:LIST:ENPower? 0
CONFigure:GPRF:MEASurement:POWer:LIST:ENPower 0, -5
```

7.3.2.6 Single Shot and Continuous Power Measurements

FPRINT ***
FPRINT Start single-shot measurement, return RMS-averaged power in last measured timeslot.
FPRINT Return standard deviation of the RMS power results (without repeating the measurement.
FPRINT Query the measurement state (should be "RDY").
FPRINT ***

```
INIT:GPRF:MEASurement:POWer
FETCh:GPRF:MEASurement:POWer:RMS:CURRent?
FETCh:GPRF:MEASurement:POWer:SDEViation?

FETCh:GPRF:MEASurement:POWer:STATe?
```

FPRINT ***
FPRINT Start continuous measurement, return last valid result for
FPRINT the RMS-averaged power in last measured timeslot of the current measurement cycle.
FPRINT Query measurement state and substates (should be "RUN,ADJ,ACT").
FPRINT ***

```
CONFigure:GPRF:MEASurement:POWer:REPetition CONTinuous
FETCh:GPRF:MEASurement:POWer:RMS:CURRent?
FETCh:GPRF:MEASurement:POWer:STATe:ALL?
```

7.3.3 Programming the External Power Sensor Measurement

The following examples show how to configure the External Power Sensor measurement via a remote-control program and retrieve measurement results.

- Key Features
- Performing a Single Shot Measurement
- Zeroing the External Sensor
- Continuous Sensor Measurement

For an introduction to instrument programming refer to the "Remote Control" chapter, in particular to section Measurement Control.

7.3.3.1 Key Features

The External Power Sensor measurement is programmed as follows:

- The measurement is controlled by SCPI commands with the following syntax:
  `...GPRF:MEASurement:EPSensor...`
- After a `*RST`, the measurement is switched off. Use `READ:GPRF:MEASurement:EPSensor?` to initiate a single-shot measurement and retrieve the results.

Advanced settings

A zeroing procedure is recommended to improve the accuracy.
You can also run the measurement in continuous mode and retrieve the results using `FETCh:GPRF:MEASurement:EPSensor?` (see Measurement Control). A reliability indicator is returned with each measurement result.

7.3.3.2 Performing a Single Shot Measurement

FPRINT ***
FPRINT System-Reset
FPRINT ***

```
*RST;*OPC?
*CLS; *OPC?
```

FPRINT ***
FPRINT Configure statistics, sensor frequency, and an external
FPRINT attenuation factor of 2 dB to correct the sensor reading,display FPRINT results
FPRINT with low resolution (rounded to 1 dB, this does not affect remote control).
FPRINT ***

```
CONFigure:GPRF:MEASurement:EPSensor:SCOunt 20
CONFigure:GPRF:MEASurement:EPSensor:FREQuency 1.922E+9
CONFigure:GPRF:MEASurement:EPSensor:ATTenuation:STATe ON
CONFigure:GPRF:MEASurement:EPSensor:ATTenuation 2
CONFigure:GPRF:MEASurement:EPSensor:RESolution PD0
```

FPRINT ***
FPRINT Start the measurement, return results and measurement state (should be RDY)
FPRINT ***

```
READ:GPRF:MEASurement:EPSensor?
FETCh:GPRF:MEASurement:EPSensor:STATe?
FETCh:GPRF:MEASurement:EPSensor:STATe:ALL?
```

7.3.3.3 Zeroing the External Sensor

```
REM    !!! The measured RF signal must be switched off for this step !!!
FPRINT ***************************************************************
FPRINT Initiate zeroing of the power sensor
FPRINT ***************************************************************
CALibration:GPRF:MEASurement:EPSensor:ZERO ON
Waitkey >Sensor zeroing initiated, press OK to read sensor state
and continue<
CALibration:GPRF:MEASurement:EPSensor:ZERO?

REM    !!! Switch on RF signal again to continue the measurement!!!
```

7.3.3.4 Continuous Sensor Measurement

```
FPRINT ***************************************************************
FPRINT Configure a continuous measurement, return results and meas. state (should
be RUN)
FPRINT ***************************************************************
INITiate:GPRF:MEASurement:EPSensor
FETCh:GPRF:MEASurement:EPSensor?
FETCh:GPRF:MEASurement:EPSensor:STATe?
```

7.4 GPRF Command Reference

The following sections provide detailed reference information on the remote control commands of the General Purpose RF application. The commands are organized as follows:

- General Measurement Settings
- RF Generator Commands
- Power Commands
- External Power Sensor Commands

For an overview of all commands refer to the Alphabetical List of Commands.

7.4.1 General Measurement Settings

The commands valid for all GPRF measurements are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Signal Routing
- Analyzer Settings

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

7.4.1.1 Command Groups (General Measurement Settings)

7.4.1.2 Signal Routing

The following commands select the path and connector for the generator and define an external attenuation value.

ROUTe:GPRF:MEAS<i>:RFSettings:CONNector <Input Connector>

Selects the input connector for the measured RF signal.

<Input Connector> **RF1C:** RF 1 COM
RF2C: RF 2 COM
Def. value: RF1C

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:RFSettings:EATTenuation <External Att>

Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF input connector (`ROUTe:...:MEAS<i>:RFSettings:CONNector`).

<External Att> Range: –50.00 dB to +90.00 dB (increment 0.01 dB)
Def. value: 0.00 dB

Def. unit: dB

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

7.4.1.3 Analyzer Settings

The following commands configure the RF input path.

CONFigure:GPRF:MEAS<i>:RFSettings:ENPower <Exp Nom Power>

Sets the expected nominal power of the measured RF signal.

<Exp Nom Power> Range: –47 dBm to +34 dBm at RF 1 COM and RF 2 COM (increment 0.01 dBm; please notice also the ranges quoted in the "Specifications")
Def. value: 0.00 dBm
Def. unit: dBm

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:RFSettings:UMARgin <User Margin>

Sets the margin that the R&S CMW 500 adds to the expected nominal power (`CONFigure:...:MEAS<i>:RFSettings:ENPower`) minus the external input attenuation (`CONFigure:...:MEAS<i>:RFSettings:EATTenuation`) in order to determine its reference power. The reference power must be within the power range of the selected input connector; refer to the "Specifications".

<User Margin> Range: 0.00 dB to +50.00 dB at RF 1 COM (increment 0.01 dB)
Def. value: 0.00 dB
Def. unit: dB

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:RFSettings:FREQuency <Frequency>

Selects the center frequency of the RF analyzer.

<Frequency>	Range: 70 MHz to 3300 MHz (increment 0.1 Hz) Def. value 900.000 MHz Def. unit: Hz
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

7.4.2 GPRF Generator Commands

The commands of the General Purpose RF generator are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Generator Control and States
- Signal Routing
- Constant-Frequency Settings
- Baseband Settings
- List Mode Settings

Issues of special interest for all commands:

GEN<i> Abbreviation of "GENerator<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

7.4.2.1 Command Groups (RF Generator)

7.4.2.2 Generator Control and States

The following command controls the RF generator and retrieve its state.

SOURce:GPRF:GEN<i>:STATe <State>

Turns the generator on or off (see Generator Control).

<State>	Switch generator **ON** or **OFF**
Return for query:	**OFF:** generator switched off **PEND:** generator switched on but no signal available yet **ON:** generator switched on, signal available Def. value: OFF
Example	See Generating a CW Signal
Characteristics	Firmware version V1.00

7.4.2.3 Signal Routing

The following commands select the input path and connector and define an external attenuation value.

ROUTe:GPRF:GEN<i>:RFSettings:CONNector <Output Connector>

Selects the output connector for the RF generator signal.

<Output Connector>	**RF1O:** RF 1 OUT **RF1C:** RF 1 COM **RF2C:** RF 2 COM Def. value: RF1C
Example	See Generating a CW Signal
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:RFSettings:EATTenuation <External Att>

Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF output connector (`ROUTe:GPRF:GEN<i>:RFSettings:Connector`).

<External Att>	Range: –50.00 dB to +90.00 dB (increment 0.01 dB) Def. value: 0.00 dB Def. unit: dB
Example	See Generating a CW Signal
Characteristics	Firmware version V1.00

7.4.2.4 Constant-Frequency Settings

The following commands configure the constant-frequency generator mode.

SOURce:GPRF:GEN<i>:RFSettings:FREQuency <Frequency>

Selects the frequency of the RF generator (Generator Frequency). Some of the baseband modes (modulation types) modify the generator frequency.

<Frequency>	Range: 70 MHz to 3300 MHz (increment 0.1 Hz) Def. value: 1200.000 MHz Def. unit: Hz
Example	See Generating a CW Signal
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:RFSettings:LEVel <LEVel>

Sets the base level (Level (RMS)) of the constant-frequency RF generator.

<Level> Range: –130 dBm to 0 dBm at RF 1 COM and RF 2 COM, –120 dBm to +13 dBm at RF 1 OUT(increment 0.01 dB); please also notice the ranges quoted in the "Specifications".
Def. value: –80.00 dBm
Def. unit: dBm

Example See Generating a CW Signal

Characteristics Firmware version V1.00

7.4.2.5 Baseband Settings

The following commands select the baseband mode for the constant-frequency generator and define the modulation parameters.

SOURce:GPRF:GEN<i>:BBMode <Baseband Mode>

Selects the baseband mode for the generator signal.

<Baseband Mode> **CW:** Unmodulated CW signal
DTONe: Dual tone signal(see commands `SOURce:GPRF:GEN<i>:DTONe...`)
ARB: ARB generator (waveform file; see `SOURce:GPRF:GEN<i>:ARB:FILE`)
Def. value: CW

Example See Generating a Dual-Tone Signal

Characteristics Firmware version V1.00

SOURce:GPRF:GEN<i>:DTONe:OFRequency<source> <Frequency>

Selects a positive or negative offset frequency. The frequency of the modulated signal is equal to the base frequency (`SOURce:GPRF:GEN<i>:FREQuency`) plus the offset frequency.

<source> No. of source signal (1 or 2)

<Frequency> Range: –40000 kHz to +40000 kHz (increment 0.1 Hz)
Def. value: 0 Hz
Def. unit: Hz

Example See Generating a Dual-Tone Signal

Characteristics Firmware version V1.00

SOURce:GPRF:GEN<i>:DTONe:RATio <Ratio>

Sets the base level (Level (RMS)) of the constant-frequency RF generator.

<Ratio> Range: –0.00 dB to +30.00 dB (increment 0.01 dB)
Def. value: 0.00 dB
Def. unit: dB

Example See Generating a Dual-Tone Signal

Characteristics Firmware version V1.00

SOURce:GPRF:GEN<i>:DTONe:LEVel<source>? <Level (RMS)>

Queries the output level of the source signal <source>. The output level is a function of the generator output level (`SOURce:GPRF:GEN<i>:RFSettings:LEVel`) and the ratio `SOURce:GPRF:GEN<i>:DTONe:RATio`.

<source> No. of source signal (1 or 2)

<Level (RMS)> Range: –143 dBm to +10 dBm at RF 1 COM and RF 2 COM, –135 dBm to +18 dBm at RF 1 OUT (increment 0.01 dB); please also notice the ranges quoted in the "Specifications"
Def. value: –80.00 dBm
Def. unit: dBm

Example See Generating a Dual-Tone Signal

Characteristics Firmware version V1.00
SCPI: Query only

SOURce:GPRF:GEN<i>:ARB:FILE '<File Name>'

Selects a waveform file, to be used for the arbitrary waveform generator (`SOURce:GPRF:GEN<i>:BBMode ARB`).

'<File Name>' String parameter, specifies the name of the waveform file (.wv).

Characteristics Firmware version V1.00

7.4.2.6 List Mode Settings

The following commands configure the list mode of the RF generator.

SOURce:GPRF:GEN<i>:LIST <Enable>

Enables or disables the list mode of the RF generator.

<Mode> Sequence Mode
OFF: List mode disabled (constant-frequency generator)
ON: List mode enabled
Def. value: OFF

Example See Using the Generator List Mode

Characteristics Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:SSTop <Start Index>, <Stop Index>

Defines the number of the first and last frequency/level step in the sequence list that is measured. These parameters are relevant for the AUTO, SING, and ESINgle list modes only (see `SOURce:GPRF:GEN<i>:LIST:MODE`). The stop index must not be smaller than the start index.

<Start Index>,	Range: 0 to 1999, Def. value: 0
<Stop Index>	Range: 0 to 1999, Def. value: 19
Example	See Using the Generator List Mode
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:COUNt?

Queries the number of frequency/level steps of the RF generator in list mode.
Returned values:

<Steps>	Number of frequency/level steps in list mode Range: 1 to 2000
Example	See Using the Generator List Mode
Characteristics	Firmware version V1.00 SCPI: Query only

SOURce:GPRF:GEN<i>:LIST:CINDex <Current Index>

Number of frequency/level step in the sequence list. This parameter is relevant in "Step" mode only (`SOURce:GPRF:GEN<i>:LIST:MODE STEP`).

<Current Index>	Range: 0 to 1999, Def. value: 0
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:MODE <Mode>

Defines how the RF generator runs through the list.

<Mode>	**AUTO:** The generator cycles through the list. **SING:** The generator runs through the list for a single time. **STEP:** Manual selection of a single frequency/level step.
Example	See Using the Generator List Mode

Characteristics Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:DTIMe <Time>

Defines the transmission time on each frequency/level step in AUTO or SING mode (Dwell Time). The value is not used in the other list modes (see `SOURce:GPRF:GEN<i>:LIST:MODE`).

<Time>	Range: 0.20000 ms to 40000.0000 ms, Def. value: 500 ms, Def. unit: s
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:FREQuency <Index>, <Frequency>
SOURce:GPRF:GEN<i>:LIST:FREQuency? <Index>

Defines or queries the frequency of the frequency/level step numbered <Index>.

<Index>,	Number of frequency/level step in the table (setting and query). Range: 0 to 1999, Def. value: n/a
<Frequency>	Frequency at the step (setting only) Range: 70 MHz to 3300 MHz (increment 0.1 Hz), Def. value: 800 MHz, Def. unit: Hz
Example	See Using the Generator List Mode
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:RFLevel <Index>, <Level>
SOURce:GPRF:GEN<i>:LIST:RFLevel? <Index>

Defines or queries the level of the frequency/level step numbered <Index>.

<Index>,	Number of frequency/level step in the table (setting and query). Range: 0 to 1999 Def. value: n/a
<Level>	RF Level at the step (setting only) Range: –130.00 dBm to 0.00 dBm for RF1 COM and RF2 COM (increment 0.01 dB), –120.00 dBm to +13.00 dBm for RF1 OUT; please also notice the ranges quoted in the "Specifications". Def. value: –30.00 dBm, Def. unit: dBm
Example	See Using the Generator List Mode
Characteristics	Firmware version V1.00

SOURce:GPRF:GEN<i>:LIST:DGAin <Index>, <Gain>
SOURce:GPRF:GEN<i>:LIST:DGAin? <Index>

Defines or queries the digital gain of the frequency/level step numbered <Index>.

<Index>,	Number of frequency/level step in the table (setting and query). Range: 0 to 1999 Def. value: n/a
<Gain>	Digital gain at the step (setting only) Range: –30.00 dB to 0.00 dB (increment 0.01 dB), Def. value: 0.0 dB, Def. unit: dB
Example	See Using the Generator List Mode
Characteristics	Firmware version V1.00

7.4.3 Power Measurement Commands

The commands valid for the "Power" measurement are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Measurement Control and States
- Measurement Parameters
- Statistical Settings
- Filter Settings
- Trigger Settings
- List Configuration
- Measurement Results

The following general measurement settings also affect the "Power" measurement:

- Signal Routing
- Analyzer Settings

Issues of special interest for all commands:

MEAS<i>	Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference. It is possible to use up to four instances of the same firmware application in parallel. For further information refer to Firmware Applications.

Issues of special interest in the context of result retrieval:

`FETCh` and `READ` commands	Both commands can be used to retrieve measurement results: ◆ `FETCh...` returns the results of the current measurement cycle (single shot measurement) after they are valid. `FETCh...` must be

used after the measurement has been started (`INITiate...`, measurement states RUN or RDY).

- `READ...` starts a new single shot measurement and returns the results.

For further information refer to Retrieving Measurement Results.

Current and statistical values

The R&S CMW 500 repeats measurements according to the selected statistic count and repetition mode. Consecutive measurement values are stored and used to calculate statistical results, e.g. average, minimum, maximum and standard deviation.

For a description of the statistical methods refer to Statistical Results.

Global Reliability Indicator

The common reliability indicator is the first value in the output arrays of the `FETCh...?` and `READ...?` queries.

e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`

Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement values)

In the present firmware version, the common reliability indicator is always set to zero.

7.4.3.1 Command Groups (Power Measurement)

Measurement Control and States **Page**

Measurement Control Parameters **Page**

Statistical Settings **Page**

Filter Settings **Page**

7.4.3.2 Measurement Control and States

The following commands control the measurement and return the current measurement state.

INITiate:GPRF:MEAS<i>:POWer
ABORt:GPRF:MEAS<i>:POWer
STOP:GPRF:MEAS<i>:POWer

Starts, stops, or aborts the measurement; see Measurement Control:

- `INITiate...` starts or restarts the measurement; the R&S CMW 500 enters the

"RUN" state.

- `ABORt...` causes a running measurement to stop immediately; the R&S CMW 500 enters the "OFF" state.
- `STOP...` causes a running measurement to stop after the current evaluation period is terminated and valid results are available; the R&S CMW 500 enters the "RDY" state.

Use `FETCh...STATe?` to query the current measurement state.

Example See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00
SCPI: No query

FETCh:GPRF:MEAS<i>:POWer:STATe?

Queries the main measurement state; see Measurement Control. Use `FETCh:...:MEAS<i>:...:STATe:ALL?` to query the measurement state including the substates. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State> **OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`)
RDY: measurement has been terminated, valid results may be available
RUN: measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates)
Def. value: OFF

Example See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00
SCPI: Query only

FETCh:GPRF:MEAS<i>:POWer:STATe:ALL?

Queries the main measurement state and the measurement substates. Both measurement substates are relevant for running measurements only. Use `FETCh:...:MEAS<i>:...:STATe?` to query the main measurement state only. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State>,	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF
<Sync State>,	**PEND:** waiting for resource allocation, adjustment, hardware switching ("pending") **ADJ:** all necessary adjustments finished, measurement running ("adjusted") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")
<Resources State>	**QUE:** measurement without resources, no results available ("queued") **ACT:** resources allocated, acquisition of results in progress but not complete ("active") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")

Example See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00
SCPI: Query only

7.4.3.3 Measurement Control Parameters

The following commands define the measurement interval. See also Filter Settings.

CONFigure:GPRF:MEAS<i>:POWer:SLENgth <Step Length>

Selects the time between the beginning of two consecutive measured power steps.

<Step Length> Range: 0.05 ms to 1 s
Def. value: 576.9230769 µs (1 GSM timeslot)
Unit: s

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:MLENgth <Length>

Selects the length of the averaging intervals that the R&S CMW 500 uses to calculate the "Power" results for each measurement step.

<Length> Range: 0.010 ms to 1 s
Def. value: 300 µs
Unit: s

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

7.4.3.4 Statistical Settings

The following commands specify the scope of the measurement.

CONFigure:GPRF:MEAS<i>:POWer:REPetition <Mode>

Specifies the repetition mode of the measurement; see Statistical Settings. The repetition mode specifies whether the measurement is stopped after a single shot or repeated continuously. Use `CONFigure:..:MEAS<i>:...:SCOunt` to determine the number of measurement intervals per single shot.

<Mode> **SINGleshot**: Single shot measurement
CONTinuous: Continuous measurement
Def. value: SINGleshot

Example See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:SCOunt <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals. A measurement interval comprises a single power/frequency step.
Range: 1 to 1000
Def. value: 10

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

7.4.3.5 Filter Settings

The following commands select the measurement filter (IF filter) for the measurement.

CONFigure:GPRF:MEAS<i>:POWer:FILTer:TYPE <Filter>

Selects the IF filter type.

<Filter>	**GAUSs:** Filter of Gaussian shape with selectable bandwidth (CONFigure:GPRF:MEAS<i>:POWer:FILTer:GAUSs:BWIDth) **BANDpass:** Bandpass filter with selectable bandwidth (CONFigure:GPRF:MEAS<i>:POWer:FILTer:BANDpas:BWIDth) **WCDMA:** 3.84 MHz RRC filter with a roll-off = 0.22 for WCDMA TX tests **CDMA:** 1.4 MHz-wide baseband receiver filter for CDMA 2000 TX tests Def. value: GAUSs
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:FILTer:GAUSs:BWIDth <Bandwidth>

Selects the bandwidth for a filter of Gaussian shape.

<Bandwidth>	Range: 1 kHz| 3 kHz | 5 kHz | 10 kHz | 30 kHz | 50 kHz| 100 kHz| 300 kHz | 500 kHz | 1 MHz| 3 MHz | 5 MHz | 10 MHz Def. value: 1 MHz Unit: Hz
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:FILTer:BANDpass:BWIDth <Bandwidth>

Selects the bandwidth for a bandpass filter.

<Bandwidth>	Range: 1 kHz| 3 kHz | 5 kHz | 10 kHz | 30 kHz | 50 kHz| 100 kHz| 300 kHz | 500 kHz | 1 MHz| 3 MHz | 5 MHz | 10 MHz | 30 MHz | 40 MHz Def. value: 300 kHz Unit: Hz
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

7.4.3.6 Trigger Settings

The following commands define the trigger parameters.

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:SOURce <Trigger Source>

Selects the source of the trigger events.

<Trigger Source>	**IFPower:** IF Power **FREerun:** Free Run Def. value: FREerun
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:SLOPe <Trigger Event>

Qualifies whether the trigger event is generated at the rising or at the falling edge of the trigger pulse (valid for the power trigger sources; see `CONFigure:...:MEAS<i>:...:TRIGger:SOURce`).

<Trigger Event>	**REDGe:** Rising edge **FEDGe:** Falling edge Def. value: REDGe
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:THReshold <Trigger Threshold>

Defines the trigger threshold for the power trigger sources; see `CONFigure:...:MEASurement<i>:...:TRIGger:SOURce`).

<Trigger Threshold>	Range: –50 dB to 0 dB Def. value: –30 dB Def. unit: dB (full scale, i.e. relative to the expected nominal power of the power steps that generate the trigger events)
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:OFFSet <Trigger Offset>

Defines a delay time for the "IF Power" trigger (`CONFigure:GPRF:MEAS<i>:POWer:TRIGger:SOURce IFPower`). The trigger offset delays the start of the measurement relative to the trigger event

<Trigger Offset>	Range: 0 s to 1 s Def. value: 0.1 ms Unit: s
Example	See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:TOUT <Trigger Timeout>

Sets a time after which the initiated measurement is automatically terminated if it does not receive a trigger event.

<Trigger Timeout> Range: 0.010 s to 300.000 s
Def. value: 0.100 s
Def. unit: s

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:TRIGger:MODE <Trigger Mode>

Selects the measurement sequence that is triggered by each single trigger event. This setting is not valid for free run measurements (`CONFigure:GPRF:MEAS<i>:POWer:TRIGger:SOURce FRUN`).

<Trigger Mode> **ONCE:** Trigger once
SWEep: Retrigger Sweep
ALL: Retrigger All
Def. value: ONCE

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

7.4.3.7 List Configuration

The following commands select the sequence mode of the "Power" measurement and configure the list mode.

CONFigure:GPRF:MEAS<i>:POWer:LIST <Enable>

Enables or disables the list mode for the "Power" measurement.

<Enable> **OFF:** List mode off (single power step)
ON: List mode on
Def. value: OFF

Example See Configuring the List Mode

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:LIST:COUNt? <Result Count>

Queries the total number of results, depending on the list mode

(CONFigure:GPRF:MEAS<i>:POWer:SEQuence:MODE).

<Result Count>	Range: 1 to 500
Example	See Configuring the List Mode
Characteristics	Firmware version V1.00 SCPI: Query only

CONFigure:GPRF:MEAS<i>:POWer:LIST:STARt <Start Index>

Start index, defines the first frequency/level step in the frequency/level list that is measured.

<Start Index>	Range: 0 to 499 Def. value: 0
Example	See Configuring the List Mode
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:LIST:STOP <Stop Index>

Stop index, defines the last frequency/level step in the frequency/level list that is measured.

<Stop Index>	Range: 0 to 499 Def. value: 19
Example	See Configuring the List Mode
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:LIST:FREQuency <List Index>, <Frequency>

Defines the frequency of frequency/level step no. <List Index> in the frequency/level list. The frequency can be queried with the <List Index> parameter; see example.

<List Index>	Range: 0 to 499 Def. value: –
<Frequency>	Range: 70 MHz to 3300 MHz Def. value: depending on list index (750 MHz to 990 MHz for index 0 to 19)
Example	See Configuring the List Mode
Characteristics	Firmware version V1.00

CONFigure:GPRF:MEAS<i>:POWer:LIST:ENPower <List Index>, <Exp. Nom. Power>

Defines the expected nominal power of frequency/level step no. <List Index> in the frequency/level list. The expected nominal power can be queried with the <List Index> parameter; see example.

<List Index>	Range: 0 to 499 Def. value: –
<Exp. Nom. Power>	Range: –47 dBm to +34 dBm Def. value: depending on list index (–10 dBm to –30 dBm in 10-dB steps for index 0 to 19)
Example	See Configuring the List Mode
Characteristics	Firmware version V1.00

7.4.3.8 Measurement Results

The following commands return the RF power results of the measurement.

FETCh:GPRF:MEAS<i>:POWer[:RMS]:CURRent?
FETCh:GPRF:MEAS<i>:POWer:MINimum:CURRent?
FETCh:GPRF:MEAS<i>:POWer:MAXimum:CURRent?
FETCh:GPRF:MEAS<i>:POWer[:RMS]:AVERage?
FETCh:GPRF:MEAS<i>:POWer:PEAK:MINimum?
FETCh:GPRF:MEAS<i>:POWer:PEAK:MAXimum?

READ:GPRF:MEAS<i>:POWer[:RMS]:CURRent?
READ:GPRF:MEAS<i>:POWer:MINimum:CURRent?
READ:GPRF:MEAS<i>:POWer:MAXimum:CURRent?
READ:GPRF:MEAS<i>:POWer[:RMS]:AVERage?
READ:GPRF:MEAS<i>:POWer:PEAK:MINimum?
READ:GPRF:MEAS<i>:POWer:PEAK:MAXimum?

Returns RF power results, see Power: Results. The results of the current, average, minimum and maximum traces can be retrieved. The additional mnemonics `RMS`, `MINimum`, `MAXimum` denote the detector type.

Returned values

<Reliability>,	Reliability indicator
<Power 1>, ..., <Power n>	RF power for each measured power step. If the list mode is switched off, a single value is returned (n = 1). In list mode, the total number n of results is equal to the list count (`CONFigure:GPRF:MEAS<i>:POWer:LIST:COUNt?`). Range: –100.0 dBm to +57.0 dBm Def. unit: dBm
Example	See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Power Measurement Commands.

FETCh:GPRF:MEAS<i>:POWer:SDEViation?
READ:GPRF:MEAS<i>:POWer:SDEViation?

Returns the standard deviation RF power trace values, see Power: Results.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev n>	Standard deviation of RMS power results for each measured power step. If the list mode is switched off, a single value is returned (n = 1). In list mode, the total number n of results is equal to the list count (`CONFigure:GPRF:MEAS<i>:POWer:LIST:COUNt?`). Range: 0.0 dB to +78 dB Def. unit: dB

Example See Single Shot and Continuous Power Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Power Measurement Commands.

7.4.4 External Power Sensor Measurement Commands

The commands valid for the External Power Sensor measurement are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Measurement Control and States
- Zeroing
- Statistical Settings
- Sensor Configuration
- Measurement Results

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

Issues of special interest in the context of result retrieval:

`FETCh` and `READ` commands	Both commands can be used to retrieve measurement results: ◆ `FETCh...` returns the results of the current measurement cycle (single shot measurement) after they are valid. `FETCh...` must be used after the measurement has been started (`INITiate...`, measurement states RUN or RDY). ◆ `READ...` starts a new single shot measurement and returns the results. For further information refer to Retrieving Measurement Results.
Current and statistical values	The R&S CMW 500 repeats measurements according to the selected statistic count and repetition mode. Consecutive measurement values are stored and used to calculate statistical results, e.g. average, minimum, maximum and standard deviation. For a description of the statistical methods refer to Statistical Results.

Global Reliability Indicator

The common reliability indicator is the first value in the output arrays of the `FETCh...?` and `READ...?` queries.
e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`
Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement values)
In the present firmware version, the common reliability indicator is always set to zero.

7.4.4.1 Command Groups (External Power Sensor Measurement)

7.4.4.2 Measurement Control and States

The following commands control the measurement and return the current measurement state.

INITiate:GPRF:MEAS<i>:EPSensor
ABORt:GPRF:MEAS<i>:EPSensor
STOP:GPRF:MEAS<i>:EPSensor

Starts, stops, or aborts the measurement; see Measurement Control:

- `INITiate...` starts or restarts the measurement; the R&S CMW 500 enters the "RUN" state.
- `ABORt...` causes a running measurement to stop immediately; the R&S CMW 500 enters the "OFF" state.
- `STOP...` causes a running measurement to stop after the current evaluation period is terminated and valid results are available; the R&S CMW 500 enters the "RDY" state.

Use `FETCh...STATe?` to query the current measurement state.

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00
SCPI: No query

FETCh:GPRF:MEAS<i>:EPSensor:STATe?

Queries the main measurement state; see Measurement Control. Use `FETCh:...:MEAS<i>:...:STATe:ALL?` to query the measurement state including the substates. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State>	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate..., READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00
SCPI: Query only

FETCh:GPRF:MEAS<i>:EPSensor:STATe:ALL?

Queries the main measurement state and the measurement substates. Both measurement substates are relevant for running measurements only. Use `FETCh:...:MEAS<i>:...:STATe?` to query the main measurement state only. Use `INITiate..., STOP..., ABORt...` to change the measurement state.

Returned values:

<Main State>,	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate..., READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF
<Sync State>,	**PEND:** waiting for resource allocation, adjustment, hardware switching ("pending") **ADJ:** all necessary adjustments finished, measurement running ("adjusted") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")
<Resources State>	**QUE:** measurement without resources, no results available ("queued") **ACT:** resources allocated, acquisition of results in progress but not complete ("active") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00
SCPI: Query only

7.4.4.3 Zeroing

The following commands initiate zeroing of the power sensor or read the zeroing state.

CALibration:GPRF:MEAS<i>:EPSensor:ZERO

Initiates zeroing of the power sensor (setting command) or reads the zeroing state. A running external power sensor measurement is interrupted and re-started after the zeroing procedure has been completed.

Zeroing states 'PASS' or 'FAIL' (if the previous zeroing resulted in an error, e.g. because the signal power was not switched off).
Def. value: n/a (the zeroing state is not affected by a *RST)

Example See Zeroing the External Sensor

Characteristics Firmware version V1.00

7.4.4.4 Statistical Settings

The following commands specify the scope of the measurement.

CONFigure:GPRF:MEAS<i>:EPSensor:REPetition <Mode>

Specifies the repetition mode of the measurement; see Statistical Settings. The repetition mode specifies whether the measurement is stopped after a single shot or repeated continuously. Use `CONFigure:..:MEAS<i>:...:SCOunt` to determine the number of measurement intervals per single shot.

<Mode> **SINGleshot**: Single shot measurement
CONTinuous: Continuous measurement
Def. value: SINGleshot

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:EPSensor:SCOunt <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals, i.e. the number of measured power values from the external sensor.
Range: 1 to 1000
Def. value: 10

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:EPSensor:RESolution <Resolution>

Defines the number of digits of the power results in the measurement dialog. This command does not affect the remote control results.

<Resolution> **PD0:** 1 (results rounded to 1 dB)
PD1: 0.1
PD2: 0.01
PD3: 0.001
Def. value: 10

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00

7.4.4.5 Sensor Configuration

The following commands specify external sensor settings.

CONFigure:GPRF:MEAS<i>:EPSensor:FREQuency <Frequency>

Specifies the input frequency at the power sensor.

<Frequency> Range: Depending on sensor model used
Def. value: 800.000000 MHz
Def. unit: MHz

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:EPSensor:ATTenuation:STATe <State>

Enables or disables an external input attenuation at the sensor.

<State> Enable (**ON**) or disable (**OFF**) external attenuation
Def. value: OFF

Example See Performing a Single Shot Measurement

Characteristics Firmware version V1.00

CONFigure:GPRF:MEAS<i>:EPSensor:ATTenuation <Attenuation>

Specifies the external input attenuation factor to correct the power reading at the sensor.

<Attenuation>	Range: –50.00 dB to +50.00 dB Def. value: 0.00 dB Def. unit: dB
Example	See Performing a Single Shot Measurement
Characteristics	Firmware version V1.00

7.4.4.6 Measurement Results

The following commands return the results of the measurement.

FETCh:GPRF:MEAS<i>:EPSensor?
READ:GPRF:MEAS<i>:EPSensor?

Returns statistical evaluation values of the sensor power results, see External Power Sensor: Results.

Returned values

<Reliability>,	Reliability indicator
<Power Current>, <Power Average>, <Power Minimum>, <Power Maximum>,	RF power (single values) Range: depending on power sensor model Def. unit: dBm
<Elapsed Statistics>	Range: 1 to "statistic count" setting (`CONFigure:GPRF:MEAS<i>:EPSensor:SCOunt`)
Example	See Performing a Single Shot Measurement
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to External Power Sensor Measurement Commands.

7.4.5 Alphabetical List of Commands (GPRF)

Command **Page**

8 GSM Applications

The GSM firmware applications provide TX tests on GSM uplink signals. Most of the tests and conformance requirements are specified in the following standard:

- 3GPP TS 51.010-1, Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification.

The R&S CMW 500 provides the following GSM firmware applications:

- GSM Multi-Evaluation Measurement

8.1 GSM TX Measurements

GSM TX measurements determine the power, modulation accuracy, and spectrum of an uplink (UL) GSM signal. All TX measurements are combined in a single measurement:

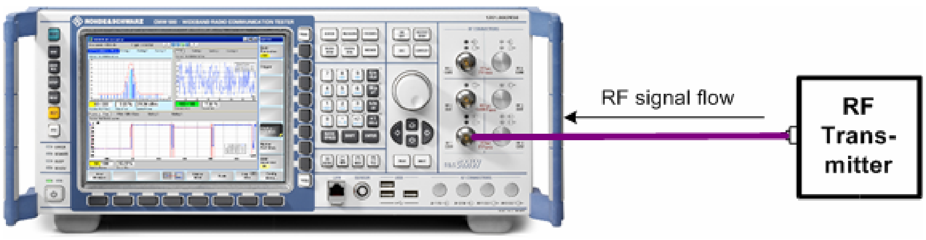
- Multi-evaluation

8.1.1 GSM Multi Evaluation Measurement

The GSM "Multi Evaluation" measurement captures an uplink (UL) GSM signal and provides the TX measurement results over a series of consecutive slots.
The following sections describe how to perform and configure the measurement.

8.1.1.1 Test Setup

The external RF signal source (mobile phone transmitter, signal generator etc.) is connected to one of the RF input connectors RF 1 COM or RF 2 COM at the front panel of the R&S CMW 500. The input level ranges of the connectors are identical; see RF Connectors. No additional cabling and no external trigger is needed.



8.1.1.2 How to Measure a UL GSM Signal

After connecting your GSM mobile phone to the R&S CMW 500 as shown above, you have to adjust the following analyzer settings to the properties of the analyzed UL GSM signal:

- The analyzer "Frequency"
- The "Expected Nominal Power" and (optional) a "User Margin" and "External Attenuation". Recommended values: "Expected Nominal Power" = average power of the UE signal; "User Margin" = + 5 dB (for EDGE bursts).

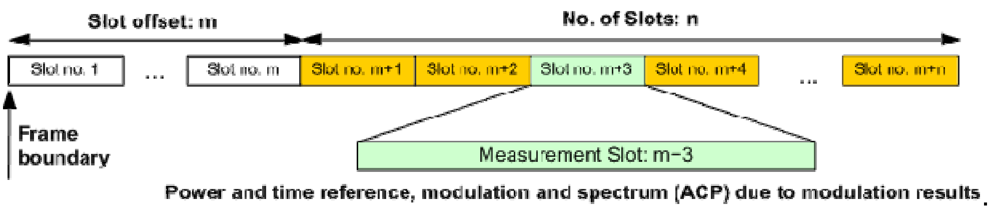
After a preset, the R&S CMW 500 uses an RF power trigger and should be able to synchronize to the incoming bursts and decode the signal.

8.1.1.3 Defining the Scope of the Measurement

The GSM "Multi Evaluation" measurement is a multislot application: The R&S CMW 500 can measure up to 8 consecutive GSM slots (1 frame) and store the power results for all slots.

Within this measurement interval, a single slot ("Measurement Slot") is selected for a more detailed analysis. The measurement slot provides:

- The reference power and time reference (symbol no. 0) for the "Power vs. Time" diagram.
- The results in all modulation and spectrum due to modulation diagrams (the spectrum due to switching results are measured over all slots).
- The statistical results in the detailed views of all modulation and spectrum diagrams.



If the interval of n measured slots is measured repeatedly, the R&S CMW 500 can evaluate the trace and slot statistics in consecutive intervals; see Statistical Settings and GSM Multi Evaluation: Results.

Tip: Burst pattern selection

The measurement provides different mechanisms for detecting and selecting multislot configurations with specific properties. Refer to the application sheets Detecting Multislot Frames and Capturing Burst Sequences.

8.1.1.4 Configuring the Spectrum Measurement

The spectrum measurements are performed in the "Measurement Slot". Compared to the power vs. time and modulation measurements, spectrum measurements depend on the following additional settings:

- The frequency offsets for the spectrum due to modulation and spectrum due to switching measurements in the frequency domain.
- The evaluation area for the spectrum due to modulation measurement and the peak hold mode for spectrum due to switching.
- The frequency offsets for the ACP vs. time measurements.
- The ACP vs. time measurements can slow down the measurement (see below), so they can be enabled separately.

8.1.1.5 Speed Considerations

The following measurement settings provide additional results but can slow down the measurement:

- Evaluation of the ACP vs. time measurements
- Evaluation of the "AM-PM" delay for polar modulators
- Access burst search

The following settings improve the accuracy of the results but require additional processing time:

- Measurement of 8PSK-modulated bursts in "Data Compensated" reference power mode.

8.1.1.6 Trigger Settings

The GSM multi-evaluation measurement can be performed in "Free Run" (untriggered) mode, however, an internal trigger is suitable for most measurement tasks. Note the following trigger source settings:

- With an internal IF power trigger, the measurement is triggered by the power ramp of the received GSM bursts. Use this trigger source for single-slot measurements and for unique events such as the access burst transmitted during the connection setup.
- With an internal acquisition trigger, the R&S CMW 500 analyzes the RF input signal and derives a frame trigger using information about the active slots. Use this trigger source for multislot measurements, in particular those with repeated burst patterns.

Refer also to the application sheet Detecting Multislot Configurations.

8.1.1.7 GSM Multi Evaluation: Results

The results of the GSM multi-evaluation measurement are displayed in several different views. Use the "Display" parameters to select the views and to change the appearance and contents of the views.

Overview

The overview dialog shows the most important RF and analyzer settings; see Signal Routing and Analyzer Settings. Below, up to eight diagrams display the power vs. time, modulation and spectrum (ACP) results.

GSM Multi Evaluation: Overview

The "Overview" dialog contains different types of results:

Power vs. Time

The "Power vs. Time" diagram covers a time interval up to 8 timeslots (1 complete TDMA frame, corresponding to 1260 symbol periods or 4.615 ms). The burst power is displayed with an oversampling factor of 16 (16 samples per symbol period) and normalized to the average burst power in the "Measurement Slot" (0-dB reference). According to the conformance test specification 3GPP TS 51.010-1, the average burst power is defined as the average power of the samples over the 147 useful symbols in each burst.

Error Vector Magnitude, Magnitude Error, and Phase Error

The modulation diagrams cover a time interval of 1 timeslot (the "Measurement Slot"). The traces contain 4 samples/symbol in GMSK and 1 sample/symbol in EDGE.

Spectrum Modulation Frequency, Spectrum Switching Frequency

The spectrum due to modulation results are measured in the "Measurement Slot". The central bar shows the power at the nominal carrier frequency; the symmetric bars to the left and the right show the off-carrier emissions. All spectrum results are measured in a 30 kHz bandwidth. The spectrum due to switching results are acquired in all slots, preferably in peak hold mode.

ACP Modulation Time, ACP Switching Time

The ACP vs. time diagrams are measured in the "Measurement Slot". They show the power vs. time at a selectable offset frequency from the carrier, measured in a 30 KHz bandwidth.

Statistical traces ("Average" "Maximum, "MinMax") are calculated according to the general rules for statistical results.

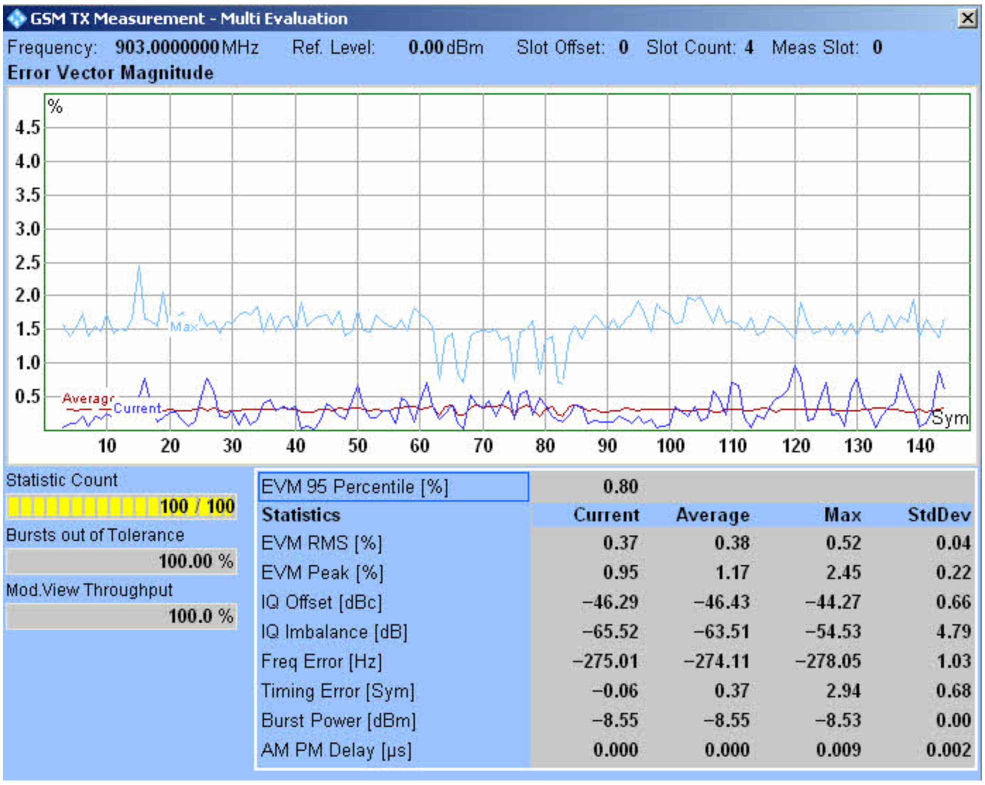
The "Overview" dialogs can be modified as follows:

- Click a diagram to select this diagram. Press ENTER or the rotary knob to open the detailed view for this diagram.
- Press "Display > Trace Select..." to select the trace types to be displayed. Use the scale settings to modify the displayed x-axis (time) or y-axis ranges.
- Use the "Measurement Control" settings in the configuration menu to modify the scope of the measurement, change the "Measurement Slot", and select the offset frequencies for the spectrum diagrams.
- Use the "Filter" settings in the configuration menu to select the filter bandwidth for the power vs. time measurement.

Detailed Views

The detailed views show the most important RF and analyzer settings; see Signal Routing and Analyzer Settings. Below, each of the detailed views shows a diagram and a statistical overview of single-slot results. The GSM multi-evaluation measurement provides eight different detailed views, one for each of the diagrams in the overview dialog. All detailed views except "Power vs. Time" show the results in the "Measurement Slot" which is displayed across the top of the views.

An example (Error Vector Magnitude) is shown below.



EVM 95 Percentile [%]	0.80			
Statistics	**Current**	**Average**	**Max**	**StdDev**
EVM RMS [%]	0.37	0.38	0.52	0.04
EVM Peak [%]	0.95	1.17	2.45	0.22
IQ Offset [dBc]	−46.29	−46.43	−44.27	0.66
IQ Imbalance [dB]	−65.52	−63.51	−54.53	4.79
Freq Error [Hz]	−275.01	−274.11	−278.05	1.03
Timing Error [Sym]	−0.06	0.37	2.94	0.68
Burst Power [dBm]	−8.55	−8.55	−8.53	0.00
AM PM Delay [µs]	0.000	0.000	0.009	0.002

GSM Multi Evaluation: EVM

The following single-slot results appear in all detailed views:

Statistic Count

Progress bar for the measurement. During the first single shot after the start of the measurement, the bar shows the current measurement interval relative to the "Statistic Length" (see Statistical Settings).

Bursts out of Tolerance

Percentage of measurement intervals / bursts that were failed because they exceeded the limits in the diagram.

Mod. View Throughput

Percentage of measurement intervals where the detected burst pattern was found to correspond to the "Modulation View" settings. Only frames which contribute to the "Mod. View Throughput" are displayed, counted, and used for the statistical results; other frames are rejected.

The "Mod. View Throughput" is evaluated in a moving window of 1000 frames. If a non-matching signal configuration is changed according to the "Modulation View" settings, the throughput increases linearly from 0 % to 100 %.

The statistical single-slot results are analogous in all modulation views.

Statistics

Statistical evaluation of the in the measurement slot. The "Statistics" table contains four rows. For each modulation result the values are calculated as follows:

- **95th percentile:** Value of the measured quantity below which 95 % of all observations fall. An EVM 95th percentile of 0.8 indicates that 95 % of all measured EVM results were below 0.8, 5 % equal to or larger than 0.8.
- **Current:** Value of the modulation result obtained in the last measurement interval. For EVM, magnitude and phase error, a current RMS result (the average over all samples in the "Measured Slot" except the guard period) and current peak value (the peak of all samples the preappointed slot except the guard period) is available.
- **Avg.:** Average of all "Current" values referenced to the last statistics cycle.
- **Min./Max.:** Largest or smallest "Current" value that the R&S CMW 500 obtained since the start of the measurement.
- **Std. Dev.:** Standard deviation of all "Current" values since the start of the measurement.

The results in the table are calculated according to the general rules for statistical evaluations.

The timing error is not available for untriggered ("Free Run") measurements.

Results in the "Statistics" table:

The EVM, magnitude error, phase error, I/Q offset and I/Q Imbalance describe the modulation accuracy of the measured uplink GSM signal; see modulation results. The frequency error is determined together with the modulation results. The multi-evaluation measurement provides the following additional quantities:

- **Timing Error:** Difference between the actual timing of the slot and the expected timing. The actual timing is given by the training sequence. The expected timing is derived from the detected frame timing, therefore the "Timing Error" measurement requires an internal trigger (trigger source "IF Power (Internal)" or "Acquisition (Internal)").
- **Bust Power:** Average burst power, evaluated over the useful part of the burst (see standard 3GPP TS 51.010-1).
- **AM PM Delay:** Time delay of the amplitude vs. time trajectory of the baseband modulation vector relative to the phase vs. time trajectory that is need to minimize the modulation errors (EVM). The AM PM delay is a characteristic quantity for polar modulation schemes which make use of polar coordinates (amplitude and phase) rather than Cartesian coordinates (I and Q amplitudes).

The detailed dialogs can be modified as follows:

- Press "Display > Trace Select..." to select the trace types to be displayed. Use the scale settings to modify the displayed x-axis (time) or y-axis ranges.
- Use the "Measurement Control" settings in the configuration menu to modify the scope of the measurement, change the "Measurement Slot", and select the offset frequencies for the spectrum diagrams.
- Use the "Filter" settings in the configuration menu to select the filter bandwidth for

the power vs. time measurement.

8.1.1.8 Conformance Requirements and Limit Settings

Conformance requirements for GSM transmitter tests are specified in standard 3GPP TS 51.010-1, section 13, "Transmitter Characteristics", and in the related specifications quoted therein (in particular 3GPP TS 05.05).
The following sections give an overview of the test requirements and the R&S CMW 500 limit settings.

- Transmit modulation
- Average burst power
- Power templates
- ACP

Transmit Modulation Limits

A poor modulation accuracy of the mobile transmitter increases the transmission errors in the uplink channel of the GSM network. The frequency error and the phase error are the critical quantities to assess the modulation accuracy of a GSM mobile phone.
According to the 3GPP standard, the frequency error, measured at various mobile transmitter output powers and frequencies, shall not exceed 0.1 ppm (0.2 ppm for GSM 400). In addition, the RMS phase error, measured after adjustment for the effect of the frequency error and averaged over all samples in the useful part of the burst, shall not exceed 5 deg. The peak phase error shall not exceed 20 deg. At each channel and mobile output power, the measurement shall be repeated with a statistic length ≥ 20 deg.
The specified limits can be set in the configuration dialog, along with limits for the other measured quantities (for reference information refer to Modulation Limits).

Limits
Modulation
GMSK

	Value		Current	Average	Max
EVM RMS	9.000	%	☑	☑	☑
EVM Peak	30.000	%	☑	☑	☑
EVM 95%	15.000	%		☑	
MErr RMS	12.500	%	☑	☑	☑
MErr Peak	17.700	%	☑	☑	☑
MErr 95%	5.000	%		☑	
PhErr RMS	9.000	°	☑	☑	☑
PhErr Peak	30.000	°	☑	☑	☑
PhErr 95%	15.000	°		☑	
IQ Offset	20.000	dB	☑	☑	☑
IQ Imbalance	20.000	dB	☑	☑	☑
Frequency Error	90.000	Hz	☑	☑	☑
Timing Error	0.000	Sym	☑	☑	☑

The table below lists the test requirements of standard 3GPP TS 51.010-1.

Characteristics	Refer to 3GPP TS 51.010-1, section...	Specified Limit
Frequency Error	13.1 Frequency Error and Phase Error see also: 13.6, 13.16.1	< 0.2 ppm (GSM 400) < 0.1 ppm (all other GSM bands)
Phase Error, RMS	13.1 Frequency Error and Phase Error see also: 13.6, 13.16.1	< 5 deg
Phase Error, peak	13.1 Frequency Error and Phase Error see also: 13.6, 13.16.1	< 20 deg

Avg. Burst Power Limits

Dynamic power control is essential to ensure stable transmission and an efficient radio resource management within the system. Generally speaking, an output power of the mobile transmitter that is too low decreases the coverage area while an excess output power may cause interference to other channels or systems. Both effects decrease the system capacity.

GSM mobile phones are divided into different power classes according to their maximum output power.

Power class	Nominal maximum output power in dBm		
	GSM 400 GSM GT800 GSM 850 GSM900	GSM 1800	GSM 1900
1 2 3 4 5	– 39 37 33 29	30 24 36 – –	30 24 33 – –

GSM power classes

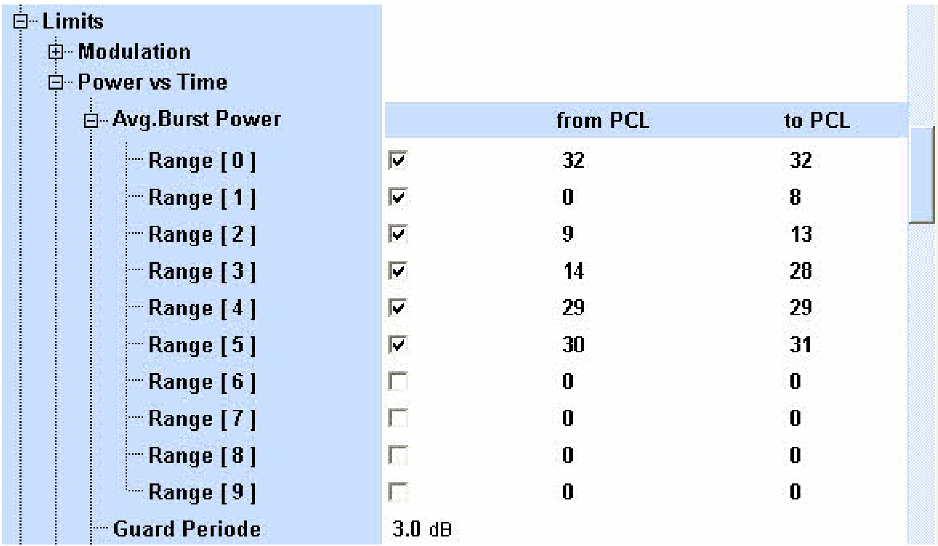
The actual transmitter output power is controlled using the dimensionless Power Control Level (PCL) scale.

Power class	Nominal maximum output power in dBm		
	GSM 400 GSM GT800 GSM 850 GSM900	GSM 1800	GSM 1900
0 1 2 3 4 5 6 7 8 9 10	39 39 39 37 35 33 31 29 27 25 23	30 28 26 24 22 20 18 16 14 12 10	30 28 26 24 22 20 18 16 14 12 10

Power class	Nominal maximum output power in dBm		
11	21	8	8
12	19	6	6
13	17	4	4
14	15	2	2
15	13	0	0
16	11	0	0
17	9	0	0
18	7	0	0
19 to 28	5	0	0
29	5	36	36
30	5	34	34
31	5	32	32

GSM power control levels

According to the GSM standard, the tolerances for the average burst powers, measured at various frequencies,depend on the GSM band and PCL; see tables below. The tolerances are applicable for both normal and access bursts.
The limits can be set in the configuration dialog (for reference information refer to Average Burst Power Limits).



The tables below list the test requirements of standard 3GPP TS 51.010-1, section 13.3. The following tolerances apply to GSM 400, GSMGT800, GSM 800, and GSM900 networks:

Power class				Power control level	Transmitter output power	Tolerances	
2	3	4	5		dBm	normal	extreme
•				2	39	±2 dB	±2,5 dB
•	•			3	37	±3 dB (note)	±4 dB (note)
•	•			4	35	±3 dB	±4 dB
•	•	•		5	33	±3 dB (note)	±4 dB (note)
•	•	•		6	31	±3 dB	±4 dB
•	•	•	•	7	29	±3 dB (note)	±4 dB (note)
•	•	•	•	8	27	±3 dB	±4 dB
•	•	•	•	9	25	±3 dB	±4 dB
•	•	•	•	10	23	±3 dB	±4 dB
•	•	•	•	11	21	±3 dB	±4 dB
•	•	•	•	12	19	±3 dB	±4 dB
•	•	•	•	13	17	±3 dB	±4 dB
•	•	•	•	14	15	±3 dB	±4 dB
•	•	•	•	15	13	±3 dB	±4 dB
•	•	•	•	16	11	±5 dB	±6 dB
•	•	•	•	17	9	±5 dB	±6 dB
•	•	•	•	18	7	±5 dB	±6 dB
•	•	•	•	19	5	±5 dB	±6 dB
NOTE: When the power control level corresponds to the power class of the MS, then the tolerances shall be 2,0 dB under normal test conditions and 2,5 dB under extreme test conditions.							

The following tolerances apply to GSM 1800 networks:

Power class			Power control level	Transmitter output power	Tolerances	
1	2	3		dBm	normal	extreme
		•	29	36	±2,0 dB	±2,5 dB
		•	30	34	±3,0 dB	±4,0 dB
		•	31	32	±3,0 dB	±4,0 dB
•		•	0	30	±3,0 dB (note)	±4 dB (note)
•		•	1	28	±3 dB	±4 dB
•		•	2	26	±3 dB	±4 dB
•	•	•	3	24	±3 dB (note)	±4 dB (note)
•	•	•	4	22	±3 dB	±4 dB
•	•	•	5	20	±3 dB	±4 dB
•	•	•	6	18	±3 dB	±4 dB
•	•	•	7	16	±3 dB	±4 dB
•	•	•	8	14	±3 dB	±4 dB
•	•	•	9	12	±4 dB	±5 dB
•	•	•	10	10	±4 dB	±5 dB
•	•	•	11	8	±4 dB	±5 dB
•	•	•	12	6	±4 dB	±5 dB
•	•	•	13	4	±4 dB	±5 dB
•	•	•	14	2	±5 dB	±6 dB
•	•	•	15	0	±5 dB	±6 dB
NOTE: When the power control level corresponds to the power class of the MS, then the tolerances shall be 2,0 dB under normal test conditions and 2,5 dB under extreme test conditions.						

The following tolerances apply to GSM 1900 networks:

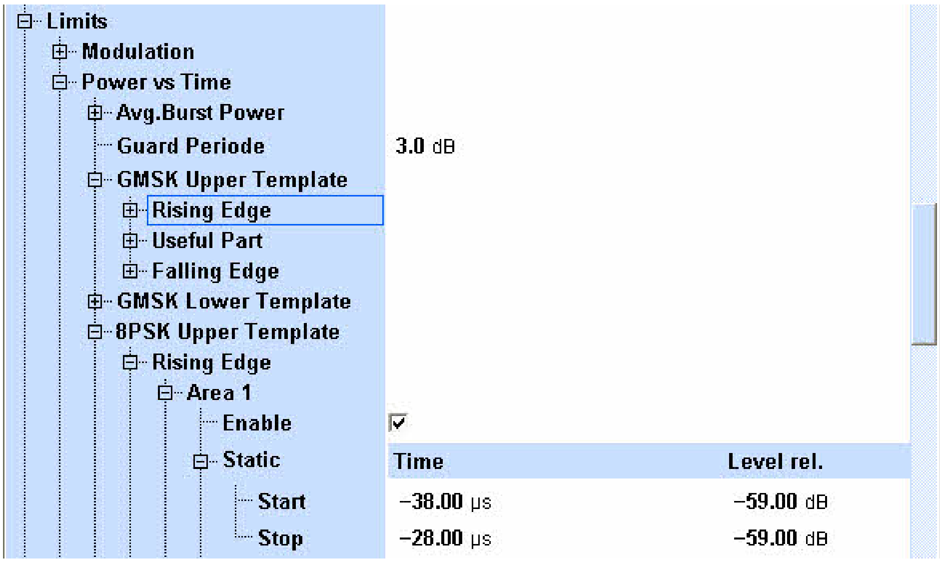
Power class			Power control level	Transmitter output power	Tolerances	
1	2	3		dBm	Normal	Extreme
		•	30	33	±2,0 dB	±2,5 dB
		•	31	32	±2,0 dB	±2,5 dB
•		•	0	30	±3,0 dB (note)	±4 dB (note)
•		•	1	28	±3 dB	±4 dB
•		•	2	26	±3 dB	±4 dB
•	•	•	3	24	±3 dB (note)	±4 dB (note)
•	•	•	4	22	±3 dB	±4 dB
•	•	•	5	20	±3 dB	±4 dB
•	•	•	6	18	±3 dB	±4 dB
•	•	•	7	16	±3 dB	±4 dB
•	•	•	8	14	±3 dB	±4 dB
•	•	•	9	12	±4 dB	±5 dB
•	•	•	10	10	±4 dB	±5 dB
•	•	•	11	8	±4 dB	±5 dB
•	•	•	12	6	±4 dB	±5 dB
•	•	•	13	4	±4 dB	±5 dB
•	•	•	14	2	±5 dB	±6 dB
•	•	•	15	0	±5 dB	±6 dB
NOTE:	When the power control level corresponds to the power class of the MS, then the tolerances shall be 2,0 dB under normal test conditions and 2,5 dB under extreme test conditions.					

In multislot operation, a reduction of the maximum transmitter output power is allowed; see standard 3GPP TS 51.010-1, sections 13.7 and 13.16.2. Moreover, during the guard periods between any two active timeslots, the power must not be larger than 3 dB above the nominal burst power (dBc value); see also multislot power template below.

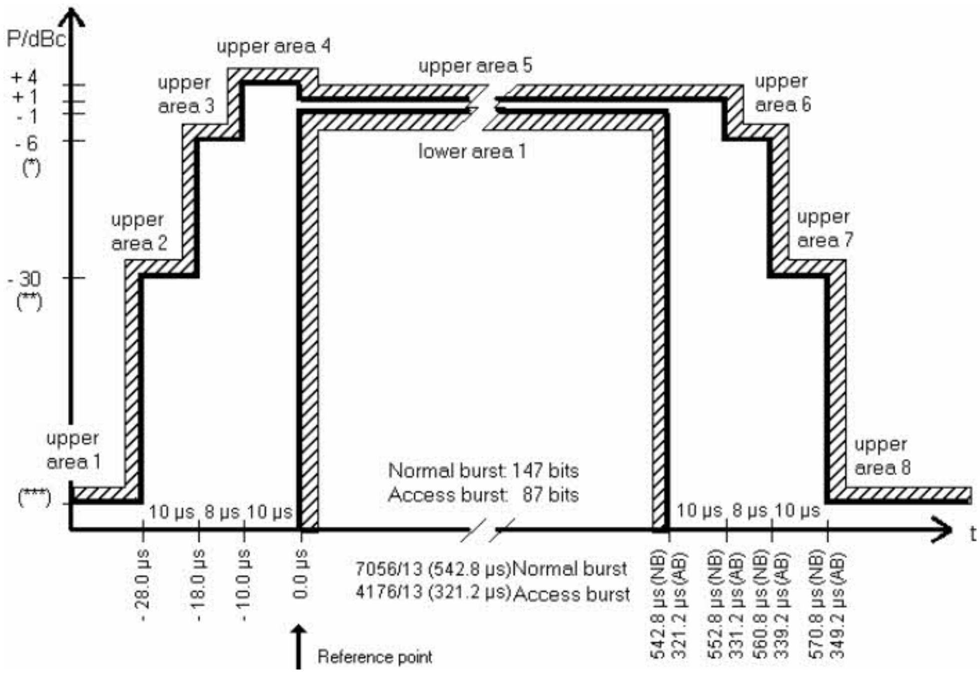
Power Templates

The GSM power templates specify the dynamic structure (power/time relationship) of the transmitted GSM bursts in single-slot and multislot operation. The burst is subdivided into different time intervals (areas) with specified upper and lower transmitter output power. The entire power template is defined relative to the average burst power, however, some the burst edges are PCL-dependent. Power templates and average burst power limits complement each other.

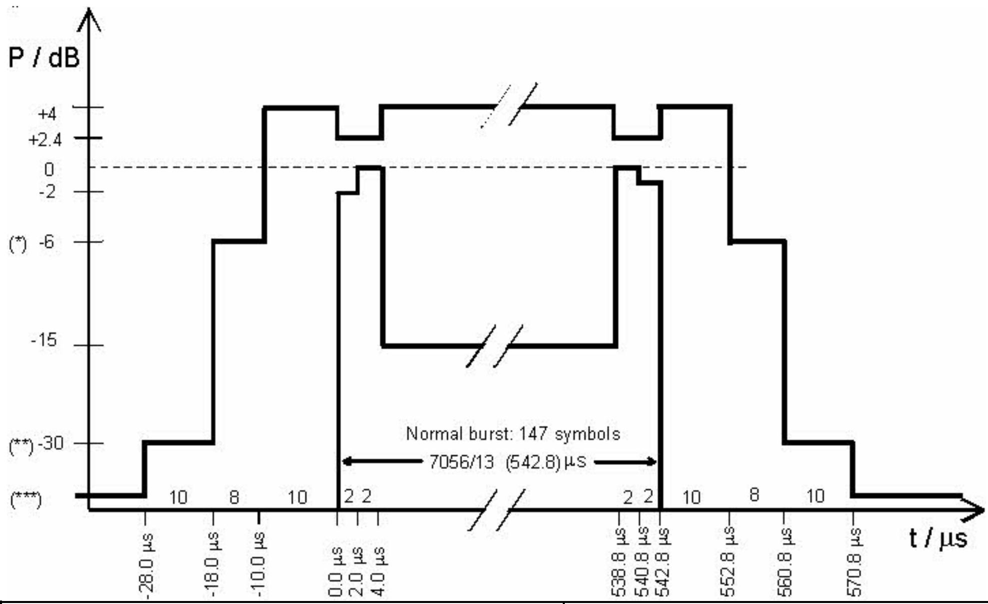
The power templates depend on the modulation scheme of the burst; they can be set in the configuration dialog (for reference information refer to Power Templates).



The figures below show the test requirements of standard 3GPP TS 51.010-1, section 13.3. The following tolerances apply to GPSK-modulated bursts (see legend below the 8PSK template below):

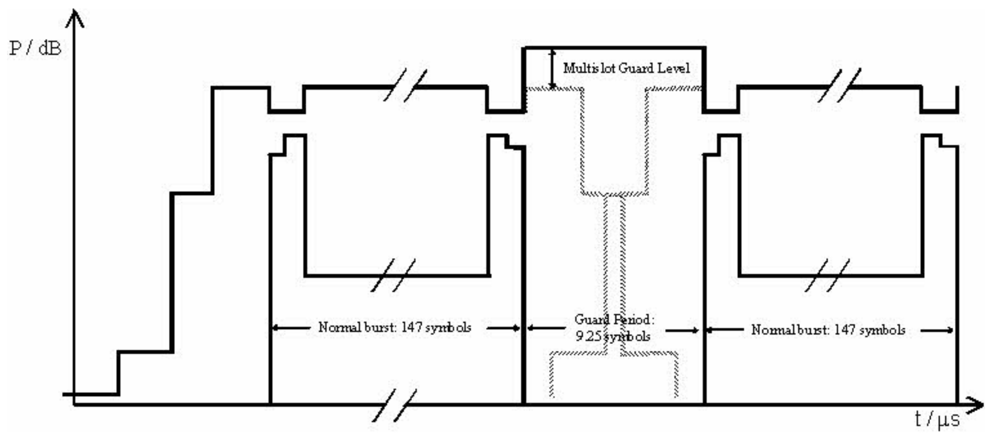


The following tolerances apply to 8PSK-modulated (EDGE) bursts:



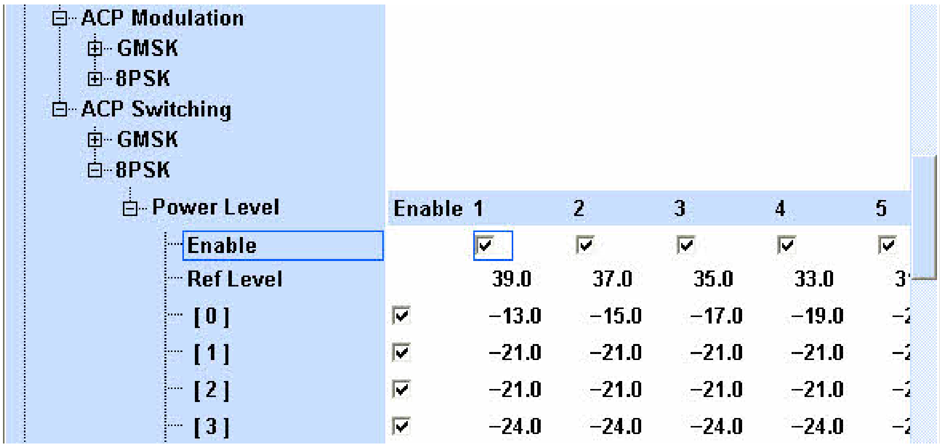
GSM400/GT800/850/900-MS	GSM1800/1900-MS
(*) –4.0 dBc for power control level (PCL) 16 2.0 dBc for PCL 17 –1.0 dBc for PCL 18 and 19	–4.0 dBc for PCL 11 –2.0 dBc for PCL 12 –1.0 dBc for PCL 13, 14, and 15
(**) –30.0 dBc or –17.0 dBm (higher value)	–30.0 dBc or –20.0 dBm (higher value)
(***) –59.0 dBc or –36.0 dBm (higher value)	–48 dBc or 48 dBm (higher value)

According to standard 3GPP TS 51.010-1, sections 13.7 and 13.16.2, the power/time template for multislot configurations coincides with the template for a single GSM burst except in the guard period between every two consecutive active timeslots, where the output power shall not exceed the level allowed for the useful part of the first timeslot or the level allowed for the useful part of the second timeslot plus a multislot guard level of 3 dB, whichever is the highest. The template for two consecutive 8PSK modulated timeslots with the same output power is shown below.



ACP Limits

The energy that spills outside the designated radio channel increases the interference with adjacent channels and decreases the system capacity. According to the conformance test specification 3GPP TS 51.010-1, the amount of unwanted off-carrier energy is assessed by the spectrum due to modulation and the spectrum due to switching (the "ACP modulation" and "ACP switching" results of the multi-evaluation measurement). The ACP limits are defined in the configuration menu.



The GSM limit specifications are equal for GMSK and 8PSK modulation, however, the limits can be chosen independently on the R&S CMW 500.

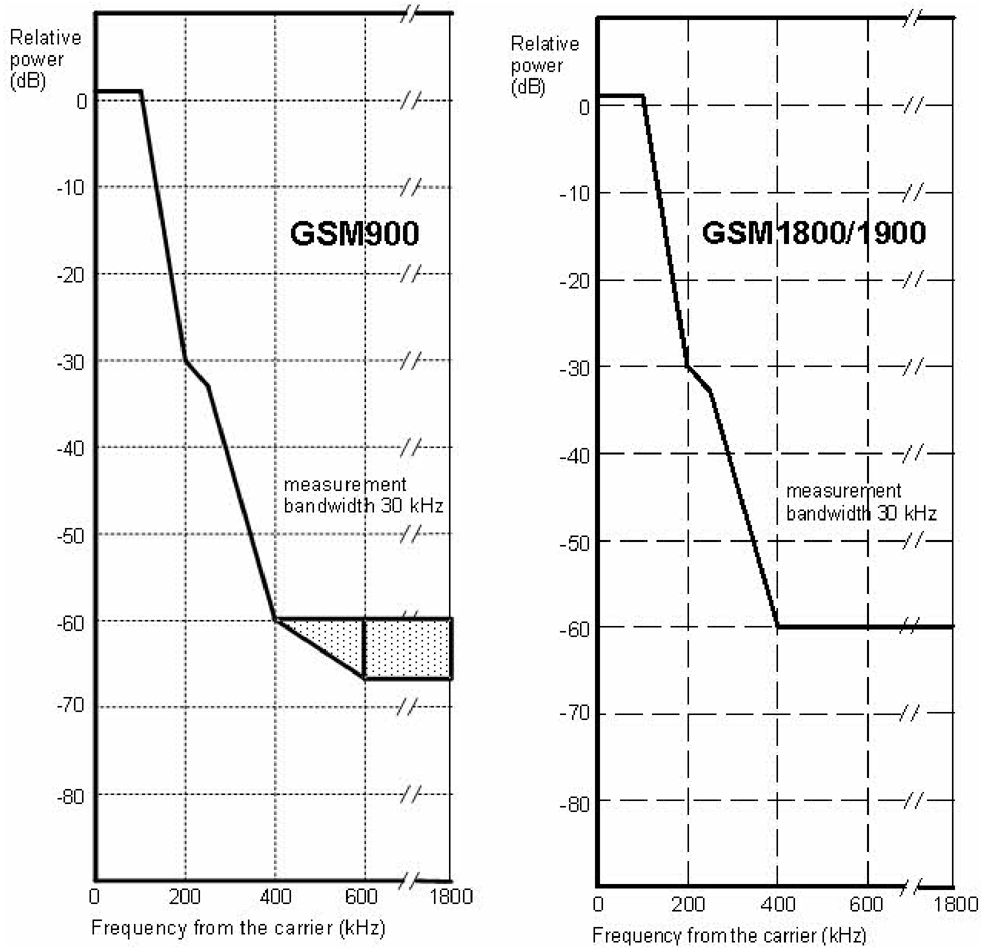
ACP Modulation Limits

The limit lines for the spectrum due to modulation depend on the GSM band, the frequency, and (for frequencies that differ from the carrier frequency by more than 400 kHz) on the output power of the mobile station. The following values apply up to a frequency offset of 1.8 MHz:

	GSM400/GT800/850/900 Relative power at MS output power		GSM1800/1900 Relative power at MS output power	
Frequency offset / [MHz]	≤ 33 dBm (in dBc)	≥ 39 dBm (in dBc)	≤ 24 dBm (in dBc)	≥ 36 dBm (in dBc)
0.1	+0.5	+0.5	+0.5	+0.5
0.2	–30	–30	–30	–30
0.25	–33	–33	–33	–33
0.4	–60 (GMSK mod.) –54 (8PSK mod.)	–60	–60 (GMSK mod.) –54/–60 (8PSK mod.)*)	–60
≥ 0.6, ≤ 1.8	–60	–66	–60	–60

*) For equipment supporting 8PSK, the limit of –54 dBc applies to MS output powers up to +30 dBm, –60 dBm to MS output powers above +30 dBm.

In the frequency range above 400 kHz from the carrier and for output powers between 33 dBm and 39 dBm (GSM400/GT800/850/900), the limit depends linearly on the output power. The resulting spectral mask for GMSK modulation is shown below.



Spectral mask for the spectrum due to modulation

As an alternative to the relative limit values quoted above, the standard specifies the following absolute limits, again depending on the frequency offset from the carrier and the GSM band. If the relative limits are below the absolute limits, the latter shall be applied.

Frequency offset / [MHz]	Absolute power, GSM400/GT800/850/900	Absolute power, GSM1800/1900
< 0.6	–36 dBm	–36 dBm
≥0.6, <1.8	–51 dBm	–56 dBm
≥1.8	–46 dBm	–51 dBm

ACP Switching Limits

The limit lines for the spectrum due to switching cover offset frequencies between 0.4 and 1.8 MHz. They depend on the output power of the mobile station. The following limits are specified in standard 3GPP TS 51.010. Note that the figures allow for superimposed contributions from the modulation spectrum (measured in peak hold mode), especially at higher power levels.

GSM 400 / GT 800 / GSM850 / GSM900	**Maximum MS level measured (peak hold) / [dBm]**

	at frequency offset			
MS power / [dBm]	0.4 MHz	0.6 MHz	1.2 MHz	1.8 MHz
+39	–13	–21	–21	–24
+37	–15	–21	–21	–24
+35	–17	–21	–21	–24
+33	–19	–21	–21	–24
+31	–21	–23	–23	–26
+29	–23	–25	–25	–28
+27	–23	–26	–27	–30
+25	–23	–26	–29	–32
+23	–23	–26	–31	–34
≤21	–23	–26	–32	–36

GSM 1800	**Maximum MS level measured (peak hold) / [dBm] at frequency offset**			
MS power / [dBm]	0.4 MHz	0.6 MHz	1.2 MHz	1.8 MHz
+36	–16	–21	–21	–24
+34	–18	–21	–21	–24
+32	–20	–22	–22	–25
+30	–22	–24	–24	–27
+28	–23	–25	–26	–29
+26	–23	–26	–28	–31
+24	–23	–26	–30	–33
+22	–23	–26	–31	–35
≤20	–23	–26	–32	–36

GSM 1900	**Maximum MS level measured (peak hold) / [dBm] at frequency offset**			
MS power / [dBm]	0.4 MHz	0.6 MHz	1.2 MHz	1.8 MHz
+33	–19	–22	–22	–25
+32	–20	–22	–22	–25
+30	–22	–24	–24	–27
+28	–23	–25	–26	–29
+26	–23	–26	–28	–31

+24	–23	–26	–30	–33
+22	–23	–26	–31	–35
≤20	–23	–26	–32	–36

8.1.1.9 Detecting GSM Multislot Frames

This application sheet describes the use of the R&S CMW 500 trigger system for detecting and measuring GSM frames filled with a particular burst sequence. With appropriate trigger settings the R&S CMW 500 can filter frames with the following properties:

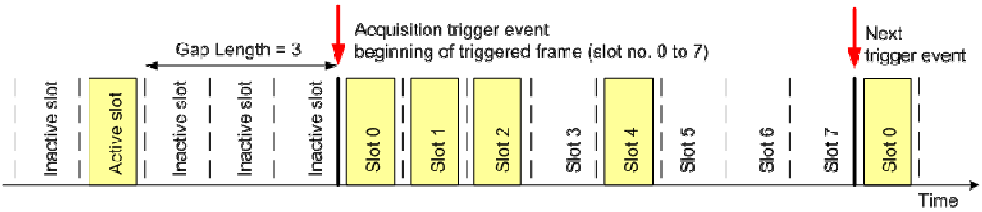
- Frames with several active timeslots but with 1 to 3 slot gap.
- Frames with a particular pattern of inactive bursts and bursts of a definite modulation scheme.

Measurement Principle

With an active "Acquisition" trigger, the R&S CMW 500 analyzes the RF input signal and derives a frame trigger using information about the active slots. After frame detection, the acquisition trigger events are repeated periodically according to the GSM frame clock. TSC detection is performed continuously in order to compensate for a possible drift. Two different acquisition trigger modes – "Gap" and "Pattern" – are available.

Gap Trigger

In the gap trigger mode the R&S CMW 500 searches for a gap in the sequence of active slots. A gap is a series of 1 to 3 inactive slots. The trigger event is generated at the beginning of the first slot after the gap and is repeated periodically.

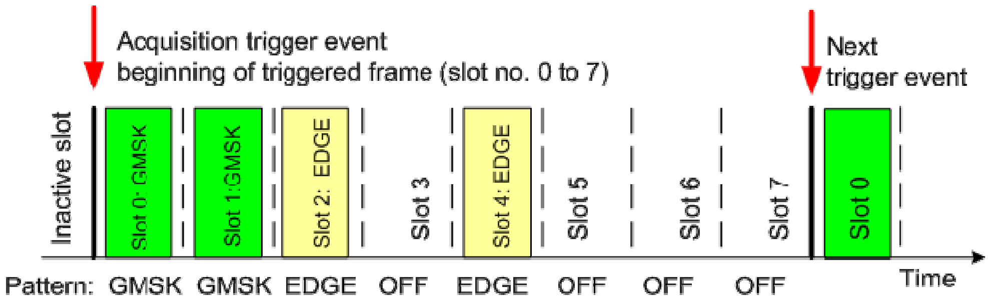


To use the gap trigger as shown above,

1. Feed the GSM uplink signal to the input connector and perform the necessary analyzer settings.
2. Open the "GSM Measurement – Multi Evaluation Configuration" menu.
3. Select "Trigger > Trigger Source: Acquisition (Internal)", "Trigger > Acquisition > Mode: Gap", "Trigger > Acquisition > Gap Length: 3".
4. Start the GSM Multi Evaluation measurement and observe the triggered frames in the "Power vs. Time" diagram.

Pattern Trigger

In the pattern trigger mode the R&S CMW 500analyzes the modulation scheme of the received bursts and searches for a predefined burst pattern. The trigger events are generated at the beginning of the pattern and repeated according to the GSM frame clock, even though the true burst pattern may have changed.



To use the pattern trigger as shown above,

1. Feed the GSM uplink signal to the input connector and perform the necessary analyzer settings.
2. Open the "GSM Measurement – Multi Evaluation Configuration" menu.
3. Select "Trigger > Trigger Source: Acquisition (Internal)", "Trigger > Acquisition > Mode: Pattern", "Trigger > Acquisition > Pattern: GMSK GMSK EDGE OFF EDGE OFF OFF OFF".
4. Start the GSM Multi Evaluation measurement and observe the triggered frames in the "Power vs. Time" diagram.

Possible Extensions

You can use various other multi configuration settings for fine-tuning your measurement:

- Select a suitable "Trigger Delay" to delay the trigger events (and thus the start of the measurement) relative to the detected frame boundaries. This is advantageous in gap trigger mode, if the gap is not located at the end of the frame.
- Use the "Modulation View" pattern to measure only burst sequences with a particular burst type and modulation scheme. This can be advantageous in combination with a gap trigger or in combination with a pattern trigger, especially if the burst sequence is not strictly periodic. See "Capturing GSM Burst Sequences" on page 220.

8.1.1.10 Capturing GSM Burst Sequences

This application sheet describes the use of the R&S CMW 500 "Modulation View" settings for capturing GSM frames filled with a particular burst sequence. The R&S CMW 500 can detect and filter GMSK, EDGE and access bursts.

Appropriate "Modulation View" settings are essential for measuring frames with burst sequences that the mobile transmits only occasionally, e.g:

- SACCH frames and idle frames that the mobile transmits with a periodicity of 26 frames.

- The periodic access bursts that the mobile may use during packet data connections in order to transmit its CTRK_ACK messages.

If no filter condition is specified ("Modulation View: Any"), the R&S CMW 500 measures any burst sequence. Varying burst types during the measurement will cause inconsistent statistical results.

Measurement Principle

Capturing a particular burst sequence requires two steps:

1. The R&S CMW 500 determines the frame structure of the measured signal (slot nos. 0 to 7), most conveniently using a gap or pattern trigger. See "Detecting GSM Multislot Frames" on page 219. After this step, the GSM multi-evaluation measurement is frame-aligned; it is continued irrespective of the actual burst pattern in the measured frames.
2. Use the "Modulation View" settings to filter frames with a definite burst pattern, rejecting all other frames.

Trigger and "Modulation View" settings

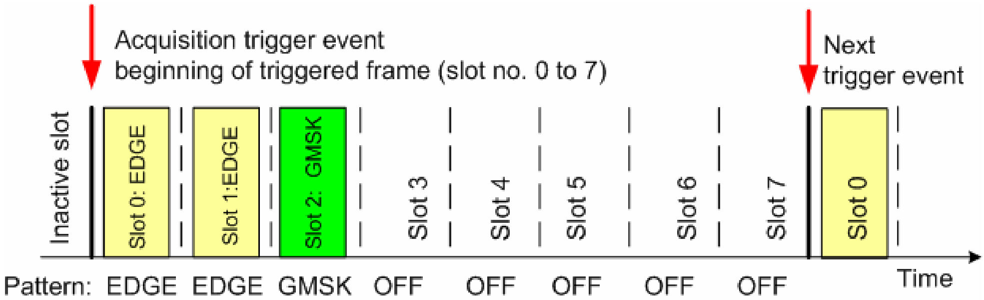
The acquisition trigger and modulation view settings are completely independent of each other. It is possible to specify the same burst pattern for the pattern trigger and the modulation view. However, it is also possible to use different settings, e.g. in order to pin down the frame boundary using the predominant burst pattern and then measure a different, occasionally transmitted burst pattern.

Example: Two EDGE bursts and one access burst

The mobile transmits two EDGE bursts in slots 0 and 1, followed by a GMSK-modulated burst in slot 2. Suppose that the GMSK-modulated burst is occasionally replaced by an access burst.

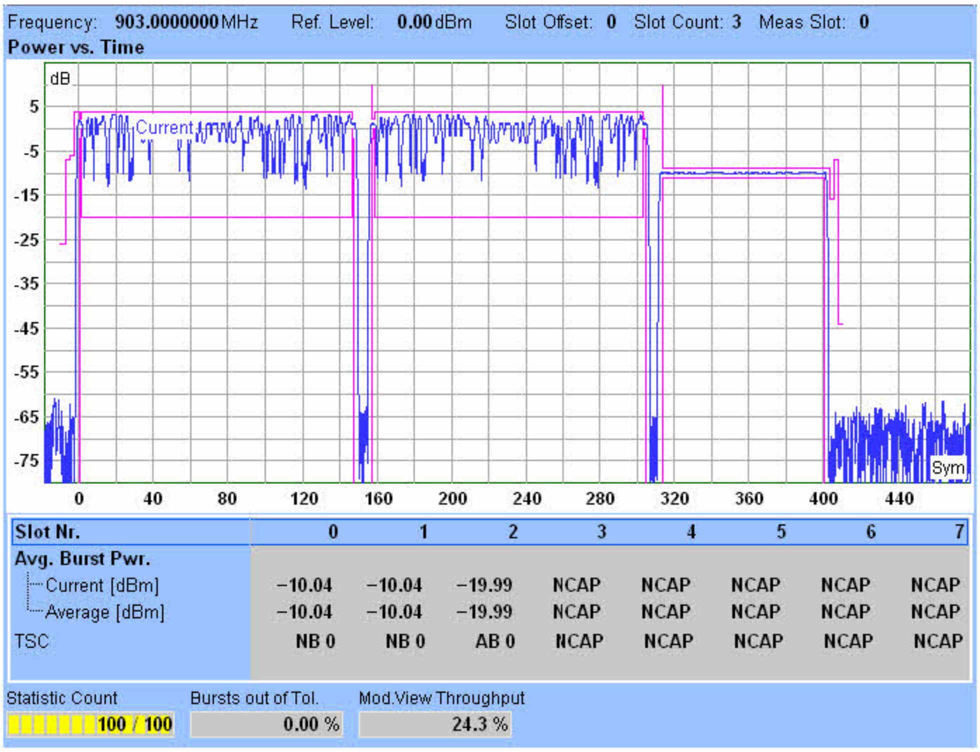
To detect the frame boundary and measure the access burst frames, proceed as follows:

1. Feed the GSM uplink signal to the input connector and perform the necessary analyzer settings.
2. Open the "GSM Measurement – Multi Evaluation Configuration" menu.
3. Select "Trigger > Trigger Source: Acquisition (Internal)", "Trigger > Acquisition > Mode: Pattern", "Trigger > Acquisition > Pattern: EDGE EDGE GMSK OFF OFF OFF OFF OFF".



4. Activate the access burst search: "Measurement Control > Access Burst Search: On".
5. Select "Measurement Control > Modulation View > Setting: EDGE EDGE Access OFF OFF OFF OFF OFF".

6. Start the GSM Multi Evaluation measurement and observe the triggered frames in the "Power vs. Time" diagram.



Mod. View Throughput

The "Modulation View Throughput" result across the bottom of the diagram denotes the number of captured frames which fulfilled the "Modulation View" conditions (matching frames). In the example above, about 1/4 of the frames were matching frames. The remaining frames were not considered for the measurement. Depending on the periodicity of the matching frames and the duration of the measurement intervals, the "Modulation View Throughput" can vary around the expected value.

Possible Extensions

You can use various other multi configuration settings for fine-tuning your measurement and improving the accuracy:

- When measuring EDGE bursts, select the data compensated "Reference Power Mode" in order to increase the accuracy of the burst power results.

8.2 GSM GUI Reference

The following sections provide detailed reference information on the parameters of the GSM application. The R&S CMW 500 provides the following GSM measurements:

- Multi Evaluation

8.2.1 GSM Multi Evaluation: Parameters and Settings

The GSM multi-evaluation measurement is configured using the following groups of settings:

- Measurement Control
- Signal Routing and Analyzer Settings
- Measurement Control Settings
- Trigger
- Limits
- Display
- Filter

The most important measurement settings are also displayed in the measurement dialog.

The measurement dialog provides all Measurement Results.

8.2.1.1 Measurement Control

The measurement is turned on or off using the "Multi Evaluation" measurement control softkey and the ON | OFF or RESTART | STOP front panel keys.

Multi Evaluation (Softkey)

Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via remote control.

GPIB command:

`INITiate:GSM:MEASurement<i>:MEValuation` etc.

`FETCh:GSM:MEASurement<i>:MEValuation:STATe?`

`FETCh:GSM:MEASurement<i>:MEValuation:STATe:ALL?`

8.2.1.2 Signal Routing and Analyzer Settings

The measurement is configured using the parameters in the "Multi Evaluation Configuration" dialog. The following parameters configure the RF input path.

Multi evaluation configuration: Signal routing and analyzer settings

RF Routing

Selects the input connector for the measured RF signal; see connector selection.
GPIB command:
`ROUTe:GSM:MEASurement<i>:RFSettings:CONNector`

External Attenuation (Input)

Defines the value of an external attenuation (or gain, if the value is negative) in the input path.
The external attenuation also enters into the internal calculation of the maximum input power that the R&S CMW 500 can measure (see "Expected Nominal Power" below).
GPIB
command:`CONFigure:GSM:MEASurement<i>:RFSettings:EATTenuation`

Frequency

Center frequency of the RF analyzer. Set this frequency to the frequency of the measured RF signal to obtain a meaningful measurement result.
GPIB command: `CONFigure:GSM:MEASurement<i>:RFSettings:FREQuency`

Expected Nominal Power

Defines the nominal power of the RF signal to be measured. The nominal power is the average output power at the DUT during the measurement intervals where the RF transmitter is on. The "Ref. Level" is calculated as the expected peak power at the output of the DUT:
Reference power = Expected Nominal Power + User Margin

Maximum input power

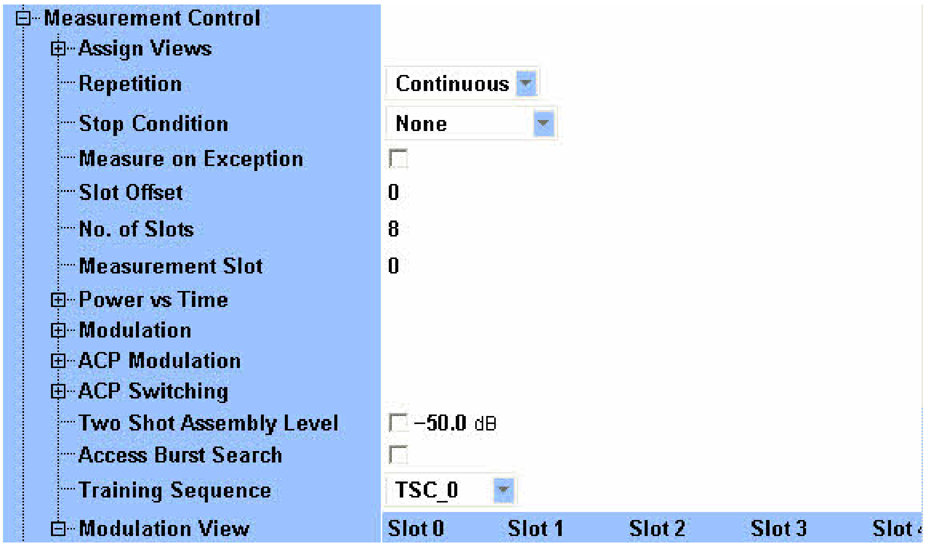
The actual input power at the connectors (i.e. the "Reference Level" minus the "External Attenuation (Input)" value, if all power settings are configured correctly) must be within the level range of the selected RF input connector; refer to the "Specifications".

GPIB command: `CONFigure:GSM:MEASurement<i>:RFSettings:ENPower`

User Margin
Margin that the R&S CMW 500 adds to the "Expected Nominal Power" in order to determine its reference power; see above. The "User Margin" is typically used to account for the known variations of the RF input signal power, e.g. the variations due to a specific channel configuration.
The appropriate values depend on the configuration of the UL GSM signal, e.g. on the modulation scheme. It is small for GMSK-modulated bursts because GMSK is a constant-envelope modulation scheme. For EDGE bursts, a user margin of approx. 5 dB is sufficient.
GPIB command: CONFigure:GSM:MEASurement<i>:RFSettings:UMARgin

8.2.1.3 GSM Multi Evaluation Configuration: Measurement Control

The "Measurement Control" parameters configure the scope of the measurement.



Multi evaluation configuration: scope

Assign Views
Selects the view types to be displayed in the overview dialog. The R&S CMW 500 does not evaluate the results for disabled views. Therefore, limiting the number of assigned views (in particular by disabling the "ACP ... Time" views) can speed up the measurement.
GPIB command:
CONFigure:GSM:MEASurement<i>:MEValuation:RESult:PVTime etc.

Repetition
Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.

- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:REPetition`

Stop Condition

Specifies the conditions for an early termination of the measurement.

None The measurement is performed according to its "Repetition" mode and "Statistic Length" (see Statistical Settings), irrespective of the limit check results.

On Limit Failure The measurement is stopped as soon as one of the limits is exceeded, irrespective of the repetition mode set. If no limit failure occurs, it is performed according to its "Repetition" mode and "Statistic Length". Use this setting for measurements that are essentially intended for checking limits, e.g. production tests.

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:SCONdition`

Measure on Exception

Specifies whether measurement results that the R&S CMW 500 identifies as faulty or inaccurate are rejected. A faulty result occurs e.g. when an overload is detected. In remote control, the cause of the error is indicated by the reliability indicator.

Off Faulty results are rejected. The measurement is continued; the statistical counters are not re-set. Use this mode to ensure that a single faulty result does not affect the entire measurement.

On Results are never rejected. Use this mode e.g. for development purposes, if you want to analyze the reason for occasional wrong transmissions.

GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:MOEXception`

Slot Offset

Specifies the start of the measurement interval (measured multislot range) relative to the GSM frame boundary, detected with an internal trigger ("IF Power (Internal)" or "Acquisition (Internal)"); see Defining the Scope of the Measurement.

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:MSLots`

No. of Slots

Specifies the number of slots to be measured and displayed in the different power and modulation views; see Defining the Scope of the Measurement. The R&S CMW 500 can measure between 1 and 8 consecutive slots (1 GSM frame).

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:MSLots`

Measurement Slot

Selects the slot to be used for the modulation and spectrum due to modulation measurement; see Defining the Scope of the Measurement. The measurement slot must be part of the measured multislot range, therefore:

Slot Offset ≤ Measurement Slot ≤ Slot Offset + No. of Slots – 1

The measurement slot should be active in multislot configurations, because it provides the 0-dB reference is the "Power vs. Time" diagram.

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:MSLots`

Power vs. Time – Statistic Length
Modulation – Statistic Length
ACP Modulation – Statistic Length
ACP Switching – Statistic Length

Defines the number of measurement intervals per measurement cycle (single shot measurement); see Statistical Settings. This value is also relevant for continuous measurements, because the averaging procedures depend on the statistic count; see Statistical Results.

In the GSM multi-evaluation measurement, the measurement interval is completed when the R&S CMW 500 has measured the full slot sequence ("No. of Slots"). The measurement provides independent statistic lengths for the power, modulation and spectrum results. In single shot mode and with shorter ACP statistic lengths, the ACP evaluation is stopped while the R&S CMW 500 still continues providing new power and modulation results.

GPIB command:

```
CONFigure:GSM:MEASurement<i>:MEValuation:SCOunt:PVTime
CONFigure:GSM:MEASurement<i>:MEValuation:SCOunt:MODulation
CONFigure:GSM:MEASurement<i>:MEValuation:SCOunt:SMODulation
CONFigure:GSM:MEASurement<i>:MEValuation:SCOunt:SSWitching
```

Power vs. Time – Evaluate Power vs. Time
Modulation – Evaluate...
ACP Modulation – Evaluate ACP Modulation
ACP Switching – Evaluate ACP Switching

Indicates which of the power, modulation, and ACP results are evaluated and displayed in the overview dialog, depending on the settings in the "Assign Views" section.

GPIB command:

`CONFigure:GSM:MEASurement<i>:MEValuation:RESult:PVTime?` etc.

Power vs. Time – Reference Power Mode

Determines how the reference power, i.e. the 0-dB line in the "Power vs. Time" measurement diagram, and the "(Average) Burst Power" is calculated for 8PSK-modulated (EDGE) bursts where the amplitude of the modulated carrier varies with the transmitted data. The setting is not valid for slots containing GMSK-modulated bursts.

Current	The current power is calculated for each measured EDGE burst, based on the actual, data-dependent power in the useful part of the burst. Reference powers for the "Average", "Minimum", and "Maximum" curves are calculated from the "Current" results according to the general rules for statistical results. Use this mode for fast measurements on bursts containing random data.
Average	The reference power is equal to the average power of the "Average" measurement curve, irrespective of the selected statistical curve. Regular transmitted bit patterns (e.g. an all zero sequence) result in a systematic deviation between the "Average" and the "Data Compensated" powers. Use this mode for measurements on bursts containing random data.
Data Compensated	The current power is calculated as the long-term average for random data; see below. Reference powers for the "Average", "Minimum", and "Maximum" curves are calculated from the "Current" results according to the general statistical rules. The reference power and "(Average) Burst Power" no longer depends on the transmitted data. Data compensated mode can slow down the measurement. Use this mode for accurate power measurements, especially if a non-random bit pattern is transmitted.

Data compensation

The amplitude of an 8PSK-modulated RF signal varies with the transmitted data. The transmitter output power of a mobile phone is defined as the long term average of the power for random data. This long time average (rather than the average power of the current burst) also represents the correct reference power (0-dB line) for the "Power vs. Time" measurement on 8PSK-modulated bursts.

In the "Data Compensated" mode, each burst is demodulated in order to estimate a correction for the measured average power. As a consequence, all busts are displayed with their correct power, irrespective of the transmitted data.

Example 1: Regular burst pattern

A regular burst sequence consisting of all zeros is transmitted. The "Current" and "Average" power results are approximately equal; the correct "Data Compensated" result is manifestly different. At constant MS power, the power variations from one measurement interval to the next are small, irrespective of the reference power mode.

Example 2: Pseudo-random burst patterns
A pseudo-random burst sequence is transmitted. The power in "Current" mode varies from one measurement interval to the next around the long-term average. The power in "Average" mode tends towards the long-term average; it becomes more and more stable as more bursts are averaged. Again, the "Data Compensated" mode provides stable and correct results from the first measurement interval.
GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:RPMode`

ACP Modulation – Frequency Offsets
ACP Switching – Frequency Offsets
Enables the ACP measurement at up to 20 offsets from the analyzer frequency (to be set to the nominal carrier frequency of the measured UL GSM signal). Each enabled frequency offset corresponds to a symmetric pair of bars in the "Spectrum Modulation Frequency" and "Spectrum Switching Frequency" diagrams.
The frequency offsets can be set to arbitrary values between 0 MHz and 3 MHz. The default configuration corresponds to the conformance test specification 3GPP TS 51.010-1 with 11 enabled frequency offsets for the "ACP Modulation" measurement and 4 enabled offsets for the "ACP Switching" measurement.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:SMODulation:FOFFsets`
`CONFigure:GSM:MEASurement<i>:MEValuation:SSWitching:FOFFsets`

ACP Modulation – Evaluation Areas
Enables and configures two time intervals (areas) that are used for the "ACP Modulation" measurement; see Configuring the Spectrum Measurement. The purpose of the evaluation areas is to "gate" the spectrum in accordance with the test specification 3GPP TS 51.010-1: Only the symbols in the enabled areas contribute to the displayed "Spectrum due to Modulation".
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:SMODulation:EARea`

ACP Modulation – Time Domain @ Frequency
ACP Switching – Time Domain @ Frequency
Defines an offset frequency for the "ACP Mod. Time" diagram. The diagram shows the measured power vs. time at the selected offset frequency; see Measurement Results.
The numbers 1 to 20 select the negative frequency offsets from the "Frequency Offsets" list, numbers 21 to 40 select the positive frequency offsets.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:SMODulation:TDFSelect`
`CONFigure:GSM:MEASurement<i>:MEValuation:SSWitching:TDFSelect`

ACP Switching – Peak Hold Mode

Specifies whether peak hold mode is used for the "Spectrum Switching" results in frequency domain (bar graphs) and in time domain. Peak hold mode means that the R&S CMW 500 displays the largest values obtained since the start of the measurement. The old results are only cleared when a new measurement is started.
In the alternative setting, the frequency domain diagram shows the largest values in the current measurement cycle (peak hold mode per statistics cycle), the time domain diagram shows current results (peak hold mode disabled). The "Statistic Length" is limited to 100 in this mode.
Peak hold mode is in accordance with the test procedure described in the conformance test specification.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:SSWitching:PHMode`

Access Burst Search

Enables or disable access burst search for all GMSK-modulated bursts. With enabled access burst search, the R&S CMW 500 can measure normal and access bursts in one multislot range.
The detection of access bursts is based on the three training sequences for access bursts specified in the GSM standard. The "Training Sequence" setting has no impact on the access burst search. The transmission of access bursts is part of the connection setup procedure. Moreover, a mobile in packet data mode can use periodic access bursts for the transmission of CONTROL_ACK_TYPE messages.
The access burst search is time-consuming because the R&S CMW 500 has to search for one out of three possible training sequences within a relatively wide time interval.
GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:ABSearch`

Training Sequence

Selects the training sequence of the analyzed bursts: With a specific training sequence setting, the R&S CMW 500 will analyze bursts with this training sequence only. The setting has no impact on the access burst search.

TSC 0 to TSC 7	One of the 8 26-bit training sequences defined in the GSM standard
Dummy	GSM-specific dummy burst
TSC Any	Search for any of the training sequences TSC 0 to TSC 7; use the detected training sequence for synchronization.
Off	Do not decode the training sequence, measure any burst. This mode is appropriate for a rough analysis only because the R&S CMW 500 cannot use the training sequence for synchronization and for compensation of a time drift.

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:TSEQuence`

Modulation View

Defines the expected modulation scheme and burst type in all measured timeslots and adjusts the power vs. time template. The modulation view settings act as a filter for the triggered GSM frames: To obtain a valid measurement result, the actual modulation scheme and burst type in all measured slots must be compatible with the "Modulation View" settings. Incompatible frames are rejected. For application examples See "Detecting GSM Multislot Frames" on page 219.

GMSK GMSK modulation and normal bursts expected; the GMSK template is used.

EDGE 8PSK modulation and normal bursts expected; the EDGE template is used.

Access Access bursts expected; the template for access bursts is used. The access burst search must be active for this setting.

Any Arbitrary modulation scheme and burst type; the R&S CMW 500 determines the modulation of the measured burst and uses the appropriate template. Valid results are obtained with both GMSK and 8PSK (EDGE) modulation.

Off No signal expected: timeslot must be inactive to obtain a valid result.

Varying burst types

If the burst type or modulation scheme changes during the measurement, the modulation view setting "Any" can cause inconsistent statistical results. In general, a comparison or average of the results for different burst types does not make sense. Moreover, the R&S CMW 500 has to adjust the evaluation areas and oversampling factors to the burst type, which makes the different traces incompatible.

Burst types and trace data

The evaluation areas and oversampling factors for the different burst types are automatically selected in accordance with the GSM conformance test specification. The following table gives an overview.

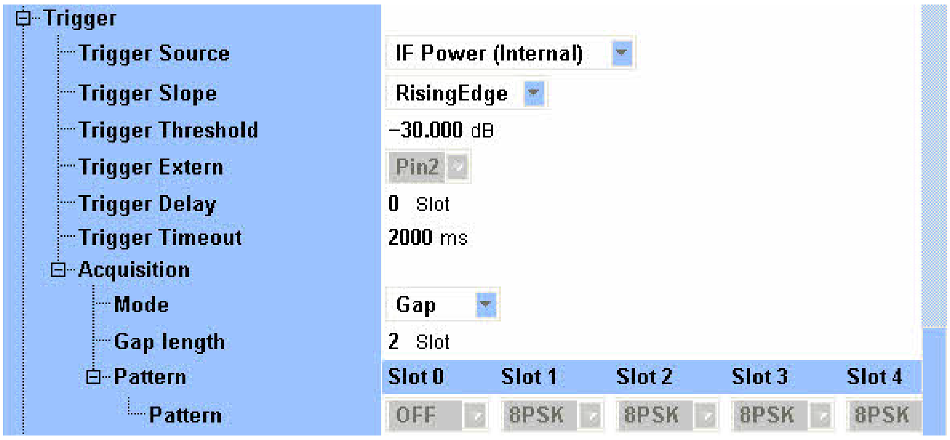
Burst type	Measured quantity	Oversampling	Samples	Evaluation area (symb. nos.)
EDGE	EVM, Magn. Error, Phase Error	1	142	3 to 144
	I/Q Data	4	568	3 to 144
GMSK, normal burst	EVM, Magn. Error, Phase Error	4	588	0.5 to 147.5
	I/Q Data	4	588	0.5 to 147.5
GMSK, access burst	EVM, Magn. Error, Phase Error	4	348	0.5 to 87.5

	I/Q Data	4	348	0.5 to 87.5

GPIB command: `CONFigure:GSM:MEASurement<i>:MEValuation:MVIew`

8.2.1.4 GSM Multi Evaluation Configuration: Trigger

The "Trigger" parameters configure the trigger system for the GSM multi-evaluation measurement.



Multi evaluation configuration: Trigger

Trigger Source

Selects the source of the trigger event.

Free Run The measurement starts immediately after it is initiated; no trigger is used. The remaining trigger settings are not relevant for "Free Run" measurements.

IF Power (Internal) The measurement is triggered by the power of the received signal, converted into an IF signal. The trigger event coincides with the rising or falling edge of the detected GSM burst. Use this trigger source for single-slot measurements and for unique events such as the access burst transmitted during the connection setup.

Acquisition (Internal) The R&S CMW 500 analyzes the RF input signal and derives a frame trigger using information about the active slots (see Acquisition settings). Use this trigger source for multislot measurements, in particular those with repeated burst patterns. The "Acquisition (Internal)" trigger algorithm can cope with several active slots with possibly different burst powers and modulation types. It is even appropriate for continuous signals with no power ramps.
After frame detection, the acquisition trigger events are repeated

periodically according to the GSM frame clock. TSC detection is performed continuously in order to compensate for a possible drift.

The "Trigger Slope", "Trigger Threshold", "Trigger Delay", and "Trigger Timeout" settings are valid for the internal trigger sources; they should be adjusted to the measured RF signal.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:TRIGger:SOURce`

Trigger Slope
Qualifies whether the trigger event is generated at the rising or at the falling edge of the trigger pulse. This setting has no influence on "Free Run" measurements.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:TRIGger:SLOPe`

Trigger Threshold
Defines the trigger threshold for the power trigger modes relative to the "Expected Nominal Power". The trigger threshold defines the measured input signal power where the trigger condition is satisfied and a trigger event is generated.
This setting has no influence on "Free Run" measurements.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:TRIGger:THReshold`

Trigger Delay
Defines a delay time for the power trigger modes. The trigger offset delays the start of the measurement relative to the trigger event. This setting has no influence on "Free Run" measurements.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:TRIGger:DELay`

Trigger Timeout
Sets a time after which the initiated measurement is automatically stopped if it does not receive a trigger event. This setting has no influence on "Free Run" measurements.
GPIB command:
`CONFigure:GSM:MEASurement<i>:MEValuation:TRIGger:TOUT`

Acquisition > Mode
Selects the synchronization method that the R&S CMW 500 uses to derive the frame boundary of the received UL signal and generate the "Acquisition (Internal)" trigger events.

Gap The R&S CMW 500 searches for a gap, i.e. for a series of 1 to 3 inactive slots. The trigger event is generated at the beginning of the first slot after the gap and repeated according to the

GSM frame clock. Use this simple synchronization method for frames that start with a series of active slots and end with inactive slots.

Pattern The R&S CMW 500 searches for a definite burst pattern, defined via "Acquisition > Pattern".The trigger events are generated at the beginning of the pattern and repeated according to the GSM frame clock, even though the true burst pattern may have changed. Use this synchronization method for arbitrary multislot configurations.

GPIB command: CONFigure:GSM:MEASurement<i>:MEValuation:AMODe

Acquisition > Gap Length

Number of consecutive inactive slots preceding the frame boundary (and therefore the acquisition trigger event).

GPIB command: CONFigure:GSM:MEASurement<i>:MEValuation:GLENgth

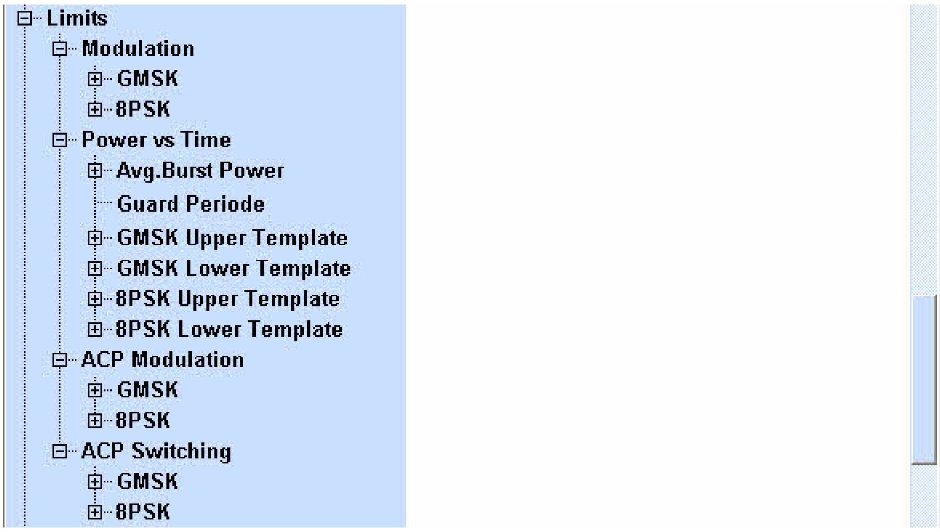
Acquisition > Pattern

Burst pattern in the UL frame. Each of the 8 timeslots can be inactive ("Off") or carry a GMSK-modulated or an EDGE burst.

GPIB command: CONFigure:GSM:MEASurement<i>:MEValuation:APATtern

8.2.1.5 GSM Multi Evaluation Configuration: Limits

The "Limits" in the "Multi Evaluation Configuration" dialog define upper limits for the modulation and spectrum results. See also Conformance Requirements and Limit Settings.



Multi evaluation configuration: Limit settings

The limits for GMSK and 8PSK-modulated (EDGE) bursts are defined separately.

Modulation

Upper limits for the measured quantities which characterize the modulation accuracy.
Three different limits are provided for the EVM, magnitude error and phase error:

EVM RMS	Upper limit for the EVM, RMS-averaged over the burst
EVM Peak	Upper limit for the peak EVM value in the burst
EVM 95%	Upper limit for the 95th percentile of the EVM. The 95th percentile is the value of the measured quantity below which 95 % of all observations fall. E.g. an EVM 95th percentile of 0.8 indicates that 95 % of all measured EVM results were below 0.8, 5 % equal to or larger than 0.8.

The definition of the phase error and magnitude error limits is similar.
A single limit is provided for the remaining quantities, however, it is possible to enable each limit check separately for the "Current", "Average", and "Max" results (see Statistics Type).
GPIB commands:

```
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:EVMagnitude
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:MERRor
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:PERRor
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:IQOFfset
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:IQIMbalance
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:FERRor
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:TERRor
```

(same list for EPSK (=8PSK) modulation)

Power vs. Time – Avg. Burst Power

Upper and lower limits for the burst power, averaged over all symbols the useful part of the burst. According to the conformance specification, the average burst power limits depend on the transmitter output power of the mobile phone, defined in terms of the Power Control Level (PCL). The limits are relative to the nominal output power of the mobile phone, corresponding to its PCL.
The R&S CMW 500 can define and enable limits for 10 independent PCL ranges (from PCL ... to PCL). For greater flexibility, lower and upper limits may be asymmetric (i.e. not of the same magnitude).
"Guard Period" is relevant for multislot configurations; this value specifies the maximum power in the guard period between any two consecutive active slots; see multislot template. The multislot guard level is defined as a dB value relative to the average burst power in the "Measurement Slot".
GPIB commands:

```
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:PVTime:ABPower<nr>
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:PVTime:GPLevel
```

Power Templates

Upper and lower limit lines for the measured power vs. time. The limit lines for GMSK and 8PSK-modulated bursts can be set independently; see Power Templates.

The upper limit lines consist of up to 11 different areas, the lower limit lines of up to 5 different areas. In each of these areas, it is possible to specify a relative limit (in dBc units) and an alternative absolute limit. If it is enabled, the absolute limit replaces the relative limit whenever it is above the relative limit. These "Static" (i.e. power-independent) limit settings can be further modified by adding a "Dynamic" (i.e. PCL-dependent) correction.

The power templates of the R&S CMW 500 are more flexible than necessary to define the templates specified in the conformance test specification.

GPIB commands:

```
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:PVTime:UPPer
:REDGe<nr>:STATic
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:PVTime:UPPer
:UPARt<nr>:STATic
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:PVTime:UPPer
:FEDGe<nr>:STATic
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:PVTime:LOWer
:UPARt<nr>:STATic
```

(same list for EPSK (=8PSK) modulation)

Adjacent Channel Power (ACP)

Upper limits for ACP due to modulation and the ACP due to switching; see ACP Limits. The limits for GMSK and 8PSK-modulated bursts can be defined independently, each at up to 20 different offsets from the nominal carrier frequency. The offset frequencies are taken from the "Measurement Control > ACP Modulation / ACP Switching > Frequency Offsets" lists.

The "Ref. Power" range for the ACP due to modulation ("ACP Modulation") defines the MS carrier output power range where the limit lines are to be determined by linear interpolation (see table in section ACP Modulation Limits): Below the lower "Ref. Power", the lower limit line ("Low Pwr" values) applies, above the upper "Ref. Power", the upper limit line ("High Pwr" values) applies. The "Low Pwr." and "High Pwr" values are relative to the MS output power, measured in 30 kHz on the carrier. The "Abs" values define alternative absolute limits for the ACP due to modulation. They are applied whenever the relative limits are below the absolute values.

The limits for the ACP due to switching ("ACP Switching") are defined at up to 10 different "Ref. Levels" and in absolute (dBm) units. For measured average burst powers between the "Ref. Levels", the limits are calculated by linear interpolation.

GPIB commands:

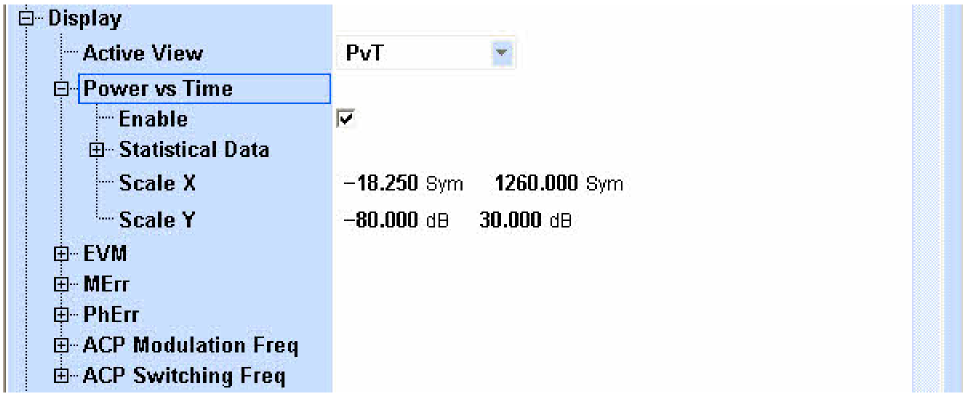
```
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:SMODulation:
RPOWer
CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:SMODulation:
MPOint<offset no>

CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:SSWitching:P
LEVel
```

CONFigure:GSM:MEASurement<i>:MEValuation:LIMit:GMSK:SSWitching:MPOint<offset no>(same list for EPSK (=8PSK) modulation)

8.2.1.6 GSM Multi Evaluation Configuration: Display

The "Display" parameters select the diagram type to be displayed ("Active View"), enable and scale the diagrams, and select the statistical traces to be displayed.



Multi evaluation configuration: Display

All settings are self-explanatory. No remote control is provided.

8.2.1.7 GSM Multi Evaluation Configuration: Filter

The "Filter" parameter selects the IF filter.

Multi evaluation configuration: Filter

Filter > PvT Filter

IF filter to be used for measuring the "Power vs Time" results. All filter settings are in accordance with the conformance specification 3GPP TS 51.010-1.

- **500 kHz Gauss** is a filter of Gaussian shape with a 3-dB bandwidth of 500 kHz, recommended for GMSK-modulated signals.
- **1 MHz Gauss** is a filter of Gaussian shape with a 3-dB bandwidth of 1 MHz (faster than the default filter but less frequency-selective).

GPIB command:

CONFigure:GSM:MEASurement1:MEValuation:PVTime:FILTer G05M | G10M

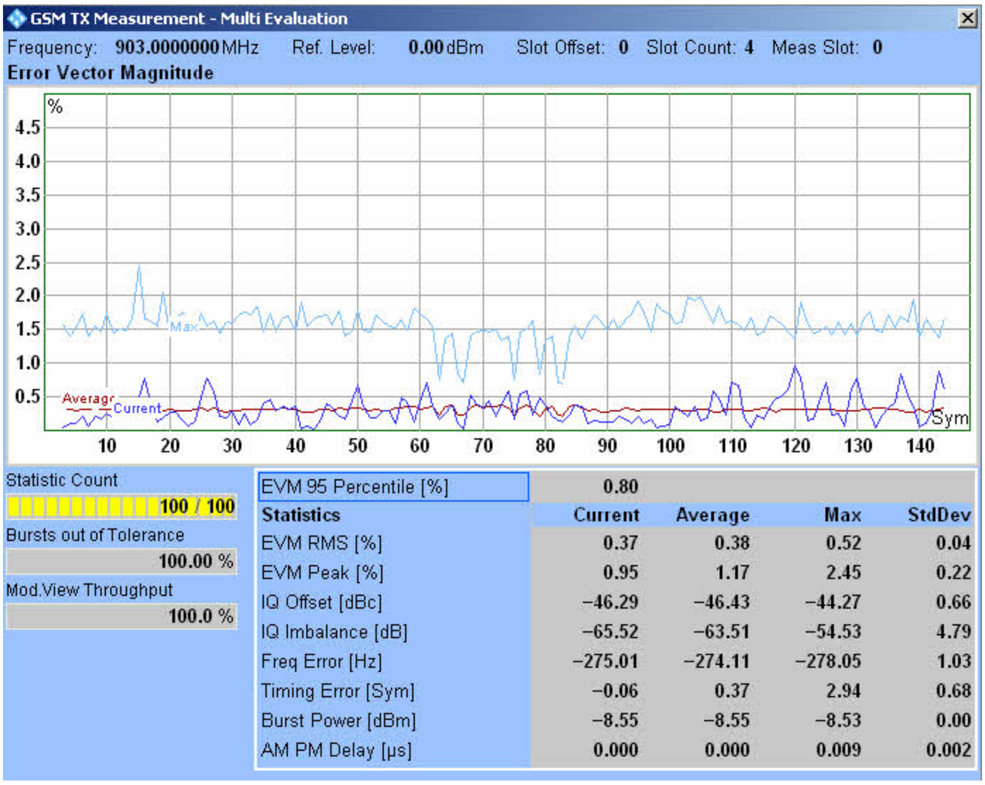
The "Return Code" parameters shows or hides a box to display the reliability indicator.

8.2.1.8 Measurement Results

The GSM "Multi Evaluation" measurement dialog shows all results in several alternative views; see detailed description in section GSM Multi Evaluation: Results.
The multi-evaluation measurement provides an overview dialog and a detailed view for each diagram in the overview. Each dialog shows the most important RF and analyzer settings.
The overview dialog displays the power vs. time, modulation and spectrum (ACP) results as traces or histograms.

GSM Multi Evaluation: Overview

Each of the detailed views shows a diagram and a statistical overview of single-slot results.



GSM Multi Evaluation: EVM

GPIB commands

To retrieve the values in the traces and histograms, use commands of the following type:

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:PVTime:CURRent?etc.

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:EVMagnitude:CURRent?etc.

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:MERRor:CURRent?etc.

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:PERRor:CURRent?etc.

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:SMODulation:FREQuency?etc.

FETCh:GSM:MEASurement<i>:MEValuation:TRACe:SSWitching:FREQuency?etc.

To retrieve the additional values in the detailed views, use the following commands:

FETCh:GSM:MEASurement<i>:MEValuation:PVTime?

FETCh:GSM:MEASurement<i>:MEValuation:EVMagnitude?

FETCh:GSM:MEASurement<i>:MEValuation:MERRor?

FETCh:GSM:MEASurement<i>:MEValuation:PERRor?

FETCh:GSM:MEASurement<i>:MEValuation:SMODulation?

FETCh:GSM:MEASurement<i>:MEValuation:SSWitching?etc.

To retrieve groups of related values, use commands of the following type:

FETCh:GSM:MEASurement<i>:MEValuation:MODulation:AVERage?FETCh:GSM:MEASurement<i>:MEValuation:MODulation:PERCentile?

8.3 GSM Programming

The following sections provide programming examples for the GSM firmware applications.

- Multi Evaluation Measurement

The examples have been tested with the aid of a simple software tool.

8.3.1 Programming the Multi Evaluation Measurement

The following examples show how to configure the GSM Multi Evaluation measurement via a remote-control program and retrieve measurement results.

- Key Features
- Specifying General Measurement Settings
- Specifying Measurement-Specific Settings
- Performing a Single-Shot Measurement
- Single Shot and Continuous Multi Evaluation Measurements

For an introduction to instrument programming refer to Remote Control, in particular to section Measurement Control.

8.3.1.1 Key Features

The GSM multi-evaluation measurement is programmed as follows:

- The measurement is controlled by SCPI commands with the following syntax: `...GSM:MEASurement:MEValuation...`
- Use general commands of the type `...:GSM:MEASurement...` (no `:MEValuation` mnemonic) to define the signal routing and perform RF and analyzer settings.
- After a `*RST`, the measurement is switched off. Use `READ:GSM:MEASurement:MEValuation?` to initiate a single-shot measurement and retrieve the results.

Advanced settings, speed considerations

You can also run the measurement in continuous mode and retrieve the results using `FETCh:GSM:MEASurement:MEValuation...?`. A reliability indicator is returned with each measurement result.

The following measurement settings provide additional results but can slow down the measurement:

- Evaluation of the ACP vs. time measurements
- Evaluation of the "AM-PM" delay for polar modulators
- Access burst search

8.3.1.2 Specifying General Measurement Settings

FPRINT **
FPRINT System-Reset
FPRINT **

```
*RST;*OPC?
*CLS; *OPC?
```

FPRINT **
FPRINT Define signal routing, perform RF and analyzer settings
FPRINT for a GSM900 uplink signal (channel 1) with a
FPRINT nominal power of 20 dBm and GMSK/8PSK modulation
FPRINT **

```
ROUTe:GSM:MEASurement:RFSettings:CONNector RF1C
CONFigure:GSM:MEASurement:RFSettings:EATTenuation 2

CONFigure:GSM:MEASurement:RFSettings:ENPower 20
CONFigure:GSM:MEASurement:RFSettings:UMARgin 5
CONFigure:GSM:MEASurement:RFSettings:FREQuency 890.2E+6

WAITKEY >Signal routing and analyzer settings completed, press
"OK" to continue<
```

8.3.1.3 Specifying Measurement-Specific Settings

FPRINT **
FPRINT Define statistic cycles and error handling
FRRINT (no stop when tolerances are exceeded, measure on exception)
FPRINT **

```
CONFigure:GSM:MEASurement:MEValuation:SCOunt:PVTime 100
CONFigure:GSM:MEASurement:MEValuation:SCOunt:MODulation 10
CONFigure:GSM:MEASurement:MEValuation:SCOunt:SMODulation 10
CONFigure:GSM:MEASurement:MEValuation:SCOunt:SSWitching 10

CONFigure:GSM:MEASurement:MEValuation:SCONdition SLFail
CONFigure:GSM:MEASurement:MEValuation:MOEXception ON
```

FPRINT **
FPRINT Use a power trigger to start the measurement
FPRINT Configure the instrument for a single-slot measurement
FPRINT in the active timeslot detected by the trigger system
FPRINT **

```
CONFigure:GSM:MEASurement:MEValuation:TRIGger:SOURce POWer
CONFigure:GSM:MEASurement:MEValuation:TRIGger:SLOPe REDGe
```

```
CONFigure:GSM:MEASurement:MEValuation:TRIGger:THReshold -2.5E+1
CONFigure:GSM:MEASurement:MEValuation:TRIGger:DELay 0
CONFigure:GSM:MEASurement:MEValuation:TRIGger:TOUT 1.0E+3
CONFigure:GSM:MEASurement:MEValuation:MSLots 0, 1, 0
WAITKEY >General configuration completed, press "OK" to start
power measurement<
```

8.3.1.4 Performing Single Shot Measurements

FPRINT ***
FPRINT Power vs. time configuration: change reference power mode for 8PSD-modulated
FPRINT bursts, select a wider IF filter, start a single-shot power vs. time measurement and return the average
FPRINT burst power trace. Query the measurement status (should be "RDY" and "RDY ,ADJ,ACT"
FPRINT ***

```
CONFigure:GSM:MEASurement:MEValuation:RPMode CURRent
CONFigure:GSM:MEASurement:MEValuation:PVTime:FILTer G10M
READ:GSM:MEASurement:MEValuation:TRACe:PVTime:AVERage?

WAITKEY >Single-slot measurement completed, press "OK" to
measure average EVM<
```

FPRINT ***
FPRINT Read the average error vector magnitude trace obtained in the
FPRINT last measurement without re-starting the measurement
FPRINT ***

```
READ:GSM:MEASurement:MEValuation:TRACe:EVMagnitude:AVERage?
```

8.3.1.5 Single Shot and Continuous Measurements

FPRINT ***
FPRINT Start single-shot measurement, return magnitude error trace.
FPRINT Return maximum magnitude error trace and maximum phase (without repeating
FRPRING the measurement. Query the measurement state (should be "RDY").
FPRINT ***

```
INIT:GSM:MEASurement:MEValuation
FETCh:GSM:MEASurement:MEValuation:TRACe:MERRor:MAXimum?
FETCh:GSM:MEASurement:MEValuation:TRACe:PERRor:MAXimum?

FETCh:GSM:MEASurement:MEValuation:STATe?
```

FPRINT ***
FPRINT Start continuous measurement, return an overview of all measurement results
FPRINT in the last measured cycle (with statistical evaluation).
FPRINT Query measurement state and substates (should be "RUN,ADJ,ACT").
FPRINT ***

```
CONFigure:GSM:MEASurement:MEValuation:REPetition CONTinuous
FETCh:GSM:MEASurement:MEValuation:MODulation:OVERview?
FETCh:GSM:MEASurement:MEValuation:STATe:ALL?
```

8.3.1.6 Configuring a Spectrum Measurement

FPRINT ***
FPRINT ACP Modulation configuration: Enable and define five frequency
FPRINT offsets, define evaluation areas
FPRINT ***

```
CONFigure:GSM:MEASurement:MEValuation:SMODulation:FOFFsets ON,
ON, ON, ON, ON, OFF, OFF, OFF, OFF, OFF, OFF, OFF, OFF, OFF,
OFF, OFF, OFF, OFF, OFF, OFF
CONFigure:GSM:MEASurement:MEValuation:SMODulation:FOFFsets 0.1,
0.2, 0.25, 0.4, 0.6, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
CONFigure:GSM:MEASurement:MEValuation:SMODulation:EARea OFF, 0,
0, ON, 90, 147
```

FPRINT ***
FPRINT ACP Switching configuration: Enable and define five frequency FPRINT offsets,
FPRINT set peak hold mode for ACP vs. frequency graphs only
FPRINT ***

```
CONFigure:GSM:MEASurement:MEValuation:SMODulation:FOFFsets ON,
ON, ON, ON, ON, OFF, OFF, OFF, OFF, OFF, OFF, OFF, OFF, OFF,
OFF, OFF, OFF, OFF, OFF, OFF
CONFigure:GSM:MEASurement:MEValuation:SMODulation:FOFFsets 0.1,
0.2, 0.25, 0.4, 0.6, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
CONFigure:GSM:MEASurement:MEValuation:SMODulation:EARea OFF, 0,
0, ON, 90, 147
CMW: CONFigure:GSM:MEASurement:MEValuation:SSWitching:PHMode SCO
```

FPRINT ***
FPRINT Re-start measurement and return ACP results
FPRINT ***

```
INIT:GSM:MEASurement:MEValuation

Waitkey >Spectrum measurement initiated, press "OK" to continue<
FETCh:GSM:MEASurement:MEValuation:TRACe:SMODulation:FREQuency?
FETCh:GSM:MEASurement:MEValuation:TRACe:SSWitching:FREQuency?
```

8.3.1.7 Selecting Specific Burst Types

```
FPRINT
************************************************************
FPRINT Select only GMSK-modulated normal bursts with a definite
FPRINT training sequence (TSC 0) . Start a single-shot modulation measurement
FPRINT and return the statistics of the EVM results
FPRINT ************************************************************

CONFigure:GSM:MEASurement:MEValuation:TSEQuence TSC1
CONFigure:GSM:MEASurement:MEValuation:MVIew GMSK, GMSK, GMSK,
GMSK, GMSK, GMSK, GMSK, GMSK
READ:GSM:MEASurement:MEValuation:EVMagnitude?

FPRINT ************************************************************
FPRINT Perform a multi-slot measurement, use a frame trigger, knowing
FPRINT that slots no. 5, 6, and 7 of the analyzed signal are inactive
FPRINT ************************************************************

CONFigure:GSM:MEASurement:MEValuation:TRIGger:SOURce ACQuisition
CONFigure:GSM:MEASurement:MEValuation:AMODe GAP
CONFigure:GSM:MEASurement:MEValuation:GLENgth 3

FPRINT ************************************************************
FPRINT Perform a multi-slot measurement, use a frame trigger, knowing
FPRINT that slots no. 2, 3, and 4 of the analyzed signal are 8PSK-modulated,
FPRINT and that the remaining slots are inactive
FPRINT ************************************************************

CONFigure:GSM:MEASurement:MEValuation:TRIGger:SOURce ACQuisition
CONFigure:GSM:MEASurement:MEValuation:AMODe PATTern
CONFigure:GSM:MEASurement:MEValuation:APATtern OFF, OFF, EDGE,
EDGE, EDGE, OFF, OFF, OFF
```

8.4 GSM Command Reference

The following sections provide detailed reference information on the remote control commands of the GSM application. The commands are organized as follows:

- General Measurement Settings
- Multi-Evaluation Measurement Commands

For an overview of all commands refer to the Alphabetical List of Commands.

8.4.1 General Measurement Settings

The commands valid for all GSM measurements are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Signal Routing
- Analyzer Settings

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

8.4.1.1 Command Groups (General Measurement Settings)

8.4.1.2 Signal Routing

The following commands select the connector and define an external attenuation value.

ROUTe:GSM:MEAS<i>:RFSettings:CONNector <Input Connector>

Selects the input connector for the measured RF signal.

<Input Connector>	**RF1C:** RF 1 COM **RF2C:** RF 2 COM Def. value: RF1C
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:RFSettings:EATTenuation <External Att.>

Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF input connector (`ROUTe:...:MEAS<i>:RFSettings:CONNector`).

<External Att>	Range: –50.00 dB to +90.00 dB (increment 0.01 dB) Def. value: 0.00 dB Def. unit: dB
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

8.4.1.3 Analyzer Settings

The following commands configure the RF input path.

CONFigure:GSM:MEAS<i>:RFSettings:ENPower <Exp Nom Power>

Sets the expected nominal power of the measured RF signal.

<Exp Nom Power>	Range: –47 dBm to +34 dBm at RF 1 COM and RF 2 COM (increment 0.01 dBm; please notice also the ranges quoted in the "Specifications") Def. value: 0.00 dBm Def. unit: dBm
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:RFSettings:UMARgin <User Margin>

Sets the margin that the R&S CMW 500 adds to the expected nominal power

(`CONFigure:...:MEAS<i>:RFSettings:ENPower`) minus the external input attenuation (`CONFigure:...:MEAS<i>:RFSettings:EATTenuation`) in order to determine its reference power. The reference power must be within the power range of the selected input connector; refer to the "Specifications".

<User Margin>	Range: 0.00 dB to +50.00 dB at RF 1 COM (increment 0.01 dB) Def. value: 0.00 dB Def. unit: dB
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:RFSettings:FREQuency <Frequency>

Selects the center frequency of the RF analyzer.

<Frequency>	Range: 100 MHz to 3300 MHz (increment 0.1 Hz) Def. value 903.000 MHz Def. unit: Hz
Example	See Specifying General Measurement Settings
Characteristics	Firmware version V1.00

8.4.2 GSM Multi Evaluation Measurement Commands

The commands valid for the GSM "Multi Evaluation" measurement are divided into the groups listed below. For an overview of the commands refer to Command Groups.

Commands for control and configuration:

- Measurement Control and States
- Enabling Results and Views
- Statistical Settings
- Measurement Settings
- Trigger Settings
- Power vs. Time Settings
- Spectrum Modulation Settings
- Spectrum Switching Settings
- Limits (GMSK Modulation)
- Limits (8PSK Modulation)
- Limits (Power vs. Time)
- Limits (Spectrum Modulation)
- Limits (Spectrum Switching)
- Filter Settings

Commands for retrieval of measurement results:

- EVM Measurement Results (Trace)
- EVM Measurement Results (Single Values)

- Magnitude Error Measurement Results (Trace)
- Magnitude Error Measurement Results (Single Values)
- Phase Error Measurement Results (Trace)
- Phase Error Measurement Results (Single Values)
- Power vs Time Measurement Results (Trace)
- Power vs Time Measurement Results (Single Values)
- Spectrum Modulation Measurement Results
- Spectrum Switching Measurement Results
- Other Measurement Results (Single Values)
- All Measurement Results (Single Values Overview)

The following general measurement settings also affect the GSM multi-evaluation measurement:

- Signal Routing
- Analyzer Settings

Issues of special interest for all commands:

MEAS<i> — Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

Issues of special interest in the context of result retrieval:

`FETCh` and `READ` commands — Both commands can be used to retrieve measurement results:

- `FETCh...` returns the results of the current measurement cycle (single shot measurement) after they are valid. `FETCh...` must be used after the measurement has been started (`INITiate...`, measurement states RUN or RDY).
- `READ...` starts a new single shot measurement and returns the results.

For further information refer to Retrieving Measurement Results.

Current and statistical values — The R&S CMW 500 repeats measurements according to the selected statistic count and repetition mode. Consecutive measurement values are stored and used to calculate statistical results, e.g. average, minimum, maximum and standard deviation.
For a description of the statistical methods refer to Statistical Results.

Global Reliability Indicator

The common reliability indicator is the first value in the output arrays of the `FETCh...?` and `READ...?` queries.

e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`

Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement

values)
In the present firmware version, the common reliability indicator is always set to zero.

8.4.2.1 Command Groups (Multi Evaluation)

Measurement Control and States **Page**

Enabling Results and Views **Page**

Statistical Settings **Page**

Measurement Settings **Page**

Trigger Settings **Page**

Power vs. Time Settings **Page**

Spectrum Modulation Settings **Page**

Spectrum Switching Settings **Page**

Limits (GMSK Modulation) **Page**

Limits (8PSK Modulation) **Page**

Limits (Power vs. Time) **Page**

Limits (Spectrum Modulation) **Page**

Limits (Spectrum Switching) **Page**

Filter Settings **Page**

EVM Measurement Results (Trace) **Page**

EVM Measurement Results (Single Values) **Page**

Magnitude Error Measurement Results (Trace) **Page**

Magnitude Error Measurement Results (Single Values) **Page**

Phase Error Measurement Results (Trace) **Page**

Phase Error Measurement Results (Single Values) **Page**

Power vs Time Measurement Results (Trace) **Page**

Power vs Time Measurement Results (Single Values) **Page**

Spectrum Modulation Measurement Results **Page**

Spectrum Switching Measurement Results **Page**

Independent Measurement Results (Single Values) **Page**

Measurement Results (Single Values Overview) **Page**

8.4.2.2 Measurement Control and States

The following commands control the measurement and return the current measurement state.

INITiate:GSM:MEAS<i>:MEValuation
ABORt:GSM:MEAS<i>:MEValuation
STOP:GSM:MEAS<i>:MEValuation

Starts, stops, or aborts the measurement; see Measurement Control:

- `INITiate...` starts or restarts the measurement; the R&S CMW 500 enters the "RUN" state.
- `ABORt...` causes a running measurement to stop immediately; the R&S CMW 500 enters the "OFF" state.
- `STOP...` causes a running measurement to stop after the current evaluation period is terminated and valid results are available; the R&S CMW 500 enters the "RDY" state.

Use FETCh...STATe? to query the current measurement state.

Example See Single Shot and Continuous Measurements

Characteristics Firmware version V1.00
SCPI: No query

FETCh:GSM:MEAS<i>:MEValuation:STATe?

Queries the main measurement state; see Measurement Control. Use FETCh:...:MEAS<i>:...:STATe:ALL? to query the measurement state including the substates. Use INITiate..., STOP..., ABORt... to change the measurement state.

Returned values:

<Main State>	**OFF:** measurement switched off, no resources allocated, no results available (when entered after STOP...) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after INITiate..., READ...), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF

Example See Single Shot and Continuous Measurements

Characteristics Firmware version V1.00
SCPI: Query only

FETCh:GSM:MEAS<i>:MEValuation:STATe:ALL?

Queries the main measurement state and the measurement substates. Both measurement substates are relevant for running measurements only. Use FETCh:...:MEAS<i>:...:STATe? to query the main measurement state only. Use INITiate..., STOP..., ABORt... to change the measurement state.

Returned values:

<Main State>,	**OFF:** measurement switched off, no resources allocated, no results available (when entered after STOP...) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after INITiate..., READ...), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF

<Sync State>, **PEND:** waiting for resource allocation, adjustment, hardware switching ("pending")
ADJ: all necessary adjustments finished, measurement running ("adjusted")
INV: not applicable because <main_state>: OFF or RDY ("invalid")

<Resources State> **QUE:** measurement without resources, no results available ("queued")
ACT: resources allocated, acquisition of results in progress but not complete ("active")
INV: not applicable because <main_state>: OFF or RDY ("invalid")

Example See Single Shot and Continuous Measurements

Characteristics Firmware version V1.00
SCPI: Query only

8.4.2.3 Enabling Results and Views

The following commands select the evaluated results and the displayed views.

CONFigure:GSM:MEAS<i>:MEValuation:RESult:PVTime
CONFigure:GSM:MEAS<i>:MEValuation:RESult:EVMagnitude
CONFigure:GSM:MEAS<i>:MEValuation:RESult:MERRor
CONFigure:GSM:MEAS<i>:MEValuation:RESult:PERRor
CONFigure:GSM:MEAS<i>:MEValuation:RESult:SMFRequency
CONFigure:GSM:MEAS<i>:MEValuation:RESult:SMTime
CONFigure:GSM:MEAS<i>:MEValuation:RESult:SSFRequency
CONFigure:GSM:MEAS<i>:MEValuation:RESult:SSTime
<Status>

Enables or disables the evaluation of results and shows or hides the views in the multi-evaluation measurement. The last mnemonic denotes the view type: Power vs. Time, Error Vector Magnitude, Magnitude Error, Phase Error, ACP Modulation Frequency, ACP Modulation Time, ACP Switching Frequency, ACP Switching Time.

Results for disabled views
Use `READ...?` queries to retrieve results for disabled views; see Retrieving results for disabled views .

<Status>	**ON:** Evaluate results and show view **OFF:** Do not evaluate results, hide view Def. value: ON (all except `SMTime` and `SSTime`)
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:RESult:AMPM <Status>

Enables or disables the evaluation of the AM-PM results.

<Status>	**ON:** Evaluate results **OFF:** Do not evaluate results Def. value: OFF
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

8.4.2.4 Statistical Settings

The following commands specify the scope of the measurement.

CONFigure:GSM:MEAS<i>:MEValuation:REPetition <Mode>

Specifies the repetition mode of the measurement; see Statistical Settings. The repetition mode specifies whether the measurement is stopped after a single shot or repeated continuously. Use `CONFigure:..:MEAS<i>:...:SCOunt` to determine the number of measurement intervals per single shot.

<Mode>	**SINGleshot**: Single shot measurement **CONTinuous**: Continuous measurement Def. value: SINGleshot
Example	See Single Shot and Continuous Measurements
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:PVTime <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals for the "Power vs. Time" measurement
Range: 1 to 10000
Def. value: 1000

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:MODulation <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals for the "Modulation" measurement
Range: 1 to 1000
Def. value: 100

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:SMODulation <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals for the "ACP Modulation" measurement
Range: 1 to 1000
Def. value: 200

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:SSWitching <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count>	Number of measurement intervals for the "ACP Switching" measurement Range: 1 to 1000 Def. value: 10
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SCONdition <Stop Condition>

Qualifies whether the measurement is stopped after a failed limit check or continued. `SONerror` means that the measurement is stopped (`STOP: ... MEAS<i>...`) and reaches the `RDY` state as soon as one of the results exceeds the limits.

<Stop Condition>	**NONE:** Continue measurement irrespective of the limit check **SLFail:** Stop measurement on limit failure Def. value: NONE
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:MOEXception <Error Handling>

Defines whether the measurement shall be continued when an exception occurs.

<Meas on Exception>	**ON:** continue **OFF:** stop Def. value: OFF
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:MSLots
<Slot Offset>, <No of Slots>, <Measured Slot>

Defines settings for the measured slots.

<Slot Offset>,	Start of the measurement interval relative to the GSM frame boundary Range: 0 to 7 Def. value: 0
<No of Slots>,	Number of slots to be measured Range: 1 to 8 Def. value: 8

<Measured Slot> Slot to be measured for one-slot measurements
Range: 0 to 7
Def. value: 0

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

8.4.2.5 Measurement Settings

The following commands provide general measurement settings.

CONFigure:GSM:MEAS<i>:MEValuation:FCRange <Range>

Selects the width of the frequency range that the R&S CMW 500 analyzes in order to establish time-synchronization with the received signal.

<Range>	**NORMal:** Normal frequency range **WIDE:** Wide frequency range Def. value: NORMal
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TSALevel <Status> | <Assembly Level>

Defines a signal level relative to the "Expected Nominal Power" (`CONFigure:GSM:MEAS<i>:RFSettings:ENPower`) where the two results obtained in a two stage measurement are joined together.

<Status> |	**ON:** Enable two-shot measurement and activate previously defined assembly level **OFF:** Disable two-shot measurement Def. value: OFF
<Assembly Level>	Set two-shot assembly level. The status is left unchanged. Range: –60.0 dB to -10.0 dB Def. value: -50.0 dB Def. unit: dB

Example	`*RST; CONF:GSM:MEAS:MEV:TSAL -20.0`
	Set the level to -20 dB; the two-shot measurement is still disabled.
	`CONF:GSM:MEAS:MEV:TSAL ON`
	Enable the two-shot measurement, using the already set level.

Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:ABSearch <State>

Enables or disables the access burst measurement.

<State>	**ON:** Enable access burst search **OFF:** Disable access burst search Def. value: OFF
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TSEQuence <Training Sequence>

Selects the training sequence of the analyzed bursts.

<Training Sequence>	**OFF:** Analyze all bursts, irrespective of their training sequence **TSC0 ... TSC7:** Analyze bursts with a particular GSM training sequence **TSCA:** Analyze bursts with any of the GSM training sequences TSC0 to TSC7 **DUMM:** Analyze GSM-specific dummy bursts Def. value: TSC0
Example	See Selecting Specific Burst Types
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:MVIew
<Slot 0>, ..., <Slot 7>

Defines the expected modulation scheme and burst type in all timeslots and adjusts the power/time template accordingly.

<Slot 0>, ..., <Slot 7>	Burst type selection for the slot. **ANY:** Any burst type can be analyzed **OFF:** No signal expected **GMSK:** GMSK-modulated normal bursts **EDGE:** 8PSK-modulated normal bursts **ACCess:** Access bursts Def. value: ANY
Example	See Selecting Specific Burst Types
Characteristics	Firmware version V1.00

8.4.2.6 Trigger Settings

The following commands define the trigger parameters.

CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:SOURce <Trigger Source>

Selects the source of the trigger events.

<Trigger Source>	**ACQuisition:** Frame trigger according to defined burst pattern **POWer:** Power trigger (received RF power) **FRUN:** Free Run Def. value: POWer
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:SLOPe <Trigger Event>

Qualifies whether the trigger event is generated at the rising or at the falling edge of the trigger pulse (valid for the power trigger sources; see `CONFigure:...:MEAS<i>:...:TRIGger:SOURce`).

<Trigger Event>	**REDGe:** Rising edge **FEDGe:** Falling edge Def. value: REDGe
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:THReshold <Trigger Threshold>

Defines the trigger threshold for the power trigger sources; see `CONFigure:...:MEASurement<i>:...:TRIGger:SOURce`).

<Trigger Threshold>	Range: –50 dB to 0 dB Def. value: –30 dB Def. unit: dB (full scale, i.e. relative to the expected nominal power of the power steps that generate the trigger events)
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:DELay <Trigger Delay>

Defines a delay time (integer number of GSM timeslots) for all trigger sources except "Free Run" (`CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:SOURce`). The parameter delays the start of the measurement relative to the trigger event.

<Trigger Offset> Range: 0 to 7
Def. value: 0
Def. unit: (slots)

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:TOUT <Trigger Timeout>

Selects the maximum time that the R&S CMW 500 will wait for a trigger event before it stops the measurement. This setting is not valid for free run measurements (`CONFigure:GSM:MEAS<i>:MEValuation:TRIGger:SOURce FRUN`).

<Trigger Timeout> Range: 0 ms to 16777215 ms
Def. value: 1000 ms
Def. unit: ms

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:AMODe <Mode>

Selects the method that the R&S CMW 500 uses for frame synchronization.

<Mode> **GAP:** Gap
PATTern: Pattern
Def. value: PATTern

Example See Selecting Specific Burst Types

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:GLENgth <Gap Length>

Defines the gap length as an integer number of slots. The gap length is used for frame synchronization if the gap acquisition mode is active (`CONFigure:GSM:MEAS<i>:MEValuation:AMODe GAP`).

<Gap Length> Range: 1 | 2 | 3
Def. value: 2
Def. unit: (slots)

Example See Selecting Specific Burst Types

Characteristics Firmware version V1.00

**CONFigure:GSM:MEAS<i>:MEValuation:APATtern
<Pattern 0>, ..., <Pattern 7>**

Defines the burst pattern that the R&S CMW 500 expects in the TDMA frames of the received GSM signal. The pattern is used for frame synchronization if the pattern acquisition mode is active (CONFigure:GSM:MEAS<i>:MEValuation:AMODe PATTern).

<Pattern 0>, ..., <Pattern 7>	Pattern selection for corresponding timeslot (0 to 7) **OFF:** No signal expected **GMSK:** GMSK-modulated normal bursts **EDGE:** 8PSK-modulated normal bursts Def. value: OFF (timeslots 0, 6, 7), EDGE (timeslots 1 to 5)
Example	See Selecting Specific Burst Types
Characteristics	Firmware version V1.00

8.4.2.7 Power vs. Time Settings

The following commands configure the "Power vs. Time " measurement.

CONFigure:GSM:MEAS<i>:MEValuation:RPMode <Mode>

Defines how the reference power, i.e. the 0-dB line in the measurement diagram, is calculated.

<Mode>	**CURRent:** Current **AVERage:** Average **DCOMpensated:** Data Compensated Def. value: AVERage
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00

8.4.2.8 Spectrum Modulation Settings

The following commands define settings for spectrum modulation frequency (ACP modulation) measurements.

CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:FOFFsets <Status 0> | <Freq Offset 0>, ..., <Status 19> | <Freq Offset 19>

Defines the frequency offsets to be used for ACP modulation measurements. The offsets are defined relative to the analyzer frequency. Up to 20 offsets can be defined and enabled.

<Status 0> | <Freq Offset 0>, ..., <Status 19> | <Freq Offset 19>	Status: **ON:** Enable measurement with the corresponding frequency offset **OFF:** Disable measurement with the corresponding frequency offset Def. value, Status 0 to 10: ON Def. value, Status 11 to 19: OFF Frequency offset: Set frequency offset. The status is left unchanged. Range: 0 MHz to 3 MHz Def. value, Offset 0 to 10 [MHz]: 0.1, 0.2, 0.25, 0.4, 0.6, 0.8, 1, 1.2, 1.4, 1.6, 1.8 Def. value, Offset 11 to 19 [MHz]: 1.9 Def. unit: MHz
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:EARea <Status 1>, <Start 1>, <Stop 1>, <Status 2>, <Start 2>, <Stop 2>

Defines the time intervals (evaluation areas) to be used for ACP modulation measurements.

<Status 1>,	**ON:** Enable area 1 **OFF:** Disable area 1 Def. value: ON
<Start 1>,	Start of evaluation area 1 Range: 0 Sym to 147 Sym Def. value: 6 Sym Def. unit: Sym
<Stop 1>,	Stop of evaluation area 1 Range: 0 Sym to 147 Sym Def. value: 45 Sym Def. unit: Sym
<Status 2>,	**ON:** Enable area 2 **OFF:** Disable area 2 Def. value: ON
<Start 2>,	Start of evaluation area 2 Range: 0 Sym to 147 Sym Def. value: 90 Sym Def. unit: Sym

<Stop 2>	Stop of evaluation area 2 Range: 0 Sym to 147 Sym Def. value: 129 Sym Def. unit: Sym
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:TDFSelect <Offset Number>

Defines the offset frequency for the "ACP Mod. Time" diagram. The diagram shows the measured power vs. time at the selected offset frequency. The numbers 1 to 20 select the negative frequency offsets from the "Frequency Offsets" list, numbers 21 to 40 select the positive frequency offsets.

<Offset Number>	Range: 0 to 40 Def. value: 0 Def. unit: -
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

8.4.2.9 Spectrum Switching Settings

The following commands define settings for spectrum switching frequency (ACP switching) measurements.

CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:FOFFsets <Status 0> | <Freq Offset 0>, ..., <Status 19> | <Freq Offset 19>

Defines the frequency offsets to be used for ACP switching measurements. The offsets are defined relative to the analyzer frequency. Up to 20 offsets can be defined and enabled.

<Status 0> | <Freq Offset 0>, ..., <Status 19> | <Freq Offset 19>	Status: **ON:** Enable measurement with the corresponding frequency offset **OFF:** Disable measurement with the corresponding frequency offset Def. value, Status 0 to 3: ON Def. value, Status 4 to 19: OFF Frequency offset: Set frequency offset. The status is left unchanged. Range: 0 MHz to 3 MHz Def. value, Offset 0 to 3 [MHz]: 0.4, 0.6, 1.2, 1.8 Def. value, Offset 4 to 19 [MHz]: 1.9 Def. unit: MHz
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:TDFSelect <Offset Number>

Defines the offset frequency for the "ACP Mod. Time" diagram. The diagram shows the measured power vs. time at the selected offset frequency. The numbers 1 to 20 select the negative frequency offsets from the "Frequency Offsets" list, numbers 21 to 40 select the positive frequency offsets.

<Offset Number>	Range: 0 to 40 Def. value: 0 Def. unit: -
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:PHMode <Mode>

Specifies how the peak hold mode is used for the "Spectrum Switching" results in frequency domain (bar graphs) and in time domain.

<Mode>	**PHOL:** Frequency and Time: Peak Hold **SCO:** Frequency: Stat. Count, Time: Current Def. value: PHOL
Example	See Configuring a Spectrum Measurement
Characteristics	Firmware version V1.00

8.4.2.10 Limits (GMSK Modulation)

The following commands define limits for results which characterize the modulation accuracy for the modulation scheme GMSK.

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:EVMagnitude <Limit RMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the error vector magnitude (EVM).

<Limit RMS>,	Range: 0 % to 50 % Def. value: 9 % Def. unit: %
<Limit Peak>,	Range: 0 % to 50 % Def. value: 30 % Def. unit: %
<Limit 95%>,	Range: 0 % to 50 % Def. value: 5 % Def. unit: %
<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>	**ON:** Apply limit to the Current, Average, Max, 95th percentile values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:MERRor <Limit RMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the magnitude error.

<Limit RMS>,	Range: 0 % to 100 % Def. value: 12.5 % Def. unit: %
<Limit Peak>,	Range: 0 % to 100 % Def. value: 17.7 % Def. unit: %
<Limit 95%>,	Range: 0 % to 100 % Def. value: 5 % Def. unit: %

<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>
: **ON:** Apply limit to the Current, Average, Max, 95th percentile values
OFF: Do not apply limit
Def. value: ON

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:PERRor <Limit RAMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the phase error.

<Limit RMS>,
: Range: 0 deg to 180 deg
Def. value: 5 deg
Def. unit: deg

<Limit Peak>,
: Range: 0 deg to 180 deg
Def. value: 20 deg
Def. unit: deg

<Limit 95%>,
: Range: 0 deg to 180 deg
Def. value: 5 deg
Def. unit: deg

<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>
: **ON:** Apply limit to the Current, Average, Max, 95th percentile values
OFF: Do not apply limit
Def. value: ON

Characteristics Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:IQOFfset <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the I/Q origin offset values.

<Limit>,
: Range: -100 dB to 0 dB
Def. value: -30 dB
Def. unit: dB

<Current>, <Average>, <Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:IQIMbalance <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the I/Q imbalance values.

<Limit>,	Range: -100 dB to 0 dB Def. value: -20 dB Def. unit: dB
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:TERRor <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the timing error.

<Limit>,	Range: -1000 Sym to 1000 Sym Def. value: 0 Sym Def. unit: Sym
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:FERRor <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the frequency error.

<Limit>,	Range: 0 to 999 Hz Def. value: 90 Hz Def. unit: Hz
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

8.4.2.11 Limits (8PSK Modulation)

The following commands define limits for results which characterize the modulation accuracy for the modulation scheme 8PSK.

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:EVMagnitude <Limit RMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the error vector magnitude (EVM).

<Limit RMS>,	Range: 0 % to 50 % Def. value: 9 % Def. unit: %
<Limit Peak>,	Range: 0 % to 50 % Def. value: 30 % Def. unit: %
<Limit 95%>,	Range: 0 % to 50 % Def. value: 5 % Def. unit: %
<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>	**ON:** Apply limit to the Current, Average, Max, 95th percentile values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:MERRor <Limit RMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the magnitude error.

<Limit RMS>,	Range: 0 % to 100 % Def. value: 12.5 % Def. unit: %
<Limit Peak>,	Range: 0 % to 100 % Def. value: 17.7 % Def. unit: %

<Limit 95%>,	Range: 0 % to 100 % Def. value: 5 % Def. unit: %
<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>	**ON:** Apply limit to the Current, Average, Max, 95th percentile values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:PERRor <Limit RMS>, <Limit Peak>, <Limit 95%>, <Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>

Defines and activates upper limits for the RMS, peak and 95th percentile values of the phase error.

<Limit RMS>,	Range: 0 deg to 180 deg Def. value: 5 deg Def. unit: deg
<Limit Peak>,	Range: 0 deg to 180 deg Def. value: 20 deg Def. unit: deg
<Limit 95%>,	Range: 0 deg to 180 deg Def. value: 5 deg Def. unit: deg
<Stat RMS Current>, <Stat RMS Average>, <Stat RMS Max>, <Stat Peak Current>, <Stat Peak Average>, <Stat Peak Max>, <Stat 95%>	**ON:** Apply limit to the Current, Average, Max, 95th percentile values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:IQOFfset <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the I/Q origin offset values.

<Limit>,	Range: -100 dB to 0 dB Def. value: -30 dB Def. unit: dB
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:IQIMbalance <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the I/Q imbalance values.

<Limit>,	Range: -100 dB to 0 dB Def. value: -20 dB Def. unit: dB
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:TERRor <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the timing error.

<Limit>,	Range: -1000 Sym to 1000 Sym Def. value: 0 Sym Def. unit: Sym
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:FERRor <Limit>, <Stat Current>, <Stat Average>, <Stat Max>

Defines and activates upper limits for the frequency error.

<Limit>,	Range: 0 to 999 Hz Def. value: 90 Hz Def. unit: Hz
<Stat Current>, <Stat Average>, <Stat Max>	**ON:** Apply limit to the Current, Average, Max values **OFF:** Do not apply limit Def. value: ON

Characteristics Firmware version V1.00

8.4.2.12 Limits (Power vs. Time)

The following commands define limit lines for power vs. time measurements.

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:PVTime:ABPower<number> <Start PCL>, <End PCL>, <Lower Limit>, <Upper Limit>, <Status>

Defines and activates limits for the average burst power, i.e. tolerances for ranges of template power control levels (TPCLs).

<number> Number of the group
Range: 1 to 10
Def. value: 1

<Start PCL>, <End PCL>, Number of first and last TPCL to which the limits are applied
Range: 0 to 31
Def. values: see table below

<Lower Limit>, Range: -10 dB to 0 dB
Def. values: see table below

<Upper Limit>, Range: 0 dB to 10 dB
Def. values: see table below

<Status> **ON:** Enable limits for the given <number>
OFF: Disable limits for the given <number>
Def. values: see table below

Characteristics Firmware version V1.00

The default settings for GSM 900/1800/1900 are according to the following table. The default settings for GSM850, GSM GT800, and GSM400 are identical to GSM900:

	<Status>	**<Start PCL>**	**<End PCL>**	**<Lower Limit> [dB]**	**<Upper Limit> [dB]**
<number>=1	ON	31	31	-2	2
<number>=2	ON	0	2/8/8	-2/-3/-3	2/3/3
<number>=3	ON	3/9/9	15/13/13	-3/-4/-4	3/4/4
<number>=4	ON	16/14/14	31/28/29	-5	5
<number>=5	OFF/ON/ON	-/29/30	-/29/31	-/-2/-2	-/5/2
<number>=6	OFF/ON/OFF	-/30/-	-/31/-	-/-3/-	-/2/-
<number>=7 to 10	OFF	-	-	-	-

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:PVTime:GPLevel <Level>

Defines the raising of the upper limit line in the guard period between two consecutive bursts.

<Level>	Range: 0 dB to 10 dB Def. value: 3 dB Def. unit: dB
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:PVTime:UPPer:REDGe<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:PVTime:UPPer:UPARt<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:PVTime:UPPer:FEDGe<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:PVTime:UPPer:REDGe<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:PVTime:UPPer:UPARt<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:PVTime:UPPer:FEDGe<number>:STATic
<Time Start>, <Time End>, <Rel Start>, <Rel End>, <Abs Start Status> | <Abs Start>, <Abs End Status> | <Abs End>, <Status Area>

These commands define and activate upper limit lines for the measured power vs. time. The lines apply to the modulation schemes GMSK or 8PSK (EPSK). Each line consists of three sections: rising edge (REDGe), useful part (UPARt) and falling edge (FEDGe). Each section consists of several areas for which relative and absolute limits can be defined (if both are defined the higher limit overrules the lower one).

<number>	Number of the area Range rising/falling edge: 1 to 4 Range useful part: 1 to 3 Def. value: 1
<Time Start>, <Time End>,	Start and end time of the area Range: -50 µs to +600 µs Def. values: see table below
<Rel Start>, <Rel End>,	Start and end level of the relative limit for the area Range: -100 dB to +20 dB Def. values: see table below
<Abs Start Status> |	**ON:** Enable the defined start level of the absolute limit **OFF:** Disable the defined start level of the absolute limit Def. values: see table below

<Abs Start>, Set start level of the absolute limit for the area. The status is left unchanged.
Range: -90 dBm to +50 dBm
Def. values: see table below

<Abs End Status> | **ON:** Enable the defined end level of the absolute limit
OFF: Disable the defined end level of the absolute limit
Def. values: see table below

<Abs End>, Set end level of the absolute limit for the area. The status is left unchanged.
Range: -90 dBm to +50 dBm
Def. values: see table below

<Status Area> **ON:** Enable area <number>
OFF: Disable area <number>
Def. values: see table below

Characteristics Firmware version V1.00

The default settings for GSM 900/1800 are according to the following tables. The default settings for GSM850 and GSM400 are identical to GSM900, the ones for GSM 1900 are identical to GSM 1800:

	<Time Start> [µs]	**<Time End> [µs]**	**<Rel Start> (=<Rel End>) [dB]**	**<Abs Start> (=<Abs End>) [dBm], <Status>**	**<Status Area>**
<number>=1	-38	-28	-59/-48	-36/-48, ON	ON
<number>=2	-28	-18	-30	-17/-20, ON	ON
<number>=3	-18	-10	-6	OFF	ON
<number>=4	-10	0	4	OFF	ON

Rising edge GMSK and 8PSK

	<Time Start> [µs]	**<Time End> [µs]**	**<Rel Start> (=<Rel End>) [dB]**	**<Abs Start> (=<Abs End>) [dBm], <Status>**	**<Status Area>**
<number>=1	0	542.8	1	OFF	ON
<number>=2	-	-	-	-	OFF
<number>=3	-	-	-	-	OFF

Useful part GMSK

	<Time Start> [µs]	**<Time End> [µs]**	**<Rel Start> (=<Rel End>) [dB]**	**<Abs Start> (=<Abs End>) [dBm], <Status>**	**<Status Area>**
<number>=1	0	4	2.4	OFF	ON
<number>=2	4	538.8	4	OFF	ON

	<Time Start> [µs]	<Time End> [µs]	<Rel Start> (=<Rel End>) [dB]	<Abs Start> (=<Abs End>) [dBm], <Status>	<Status Area>
<number>=3	538.8	542.8	2.4	OFF	ON

Useful part 8PSK

	<Time Start> [µs]	<Time End> [µs]	<Rel Start> (=<Rel End>) [dB]	<Abs Start> (=<Abs End>) [dBm], <Status>	<Status Area>
<number>=1	542.8	552.8	GMSK: 1, 8PSK: 4	OFF	ON
<number>=2	552.8	560.8	-6	OFF	ON
<number>=3	560.8	570.8	-30	-17/-20, ON	ON
<number>=4	570.8	580.8	-59/-48	-36/-48, ON	ON

Falling edge GMSK and 8PSK

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:PVTime:LOWer:UPARt<number>:STATic
CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:PVTime:LOWer:UPARt<number>:STATic
<Time Start>, <Time End>, <Rel Start>, <Rel End>, <Abs Start Status> | <Abs Start>, <Abs End Status> | <Abs End>, <Status Area>

These commands define and activate lower limit lines for the measured power vs. time. The lines apply to the "useful part" of a burst for modulation schemes GMSK or 8PSK (EPSK). Each line may consist of several areas for which relative and absolute limits can be defined (if both are defined the lower limit overrules the higher one).

<number>	Number of the area Range: 1 to 5 Def. value: 1
<Time Start>, <Time End>,	Start and end time of the area Range: -50 µs to +600 µs Def. values: see table below
<Rel Start>, <Rel End>,	Start and end level of the relative limit for the area Range: -100 dB to +20 dB Def. values: see table below
<Abs Start Status>,	**ON:** Enable the defined start level of the absolute limit **OFF:** Disable the defined start level of the absolute limit Def. values: see table below
<Abs Start>,	Set start level of the absolute limit for the area. The status is left unchanged. Range: -90 dBm to +50 dBm Def. values: see table below

<Abs End Status>, **ON:** Enable the defined end level of the absolute limit
OFF: Disable the defined end level of the absolute limit
Def. values: see table below

<Abs End>, Set end level of the absolute limit for the area. The status is left unchanged.
Range: -90 dBm to +50 dBm
Def. values: see table below

<Status Area> **ON:** Enable area <number>
OFF: Disable area <number>
Def. values: see table below

Characteristics Firmware version V1.00

The default settings are according to the following tables:

	<Time Start> [µs]	**<Time End> [µs]**	**<Rel Start> (=<Rel End>) [dB]**	**<Abs Start> (=<Abs End>) [dBm], <Status>**	**<Status Area>**
<number>=1	0	542.8	-1	OFF	ON
<number>=2 to 5	-	-	-	-	OFF

GMSK

	<Time Start> [µs]	**<Time End> [µs]**	**<Rel Start> (=<Rel End>) [dB]**	**<Abs Start>(=<Abs End>) [dBm], <Status>**	**<Status Area>**
<number>=1	0	2	-2	OFF	ON
<number>=2	2	4	0	OFF	ON
<number>=3	4	538.8	-15	OFF	ON
<number>=4	538.8	540.8	0	OFF	ON
<number>=5	540.8	542.8	-2	OFF	ON

8PSK

8.4.2.13 Limits (Spectrum Modulation)

The following commands define limit lines for spectrum modulation frequency (ACP modulation) measurements.

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:SMODulation:RPOWer <Low Power>, <High Power>

Defines two reference power values for the modulation scheme GMSK. These values are relevant in the context of the next command.

<Low Power>,	Low reference power value Range: 0 dBm to 43 dBm Def. value: 33 dBm Def. unit: dBm
<High Power>	High reference power value Range: 0 dBm to 43 dBm Def. value: 39 dBm Def. unit: dBm
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:SMODulation:MPOint<offset>
<Low Power Limit>, <High Power Limit>, <Absolute Limit>, <Status>

Defines and activates a limit line for the modulation scheme GMSK for a certain frequency offset. The specified limits apply above the high power reference value and below the low power reference value defined by the previous command. Between the two reference power values the limits are determined by linear interpolation.

<offset>	Number of the frequency offset value. The offsets are defined by the command `CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:FOFFsets` Range: 1 to 20 Def. value: 1
<Low Power Limit>,	Relative power limit applicable below the low reference power (see previous command). Range: -120 dB to 31.5 dB Def. value, <offset> = 1 to 3: 0.5 dB, -30 dB, -33 dB Def. value, <offset> = 4 to 20: -60 dB Def. unit: dB
<High Power Limit>,	Relative power limit applicable above the high reference power (see previous command). Range: -120 dB to 31.5 dB Def. value, <offset> = 1 to 4: 0.5 dB, -30 dB, -33 dB, -60 dB Def. value, <offset> = 5 to 20: -66 dB Def. unit: dB
<Absolute Limit>,	Alternative absolute power limit. If the relative limits are tighter than the absolute limit, the latter applies. Range: -120 dBm to 31.5 dBm Def. value, <offset> = 1 to 4: -36 dBm Def. value, <offset> = 5 to 20: -51 dBm Def. unit: dBm

<Status>	**ON:** Enable limits for the given <offset> **OFF:** Disable limits for the given <offset> Def. value, <offset> = 1 to 11: ON Def. value, <offset> = 12 to 20: OFF
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:SMODulation:RPOWer <Low Power>, <High Power>

Defines two reference power values for the modulation scheme 8PSK. These values are relevant in the context of the next command.

<Low Power>,	Low reference power value Range: 0 dBm to 43 dBm Def. value: 33 dBm Def. unit: dBm
<High Power>	High reference power value Range: 0 dBm to 43 dBm Def. value: 34 dBm Def. unit: dBm
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:SMODulation:MPOint<offset>
<Low Power Limit>, <High Power Limit>, <Absolute Limit>, <Status>

Defines and activates a limit line for the modulation scheme 8PSK for a certain frequency offset. The specified limits apply above the high power reference value and below the low power reference value defined by the previous command. Between the two reference power values the limits are determined by linear interpolation.

<offset>	Number of the frequency offset value. The offsets are defined by the command `CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:FOFFsets` Range: 1 to 20 Def. value: 1
<Low Power Limit>,	Relative power limit applicable below the low reference power (see previous command). Range: -120 dB to 31.5 dB Def. value, <offset> = 1 to 4: 0.5 dB, -30 dB, -33 dB, -54 dB Def. value, <offset> = 5 to 20: -60 dB Def. unit: dB

<High Power Limit>,	Relative power limit applicable above the high reference power (see previous command). Range: -120 dB to 31.5 dB Def. value, <offset> = 1 to 4: 0.5 dB, -30 dB, -33 dB, -54 dB Def. value, <offset> = 5 to 20: -66 dB Def. unit: dB
<Absolute Limit>,	Alternative absolute power limit. If the relative limits are tighter than the absolute limit, the latter applies. Range: -120 dBm to 31.5 dBm Def. value, <offset> = 1 to 4: -36 dBm Def. value, <offset> = 5 to 20: -51 dBm Def. unit: dBm
<Status>	**ON:** Enable limits for the given <offset> **OFF:** Disable limits for the given <offset> Def. value, <offset> = 1 to 11: ON Def. value, <offset> = 12 to 20: OFF
Characteristics	Firmware version V1.00

8.4.2.14 Limits (Spectrum Switching)

The following commands define limit lines for spectrum switching frequency (ACP switching) measurements.

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:SSWitching:PLEVel <Status 1>, ..., <Status 10>, <Power Level 1>, ..., <Power Level 10>

Defines and activates reference power values for the modulation scheme GMSK. These values are relevant in the context of the next command.

<Status 1>, ..., <Status 10>,	**ON:** Enable reference value **OFF:** Disable reference value Def. value: ON
<Power Level 1>, ..., <Power Level 10>	Reference power value Range: 0 dBm to 39 dBm Def. values, Level 1 to 10 [dBm]: 39, 37, 35, 33, 31, 29, 27, 25, 23, 21 Def. unit: dBm
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:GMSK:SSWitching:MPOint<offsetno>
<Power Limit 1>, ..., <Power Limit 10>, <Status>

Defines and activates a limit line for the modulation scheme GMSK for a certain frequency offset. The specified limits apply at the reference power values defined by the previous command. Between the reference power values the limits are determined by linear interpolation.

<offsetno> Number of the frequency offset value. The offsets are defined by the command
CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:FOFFsets
Range: 1 to 20
Def. value: 1

<Power Limit 1>, ..., <Power Limit 10>, Relative power limit applicable at the corresponding reference power (see previous command).
Range: -60 dB to 30 dB
Def. values: see table below
Def. unit: dB

<Status> **ON:** Enable limits for the given <offsetno>
OFF: Disable limits for the given <offsetno>
Def. values: see table below

Characteristics Firmware version V1.00

Default values for <Status> (ON/OFF) and <Power Limit n> (values in dB) depending on <offsetno>:

	<Status>	**n=1**	**n=2**	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
<offsetno>=1	ON	-13	-15	-17	-19	-21	-23	-23	-23	-23	-23
<offsetno>=2	ON	-21	-21	-21	-21	-23	-25	-26	-26	-26	-26
<offsetno>=3	ON	-21	-21	-21	-21	-23	-25	-27	-29	-31	-32
<offsetno>=4	ON	-24	-24	-24	-24	-26	-28	-30	-32	-34	-36
<offsetno>=5 to 7	OFF	0	0	0	0	0	0	0	0	0	0
<offsetno>=8 to 20	OFF	0	-15	-17	-19	-21	-23	-23	-23	-23	-23

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:SSWitching:PLEVel
<Status 1>, ..., <Status 10>, <Power Level 1>, ..., <Power Level 10>

Defines and activates reference power values for the modulation scheme 8PSK. These values are relevant in the context of the next command.

<Status 1>, ..., <Status 10>,	**ON:** Enable reference value **OFF:** Disable reference value Def. value: ON
<Power Level 1>, ..., <Power Level 10>	Reference power value Range: 0 dBm to 39 dBm Def. values, Level 1 to 10 [dBm]: 39, 37, 35, 33, 31, 29, 27, 25, 23, 21 Def. unit: dBm
Characteristics	Firmware version V1.00

CONFigure:GSM:MEAS<i>:MEValuation:LIMit:EPSK:SSWitching:MPOint<offsetno>
<Power Limit 1> ... <Power Limit 10>, <Status>

Defines and activates a limit line for the modulation scheme 8PSK for a certain frequency offset. The specified limits apply at the reference power values defined by the previous command. Between the reference power values the limits are determined by linear interpolation.

<offsetno>	Number of the frequency offset value. The offsets are defined by the command `CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:FOFFsets` Range: 1 to 20 Def. value: 1
<Power Limit 1>, ..., <Power Limit 10>,	Relative power limit applicable at the corresponding reference power (see previous command). Range: -60 dB to 30 dB Def. values: see table below Def. unit: dB
<Status>	**ON:** Enable limits for the given <offsetno> **OFF:** Disable limits for the given <offsetno> Def. values: see table below
Characteristics	Firmware version V1.00

Default values for <Status> (ON/OFF) and <Power Limit n> (values in dB) depending on <offsetno>:

	<Status>	**n=1**	**n=2**	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
<offsetno>=1	ON	-13	-15	-17	-19	-21	-23	-23	-23	-23	-23
<offsetno>=2	ON	-21	-21	-21	-21	-23	-25	-26	-26	-26	-26
<offsetno>=3	ON	-21	-21	-21	-21	-23	-25	-27	-29	-31	-32
<offsetno>=4	ON	-24	-24	-24	-24	-26	-28	-30	-32	-34	-36

	<Status>	n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
<offsetno>=5 to 14	OFF	0	0	0	0	0	0	0	0	0	0
<offsetno>=15 to 20	OFF	0	-15	-17	-19	-21	-23	-23	-23	-23	-23

8.4.2.15 Filter Settings

The following commands select the measurement filters (IF filters).

CONFigure:GSM:MEAS<i>:MEValuation:PVTime:FILTer <PvT Filter>

Selects the bandwidth of the IF filter for the "Power vs. Time" measurement.

<PvT Filter> **G05M:** 500 kHz Gauss filter
G10M: 1 MHz Gauss filter
Def. value: G05M

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00

8.4.2.16 EVM Measurement Results (Trace)

The following commands return the EVM trace results of the multi-evaluation measurement for the "measured slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:CURRent?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:AVERage?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:MAXimum?

READ:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:CURRent?
READ:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:AVERage?
READ:GSM:MEAS<i>:MEValuation:TRACe:EVMagnitude:MAXimum?

Returns the values of the EVM traces. The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>, Reliability indicator

<EVM 1>, n EVM results, depending on the type of modulation
..., 8PSK modulation: 142 values (one value per symbol period)
<EVM n> GMSK modulation:588 values (four values per symbol period)
Range: 0 % to 100 %
Def. unit: %

Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.17 EVM Measurement Results (Single Values)

The following commands return the EVM results of the multi-evaluation measurement for the "Measured Slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:EVMagnitude?
READ:GSM:MEAS<i>:MEValuation:EVMagnitude?

Returns the RMS and peak EVM values measured in the "Measured Slot". In addition to the current value statistical values are returned (average, maximum, standard deviation and 95th percentile).

Returned values

<Reliability>,	Reliability indicator
<RMS Current>, <RMS Average>, <RMS Maximum>,	Range: 0 % to 100 % Def. unit: %
<RMS Std Dev>,	Range: 0 % to 50 % Def. unit: %
<Peak Current>, <Peak Average>, <Peak Maximum>,	Range: 0 % to 100 % Def. unit: %
<Peak Std Dev>,	Range: 0 % to 50 % Def. unit: %
<95th Percentile>,	Range: 0 % to 100 % Def. unit: %
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.18 Magnitude Error Measurement Results (Trace)

The following commands return the magnitude error trace results of the multi-evaluation measurement for the "measured slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:TRACe:MERRor:CURRent?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:MERRor:AVERage?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:MERRor:MAXimum?

READ:GSM:MEAS<i>:MEValuation:TRACe:MERRor:CURRent?
READ:GSM:MEAS<i>:MEValuation:TRACe:MERRor:AVERage?
READ:GSM:MEAS<i>:MEValuation:TRACe:MERRor:MAXimum?

Returns the values of the magnitude error traces. The results of the current, average and minimum/maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Mag Err 1>, ..., <Mag Err n>	n magnitude error results, depending on the type of modulation 8PSK modulation: 142 values (one value per symbol period) GMSK modulation:588 values (four values per symbol period) Range: –100.0 % to +100.0 % Def. unit: %
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.19 Magnitude Error Measurement Results (Single Values)

The following commands return the magnitude error results of the multi-evaluation measurement for the "Measured Slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:MERRor?
READ:GSM:MEAS<i>:MEValuation:MERRor?

Returns the RMS and peak magnitude error values measured in the "Measured Slot". In addition to the current value statistical values are returned (average, minimum/maximum, standard deviation and 95th percentile).

Returned values

<Reliability>,	Reliability indicator
<RMS Current>,	Range: –100.0 % to +100.0 % Def. unit: %
<RMS Average>,	Range: 0 % to +100.0 % Def. unit: %

<RMS Min/Max>,	Range: –100.0 % to +100.0 % Def. unit: %
<RMS Std Dev>,	Range: 0 % to 50 % Def. unit: %
<Peak Current>,	Range: –100.0 % to +100.0 % Def. unit: %
<Peak Average>,	Range: 0 % to +100.0 % Def. unit: %
<Peak Min/Max>,	Range: –100.0 % to +100.0 % Def. unit: %
<Peak Std Dev>,	Range: 0 % to 50 % Def. unit: %
<95th Percentile>	Range: 0 % to 100 % Def. unit: %
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.20 Phase Error Measurement Results (Trace)

The following commands return the phase error trace results of the multi-evaluation measurement for the "measured slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:TRACe:PERRor:CURRent?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:PERRor:AVERage?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:PERRor:MAXimum?

READ:GSM:MEAS<i>:MEValuation:TRACe:PERRor:CURRent?
READ:GSM:MEAS<i>:MEValuation:TRACe:PERRor:AVERage?
READ:GSM:MEAS<i>:MEValuation:TRACe:PERRor:MAXimum?

Returns the values of the phase error traces. The results of the current, average and minimum/maximum traces can be retrieved.

Returned values

<Reliability>, Reliability indicator

<Phase Err 1>, ..., <Phase Err n>	n phase error results, depending on the type of modulation 8PSK modulation: 142 values (one value per symbol period) GMSK modulation:588 values (four values per symbol period) Range: -180 deg to +180 deg Def. unit: deg
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.21 Phase Error Measurement Results (Single Values)

The following commands return the phase error results of the multi-evaluation measurement for the "Measured Slot" (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`).

FETCh:GSM:MEAS<i>:MEValuation:PERRor?
READ:GSM:MEAS<i>:MEValuation:PERRor?

Returns the RMS and peak phase error values measured in the "Measured Slot". In addition to the current value statistical values are returned (average, minimum/maximum, standard deviation and 95th percentile).

Returned values

<Reliability>,	Reliability indicator
<RMS Current>,	Range: -180 deg to +180 deg Def. unit: deg
<RMS Average>,	Range: 0 deg to +180 deg Def. unit: deg
<RMS Min/Max>,	Range: -180 deg to +180 deg Def. unit: deg
<RMS Std Dev>,	Range: 0 deg to +90 deg Def. unit: deg
<Peak Current>,	Range: -180 deg to +180 deg Def. unit: deg
<Peak Average>,	Range: 0 deg to +180 deg Def. unit: deg
<Peak Min/Max>,	Range: -180 deg to +180 deg Def. unit: deg
<Peak Std Dev>,	Range: 0 deg to +90 deg Def. unit: deg

<95th Percentile>	Range: 0 deg to +180 deg Def. unit: deg
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.22 Power vs Time Measurement Results (Trace)

The following commands return the power vs. time trace results of the multi-evaluation measurement.

FETCh:GSM:MEAS<i>:MEValuation:TRACe:PVTime:CURRent?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:PVTime:AVERage?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:PVTime:MINimum?
FETCh:GSM:MEAS<i>:MEValuation:TRACe:PVTime:MAXimum?

READ:GSM:MEAS<i>:MEValuation:TRACe:PVTime:CURRent?
READ:GSM:MEAS<i>:MEValuation:TRACe:PVTime:AVERage?
READ:GSM:MEAS<i>:MEValuation:TRACe:PVTime:MINimum?
READ:GSM:MEAS<i>:MEValuation:TRACe:PVTime:MAXimum?

Returns the values of the power vs. time traces. 16 results are available for each symbol period of the measured slots (`CONFigure:GSM:MEAS<i>:MEValuation:MSLots`). The results of the current, average minimum and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<PvT 1>, ..., <PvT n>	n power results, 16 for each symbol period of the measured slots Range: –100.0 dBm to +57.0 dBm Def. unit: dBm
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.23 Power vs Time Measurement Results (Single Values)

The following commands return the statistical power vs. time results of the multi-evaluation measurement.

FETCh:GSM:MEAS<i>:MEValuation:PVTime?
READ:GSM:MEAS<i>:MEValuation:PVTime?

Returns burst power values for slot 0 to slot 7. In addition to the current value statistical values are returned (average, minimum and maximum). The relative number of bursts out of tolerance is also returned.

Returned values

<Reliability>,	Reliability indicator
<Average 0>, ..., <Average 7>, <Current 0>, ..., <Current 7>, <Maximum 0>, ..., <Maximum 7>, <Minimum 0>, ..., <Minimum 7>,	"Average", "Current", "Maximum" and "Minimum" burst power values for slot 0 to slot 7 Range: -137 dBm to +53 dBm Def. unit: dBm
<Out Tolerance>	Percentage of measurement intervals / bursts of the statistic count (`CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:PVTime`) exceeding the specified limits, see Limits (Power vs. Time). Range: 0 % to 100 % Def. unit: %
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.24 Spectrum Modulation Measurement Results

The following commands return the spectrum modulation frequency (ACP modulation) results of the multi-evaluation measurement.

FETCh:GSM:MEAS<i>:MEValuation:TRACe:SMODulation:FREQuency?
READ:GSM:MEAS<i>:MEValuation:TRACe:SMODulation:FREQuency?

Returns the average burst power measured at a series of frequencies. The frequencies are determined by the offset values defined via the command CONFigure:GSM:MEAS<i>:MEValuation:SMODulation:FOFFsets. All defined offset values are considered (irrespective of their activation status).

Returned values

<Reliability>,	Reliability indicator
<Pow Offset -19>, ..., <Pow Offset -0>, <Pow Carrier>, <Pow Offset +0>, ..., <Pow Offset +19>	<Pow Offset +/-n> refers to the average burst power at the carrier frequency +/- the frequency offset value number n. Range: -100 dB to 20 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:SMODulation?
READ:GSM:MEAS<i>:MEValuation:SMODulation?

Returns general spectrum modulation frequency results.

Returned values

<Reliability>,	Reliability indicator
<Out of Tol>,	Percentage of measurement intervals / bursts of the statistic count (CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:SMODulation) exceeding the specified limits, see Limits (Spectrum Modulation) Range: 0 % to 100 % Def. unit: %
<Carrier Power>	Measured carrier output power (reference power) Range: -100 dBm to +100 dBm Def. unit: dBm

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.25 Spectrum Switching Measurement Results

The following commands return the spectrum switching frequency (ACP switching) results of the multi-evaluation measurement.

FETCh:GSM:MEAS<i>:MEValuation:TRACe:SSWitching:FREQuency?
READ:GSM:MEAS<i>:MEValuation:TRACe:SSWitching:FREQuency?

Returns the maximum burst power measured at a series of frequencies. The frequencies are determined by the offset values defined via the command `CONFigure:GSM:MEAS<i>:MEValuation:SSWitching:FOFFsets`. All defined offset values are considered (irrespective of their activation status).

Returned values

<Reliability>,	Reliability indicator
<Pow Offset -19>, ..., <Pow Offset -0>, <Pow Carrier>, <Pow Offset +0>, ..., <Pow Offset +19>	<Pow Offset +/-n> refers to the maximum burst power at the carrier frequency +/- the frequency offset value number n. Range: -100 dBm to 100 dBm Def. unit: dBm
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:SSWitching?
READ:GSM:MEAS<i>:MEValuation:SSWitching?

Returns general spectrum switching frequency results.

Returned values

<Reliability>,	Reliability indicator
<Out of Tol>,	Percentage of measurement intervals / bursts of the statistic count (`CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:SSWitching`) exceeding the specified limits, see Limits (Spectrum Switching). Range: 0 % to 100 % Def. unit: %
<Carrier Power>	Measured carrier output power (reference power) Range: -100 dBm to +100 dBm Def. unit: dBm
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.26 Independent Measurement Results (Single Values)

The following commands return measurement results of the multi-evaluation measurement for the "measured slot" (CONFigure:GSM:MEAS<i>:MEValuation:MSLots) that are independent of the measurement type (i.e. the same values are determined e.g. for EVM, magnitude error and phase error measurements).
The results comprise timing error, frequency error, I/Q imbalance, I/Q origin offset, burst power and AM-PM delay.

FETCh:GSM:MEAS<i>:MEValuation:TERRor?
READ:GSM:MEAS<i>:MEValuation:TERRor?

Returns the timing error measured in the "Measured Slot". In addition to the current value statistical values are returned (average, minimum/maximum and standard deviation).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Min/Max>,	Range: -100 Sym to +100 Sym Def. unit: Sym
<Std Dev>	Range: 0 Sym to 100 Sym Def. unit: Sym
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:FERRor?
READ:GSM:MEAS<i>:MEValuation:FERRor?

Returns the frequency error measured in the "Measured Slot". In addition to the current value statistical values are returned (average, minimum/maximum and standard deviation).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Min/Max>,	Range: -5000 Hz to +5000 Hz Def. unit: Hz
<Std Dev>	Range: 0 Hz to 2500 Hz Def. unit: Hz

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:IQIMbalance?
READ:GSM:MEAS<i>:MEValuation:IQIMbalance?

Returns the I/Q imbalance measured in the "Measured Slot". In addition to the current value statistical values are returned (average, maximum and standard deviation).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Maximum>,	Range: -100 dB to 0 dB Def. unit: dB
<Std Dev>	Range: 0 dB to 50 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:IQOFfset?
READ:GSM:MEAS<i>:MEValuation:IQOFfset?

Returns the I/Q origin offset measured in the "Measured Slot". In addition to the current value statistical values are returned (average, maximum and standard deviation).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Maximum>,	Range: -100 dB to 0 dB Def. unit: dB
<Std Dev>	Range: 0 dB to 50 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:BPOWer?
READ:GSM:MEAS<i>:MEValuation:BPOWer?

Returns the burst power measured in the "Measured Slot". In addition to the current value statistical values are returned (average, maximum and standard deviation).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Maximum>,	Range: -137 dBm to 53 dBm Def. unit: dBm
<Std Dev>	Range: -80 dBm to 80 dBm Def. unit: dBm
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:AMPM?
READ:GSM:MEAS<i>:MEValuation:AMPM?

Returns the AM-PM delay measured in the "Measured Slot". In addition to the current value statistical values are returned (average, minimum/maximum and standard deviation). The AM-PM delay is determined for 8PSK modulation only (for other modulation types zeros are returned).

Returned values

<Reliability>,	Reliability indicator
<Current>, <Average>, <Min/Max>,	Range: -0.9225 µs to 0.9225 µs (a quarter of a symbol period) Def. unit: µs
<Std Dev>	Range: 0 µs to 0.46125 µs Def. unit: µs
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.2.27 Measurement Results (Single Values Overview)

The following commands allow to retrieve all single value measurement results.

FETCh:GSM:MEAS<i>:MEValuation:MODulation:AVERage?

FETCh:GSM:MEAS<i>:MEValuation:MODulation:CURRent?
FETCh:GSM:MEAS<i>:MEValuation:MODulation:MAXimum?
FETCh:GSM:MEAS<i>:MEValuation:MODulation:SDEViation?

READ:GSM:MEAS<i>:MEValuation:MODulation:AVERage?
READ:GSM:MEAS<i>:MEValuation:MODulation:CURRent?
READ:GSM:MEAS<i>:MEValuation:MODulation:MAXimum?
READ:GSM:MEAS<i>:MEValuation:MODulation:SDEViation?

Returns the average, current, minimum, and maximum modulation results of the multi-evaluation measurement. Use these commands to retrieve the values in the "Statistics" table of the detailed views column by column.
It is also possible to retrieve only a part of these results using dedicated commands. A reference to the description of the corresponding commands and returned values is given below.

Returned values

<Reliability>,	Reliability indicator
<Bursts Out Tol>,	Percentage of measurement intervals / bursts of the statistic count (`CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:MODulation`) exceeding the specified limits, see Limits (8PSK Modulation) and Limits (GMSK Modulation). Range: 0 % to 100 % Def. unit: %
<EVM RMS>, <EVM Peak>,	see EVM Measurement Results (Single Values)
<MERR RMS>, <MERR Peak>,	see Magnitude Error Measurement Results (Single Values)
<PERR RMS>, <PERR Peak>,	see Phase Error Measurement Results (Single Values)
<IQOF>,	see Measurement Results (Single Values) - ...IQOFfset
<IQIM>,	see Measurement Results (Single Values) - ...IQIMbalance
<TERR>,	see Measurement Results (Single Values) - ...TERRor
<FERR>,	see Measurement Results (Single Values) - ...FERRor
<BPOW>,	see Measurement Results (Single Values) - ...BPOWer
<AMPM Delay>,	see Measurement Results (Single Values) - ...AMPM
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:MODulation:PERCentile?

READ:GSM:MEAS<i>:MEValuation:MODulation:PERCentile?

Returns the 95th percentile results of the multi-evaluation measurement.
It is also possible to retrieve only a part of these results using dedicated commands. A reference to the description of the corresponding commands and returned values is given below.

Returned values

<Reliability>,	Reliability indicator
<Bursts Out Tol>,	Percentage of measurement intervals / bursts of the statistic count (`CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:MODulation`) exceeding the specified limits, see Limits (8PSK Modulation) and Limits (GMSK Modulation). Range: 0 % to 100 % Def. unit: %
<EVM Percentile>,	see EVM Measurement Results (Single Values)
<MERR Percentile>,	see Magnitude Error Measurement Results (Single Values)
<PERR Percentile>	see Phase Error Measurement Results (Single Values)
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:GSM:MEAS<i>:MEValuation:MODulation:OVERview?
READ:GSM:MEAS<i>:MEValuation:MODulation:OVERview?

Returns an overview of all single value measurement results of the multi-evaluation measurement.
It is also possible to retrieve only a part of these results using dedicated commands. A reference to the description of the corresponding commands and returned values is given below.
The symbols (x4)/(x9) behind a value indicate that the list contains four/nine results as follows:

- (x4): Current, Average, Min/Max, Standard Deviation
- (x9): RMS (x4), Peak (x4), 95th Percentile

Returned values

<Reliability>,	Reliability indicator

<Bursts Out Tol>,	Percentage of measurement intervals / bursts of the statistic count (`CONFigure:GSM:MEAS<i>:MEValuation:SCOunt:MODulation`) exceeding the specified limits, see Limits (8PSK Modulation) and Limits (GMSK Modulation). Range: 0 % to 100 % Def. unit: %
<EVM (x9)>,	see EVM Measurement Results (Single Values)
<MERR (x9)>,	see Magnitude Error Measurement Results (Single Values)
<PERR (x9)>,	see Phase Error Measurement Results (Single Values)
<IQOF (x4)>,	see Measurement Results (Single Values) - ...IQOFfset
<IQIM (x4)>,	see Measurement Results (Single Values) - ...IQIMbalance
<TERR (x4)>,	see Measurement Results (Single Values) - ...TERRor
<FERR (x4)>,	see Measurement Results (Single Values) - ...FERRor
<BPOW (x4)>,	see Measurement Results (Single Values) - ...BPOWer
<AMPM Delay>	see Measurement Results (Single Values) - ...AMPM
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

8.4.3 Alphabetical List of Commands (GSM)

Command **Page**

9 WCDMA Applications

The WCDMA firmware applications provide quick and flexible TX tests on WCDMA FDD uplink signals. The tests cover the following UE transmitter properties:

- UE output power over a wide range of slots
- Modulation accuracy
- Adjacent Channel Leakage power Ratio (ACLR)
- Spectrum emissions
- Code Domain Power (CDP)

The transmitter tests can be performed in accordance with standard 3GPP TS 34.121-1, "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) conformance specification; Radio transmission and reception (FDD)". The R&S CMW 500 provides the following WCDMA firmware applications:

- WCDMA Multi-Evaluation Measurement

9.1 WCDMA TX Measurements

WCDMA TX measurements (option R&S CMW-KM400) determine the power, modulation accuracy, frequency, timing, and the Adjacent Channel Leakage Ratio (ACLR) of an uplink WCDMA signal. All WCDMA TX measurements are combined in a single multi-evaluation measurement.

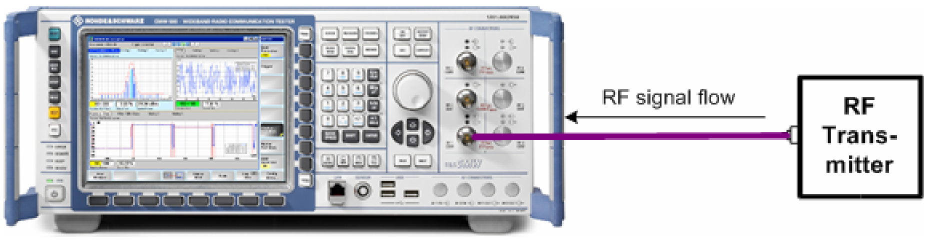
9.1.1 WCDMA Multi Evaluation Measurement

The WCDMA "Multi Evaluation" measurement captures an uplink (UL) WCDMA signal (which may contain HSDPA and HSUPA channels, if the relevant option CMW-KM401 is installed) and provides the TX measurement results over a series of consecutive slots.

The following sections describe how to perform and configure the measurement.

9.1.1.1 Test Setup

The external RF signal source (mobile phone transmitter, signal generator etc.) is connected to one of the RF input connectors RF 1 COM or RF 2 COM at the front panel of the R&S CMW 500. The input level ranges of the connectors are identical; see RF Connectors. No additional cabling and no external trigger is needed.



9.1.1.2 How to Measure an Uplink WCDMA Signal

After connecting your WCDMA UE to the R&S CMW 500 as shown above, you have to adjust the following analyzer settings to the properties of the analyzed UL WCDMA signal:

- The analyzer "Frequency"
- The "Expected Nominal Power" and (optional) a "User Margin" and "External Attenuation". Recommended values: "Expected Nominal Power" = peak power of the UE signal over the entire measurement range; "User Margin" = 0 dB (the smallest possible value ensures maximum dynamic range).

For synchronization to the received signal and proper decoding, the "UE Signal Info" settings in the configuration menu must be in accordance with the measured signal. In particular, ensure that the following parameters match up:

- The "Scrambling Code" and the "UL DPCCH Slot Format"
- The information whether the UL signal contains a single DPCCH or a DPCCH plus a DPDCH ("UL DPDCH Available").

The R&S CMW 500 can auto-detect the spreading factor of the DPDCH and the corresponding symbol rate.

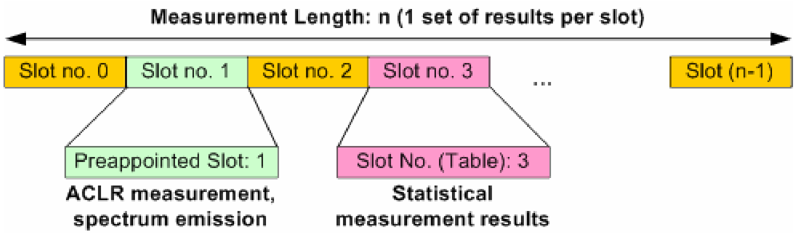
With matching "UE Signal Info" settings, the R&S CMW 500 is able to decode the WCDMA UL signal and determine its slot timing. No additional measurement trigger is required. Non-matching "UE Signal Info" settings generally result in large EVM results.

9.1.1.3 Defining the Scope of the Measurement

The WCDMA "Multi Evaluation" measurement is a multislot application: The R&S CMW 500 can measure up to 120 consecutive WCDMA slots (8 frames) in a single measurement cycle and store the measurement results for each slot. The total number n of slots per measurement cycle is termed the "Measurement Length" (slots no. 0 to n – 1).

Within this measurement interval, two individual slots are selected for a more detailed analysis:

- The "Preappointed Slot" is used to measure the Adjacent Channel Leakage power Ratio (ACLR)and the spectrum emissions.
- The "Slot Number (Table)" is used to draw up a statistics of the modulation and code domain power results. Statistical results are relevant in particular if the "Measurement Length" is measured repeatedly; see Statistical Settings .



The "Preappointed Slot" and the "Slot Number (Table)" are completely independent from each other. See "WCDMA Multi Evaluation: Results" on page 304.

WCDMA frame synchronization

The trigger settings (see below) ensure WCDMA slot and frame synchronization with the analyzed UL WCDMA signal. The "Measurement Length" can start with any WCDMA slot number, depending on the "Synchronization" setting.

9.1.1.4 Trigger Modes

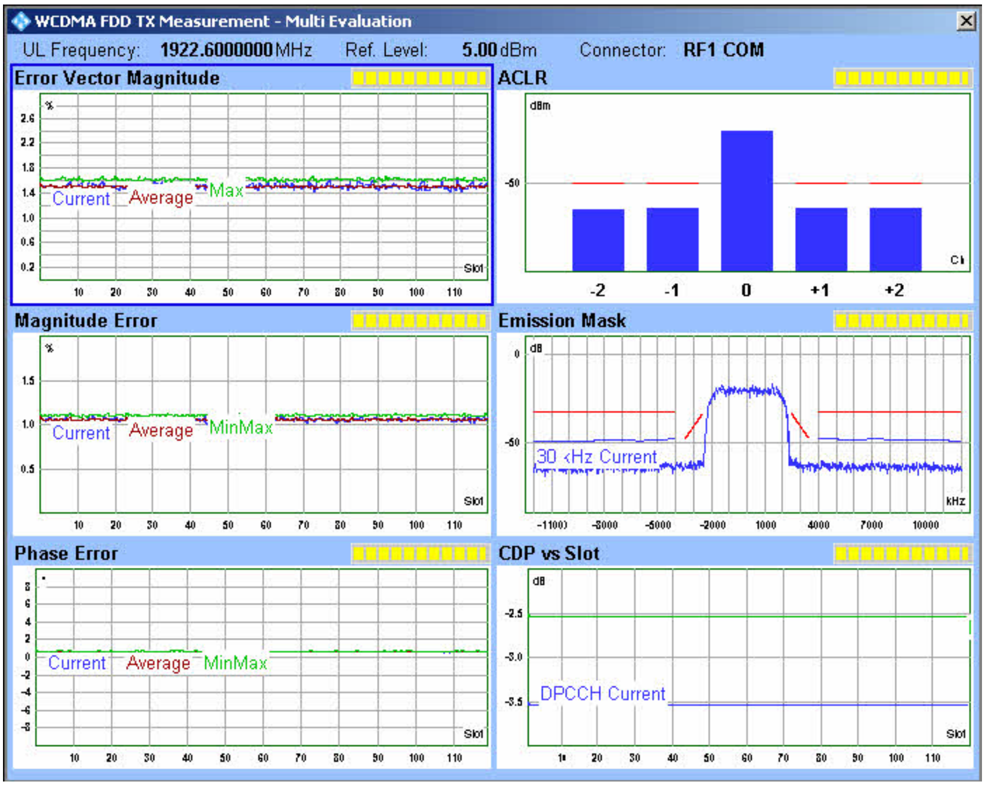
The WCDMA "Multi Evaluation" measurement is triggered by the analyzer RF signal. The R&S CMW 500 decodes the signal to derive its slot and frame timing so that the "Measurement Length" can start at a frame boundary of the UL WCDMA signal or at any selected slot within the frame (see "Synchronization"). The "Trigger Source" settings determine how often the R&S CMW 500 repeats slot and frame synchronization, if the measurement extends over more than one measurement cycle.

9.1.1.5 WCDMA Multi Evaluation: Results

The results of the WCDMA multi-evaluation measurement are displayed in several different views. Use the "Display" parameters to select the views and to change the appearance and contents of the views.
Below the title bar, all views show the most important RF and analyzer settings; see Signal Routing and Analyzer Settings.

Overview

In the overview dialog, up to six diagrams display the Error Vector Magnitude (EVM), Magnitude Error, Phase Error (left side), and the ACLR, Spectrum Emission Mask, and CDP vs. Slot results.



WCDMA Multi Evaluation: Overview

The "Overview" dialog contains two types of results:

Error Vector Magnitude, Magnitude Error, and Phase Error

The three upper diagrams cover a time interval of up to 120 slots. The "Current" traces contain one measurement result per slot, which is calculated as the average of the measured quantity of all samples in the slot, excluding a 25 µs guard period at the beginning and at the end. The "Average" and "MinMax" traces are calculated according to the general rules for statistical results.

ACLR

The ACLR results are measured in the "Preappointed Slot". The central bar shows the power at the nominal carrier frequency (UL Frequency); the bars ±1 correspond to the 1st adjacent channels (±5 MHz from the UL frequency) and the 2nd adjacent channels (±10 MHz from the UL frequency).

The method of measurements ensures that the results correspond to the ACLR specified in standard 3GPP TS 34.121 where a WCDMA channel filter is used.

According to the standard, ACLR tests must be carried out at maximum output power of the UE.

Emission Mask

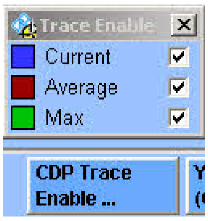
The spectrum emission of the UE is measured in the "Preappointed Slot". The measurement covers a symmetric, 25 MHz wide frequency range around the UE center carrier frequency. The maximum display range is [carrier frequency – 12.5 MHz, carrier frequency + 12.5 MHz]. According to the standard 3GPP TS 34.121, a resolution filter of Gaussian shape with a bandwidth of 30 kHz (for frequencies between 2.515 MHz and 3.485 MHz from the carrier) or 1 MHz (for frequencies between 4 MHz and 12 MHz) is used. All measured spectrum emission values are relative to the UE output power measured in a 3.84 MHz bandwidth (reference power).

CDP vs Slot

The CDP vs Slot diagram covers a time interval of up to 120 slots. The CDP measurement provides a comparison of the DPCCH and the DPDCH powers within the UL WCDMA signal. Note that the channelization code of the DPCCH is fixed ($C_{256,0}$, Q signal), whereas the f the Q-signal whereas the DPDCH can use variable spreading factors and channelization codes.

The "Overview" dialogs can be modified as follows:

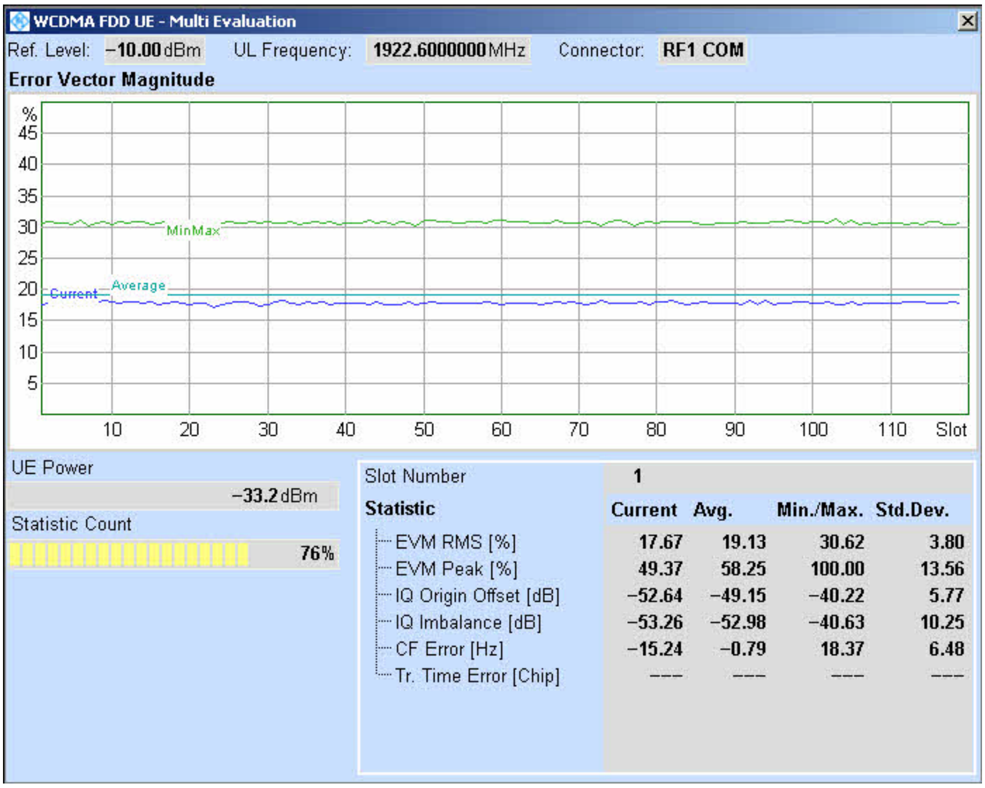
- Click a diagram to select this diagram. Press ENTER or the rotary knob to open the detailed view for this diagram.
- Press "Display > ...Trace Enable..." to select the displayed trace types.



- Use the "Multi Evaluation" settings in the configuration menu to modify the scope of the measurement. Note that a half-slot "Measurement Period" increases the number of results in the upper three diagrams by a factor of two.

Detailed Views: Modulation and Code Domain Power

Each of the detailed views shows a diagram and a statistical overview of single-slot results. The WCDMA multi-evaluation measurement provides four different detailed views, corresponding to the three modulation diagrams (Error Vector Magnitude (EVM), Magnitude Error, Phase Error) and to the ACLR diagram.
An example (Error Vector Magnitude) is shown below.



WCDMA Multi Evaluation: EVM

The following single-slot results appear in the detailed views:

UE Power

Transmitter output power of the UE in the "Preappointed Slot", measured in a bandwidth of at least (1+ α) times the chip rate, where a is the roll-off factor of the WCDMA channel filter. The UE power corresponds to the "mean power" defined in standard 3GPP TS 34.121. For a perfectly modulated WCDMA signal, it is approx. 0.246 dB above the central value of the ACLR diagram (channel 0), which is obtained with a WCDMA channel filter.

Statistic Count

Progress bar for the measurement. During the first single shot after the start of the measurement, the bar shows the current measurement interval relative to the "Statistic Length" (see Statistical Settings).

The statistical single-slot results appear in the three modulation views:

Slot Number

Number of the "Slot Number (Table)" within the measurement interval. All results below are based on this slot.

Statistic

Statistical evaluation of the modulation results in the preappointed slot. The table contains four rows. For each modulation result the values are calculated as follows:

- **Current:** Value of the modulation result obtained in the last measurement interval. For EVM, magnitude and phase error, a current RMS result (the average over all samples in the preappointed slot except the guard period) and current peak value (the peak of all samples the preappointed slot except the guard period) is available.
- **Avg.:** Average of all "Current" values referenced to the last statistics cycle.
- **Min./Max.:** Largest or smallest "Current" value that the R&S CMW 500 obtained since the start of the measurement.
- **Std. Dev.:** Standard deviation of all "Current" values since the start of the measurement.

The results in the table are calculated according to the general rules for statistical evaluations.

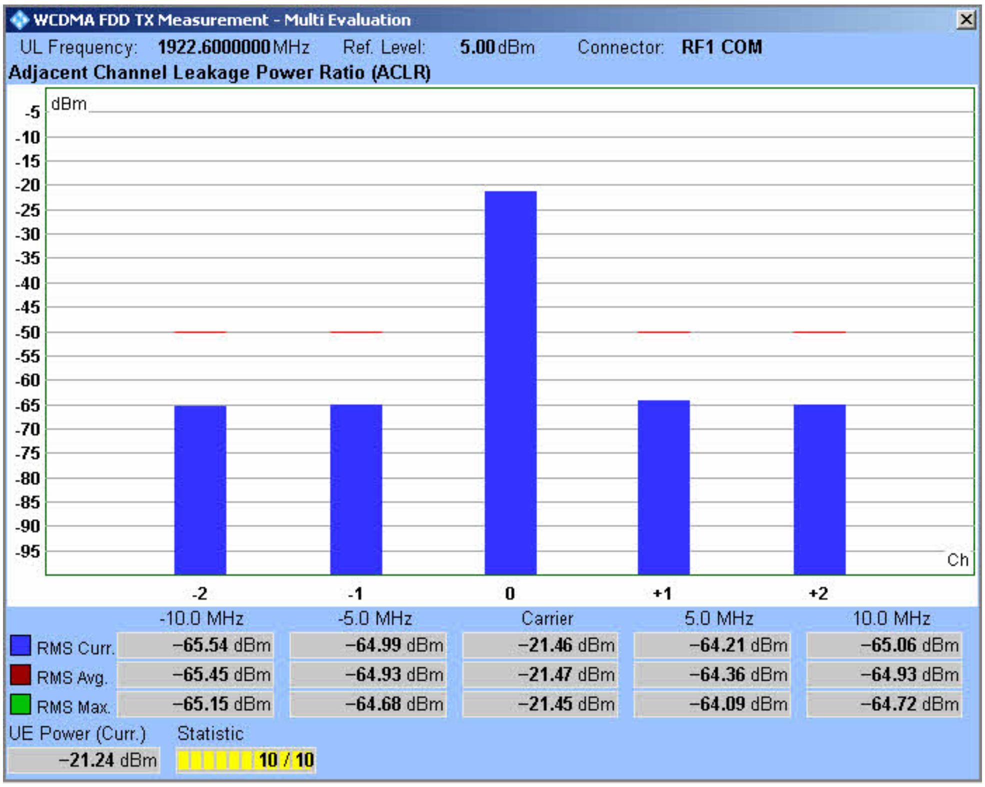
The transmit time error ("Tr. Time Error [Chip]") is not available in the present firmware version.

The detailed dialogs can be modified as follows:

- Press "Display > ...Trace Select..." to select the trace types to be displayed in the diagram.
- Use the "Multi Evaluation" settings in the configuration menu to modify the scope of the measurement or change the "Slot Number (Table)". Note that a half-slot "Measurement Period" increases the number of results in the modulation and Code Domain Power diagrams by a factor of two.
- Press "Display > Overview" to switch back to the overview diagram.

Detailed Views: ACLR

The ACLR in the "Preappointed Slot" is displayed in a bar graph (see Overview) and as a table of statistical results.



WCDMA Multi Evaluation: ACLR

The statistical ACLR results are calculated for the nominal "Carrier" frequency (UL Frequency); the 1st adjacent channels (±5 MHz from the UL frequency) and the 2nd adjacent channels (±10 MHz from the UL frequency). All results can be displayed in the bar graph; see below.

RMS Curr.
RMS power of the current measurement interval.

RMS Avg.
Average of the "RMS Curr." values referenced to the last statistics cycle; see Averaging.

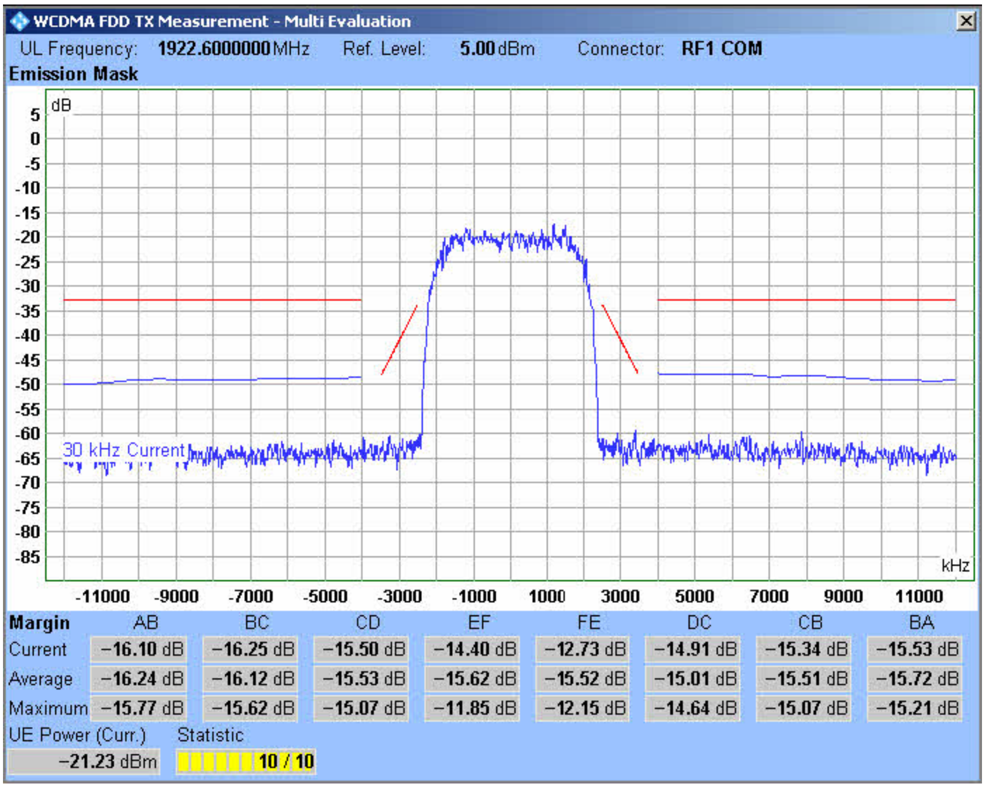
RMS Max.
Maximum of all "RMS Curr." values since the start of the measurement.

The "UE Power" and the "Statistic" results are calculated as described above (Detailed Views: Modulation and Code Domain Power).

- Press "Display > ...Trace Select..." to select the statistical results to be displayed in the diagram.
- Use the "Multi Evaluation" settings in the configuration menu to modify the scope of the measurement or change the "Preappointed Slot".
- Press "Display > Overview" to switch back to the overview diagram.

Detailed Views: Spectrum Emission Mask

The spectrum emissions in the "Preappointed Slot" are displayed in a diagram (see Overview) and as a table of statistical results.



WCDMA Multi Evaluation: Emission Mask

The emission mask results are calculated in resolution bandwidths of 30 kHz (lower blue curve, including the center) and 1 MHz (upper curves at offset frequencies larger than 3.5 MHz). The table below the diagram contains the values which are relevant for the limit check; see "Conformance Requirements".

Current

RMS power in the current measurement interval, averaged over a limit line section.

Average

Average of the "Current" values referenced to the last statistics cycle; see Averaging.

Maximum

Maximum of all "Current" values since the start of the measurement.

The "UE Power" and the "Statistic" results are calculated as described above (Detailed Views: Modulation and Code Domain Power).

- Press "Display > ...Trace Select..." to select the statistical results to be displayed in the diagram.

- Use the "Multi Evaluation" settings in the configuration menu to modify the scope of the measurement or change the "Preappointed Slot".
- Press "Display > Overview" to switch back to the overview diagram.

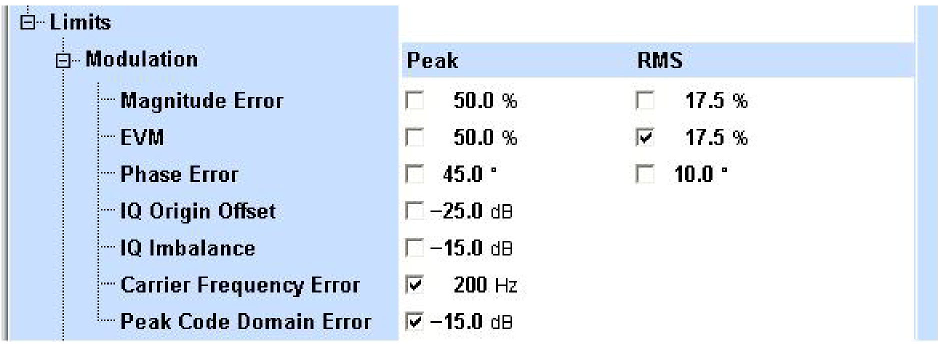
9.1.1.6 Conformance Requirements and Limit Settings

Conformance requirements for WCDMA transmitter tests are specified in standard 3GPP TS 34.121, section 5, "Transmitter Characteristics".
The following sections give an overview of the test requirements and the R&S CMW 500 limit settings.

- Transmit Modulation
- ACLR
- Spectrum Emission Mask

Transmit Modulation Limits

A poor modulation accuracy of the UE transmitter increases the transmission errors in the uplink channel of the WCDMA network. The Error Vector Magnitude (EVM) is the critical quantity to assess the modulation accuracy of a WCDMA UE.
According to the 3GPP standard, the EVM measured at UE output powers ≥ −20 dBm and under normal operating conditions shall not exceed 17.5 %. The frequency error shall not exceed ±0.1 ppm. These limits can be set in the configuration dialog, along with limits for the other measured quantities.

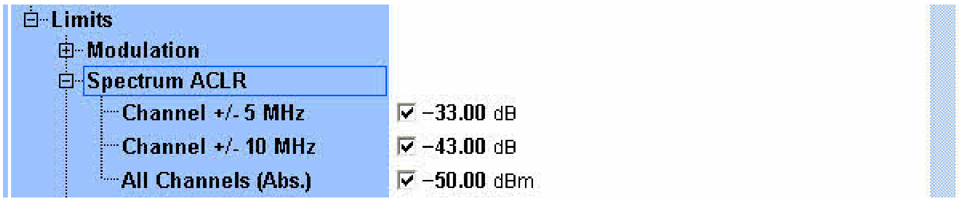


The table below lists the test requirements of standard 3GPP TS 34.121.

Characteristics	Refer to 3GPP TS 34.121, section...	Specified Limit
EVM (RMS)	5.13.1 Error Vector Magnitude (EVM) 5.13.1A Error Vector Magnitude (EVM) with HS-DPCCH	< 17.5 %
Peak Code Domain Error	5.13.2 Peak Code Domain Error	<–15 dB
Frequency Error	5.3 Frequency Error	< 0.1 ppm

ACLR Limits

The energy that spills outside the designated radio channel increases the interference with adjacent channels and decreases the system capacity. The amount of unwanted off-carrier energy is assessed by the out-of-band emissions (excluding spurious emissions) that are specified in terms of the Adjacent Channel Leakage power Ratio (ACLR) and the Spectrum Emission Mask. The ACLR limits are defined in the configuration menu.



For both power class 3 and power class 4 UE, the ACLR shall not exceed –33 dB at frequencies ±5 MHz from the carrier (channels ±1) and –43 dB at frequencies ±10 MHz from the carrier (channels ±2). The limits must be met if the adjacent channel power is larger than –50 dBm (absolute limit); they must hold even in the presence of switching transients.

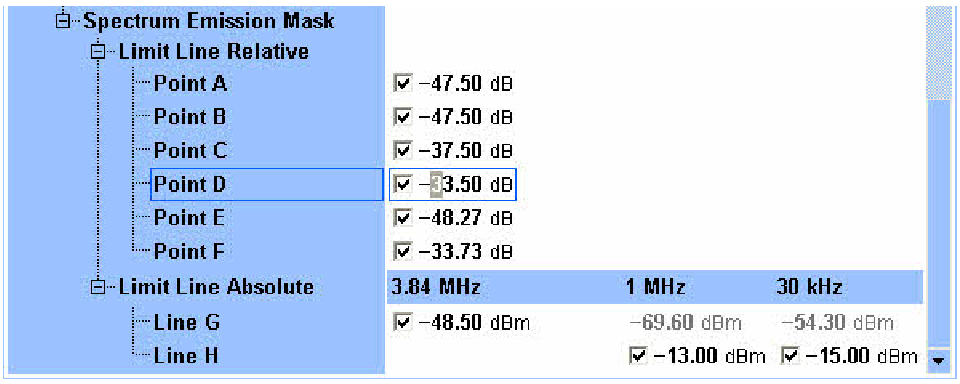
The table below lists the test requirements of standard 3GPP TS 34.121.

Characteristics	Refer to 3GPP TS 34.121, section...	Specified Limit
ACLR	5.10 Adjacent Channel Leakage power Ratio (ACLR) 5.10A Adjacent Channel Leakage power Ratio (ACLR) with HS-DPCCH 5.10B Adjacent Channel Leakage power Ratio (ACLR) with E-DCH	<–33 dB (channels ±1) <–43 dB (channels ±2)[1)]

1) For compatibility with other R&S CMW 500 measurements, we define the ACLR and the limits with a relative minus sign compared to the 3GPP standard.

Spectrum Emission Mask

The spectrum emission mask complements the ACLR Limits. The limits are defined in the configuration menu.



The mask is defined as shown below. The R&S CMW 500 settings are shown in green color.

Spectrum Emission Mask

Frequency Offset from carrier Δf	Minimum requirement	Additional requirement for bands II, IV, V, X	Measurement bandwidth

Frequency Offset from carrier Δf	Minimum requirement	Additional requirement for bands II, IV, V, X	Measurement bandwidth
2.5 MHz to 3.5 MHz	–33.5 dBc – 15*(Δf/MHz – 2.5) dBc **(--> Point E, F)**	–15 dBm **(--> Line H)**	30 kHz[2)]
3.5 MHz to 7.5 MHz	–33.5 dBc – 1*(Δf/MHz – 3.5) dBc **(--> Point C, D)**	–13 dBm **(--> Line H)**	1 MHz[3)]
7.5 MHz to 8.5 MHz	–37.5 dBc – 10*(Δf/MHz – 7.5) dBc **(--> Point B, C)**	–13 dBm **(--> Line H)**	1 MHz[3)]
8.5 MHz to 12.5 MHz	–47.5 dBc **(--> Point A, B)**	–13 dBm **(--> Line H)**	1 MHz[3)]

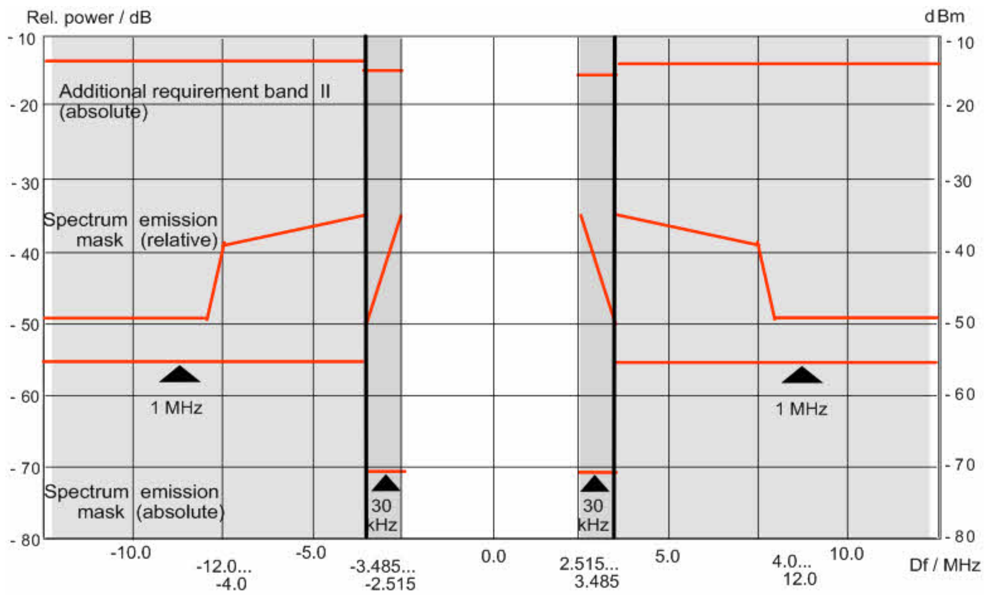
Note 1) Δf is the separation between the carrier frequency and the center of the measurement bandwidth. Each linear limit line section is defined by a pair of points (A, B), (B, C) ... (E, F), assuming a linear power/frequency dependence. The points correspond to the frequency offsets ±12.5 MHz (A), ±8.5 MHz (B), ±7.5 MHz (C), ±4.0 MHz (D), ±3.845 MHz (E), ±2.515 MHz (F).
Note 2) The first and last measurement position with a 30 kHz filter is 2.515 MHz and 3.485 MHz.
Note 3) The first and last measurement position with a 1 MHz filter is 4 MHz and 12 MHz.
Note 4) The limit specifications in the table above only apply if the power in the measured frequency range exceeds the absolute limit of –48.5 dBm referenced to a 3.84 MHz filter **(--> Line G)**. This implies that the absolute spectrum emissions must be:

$$-48.5\ \text{dBm} + 10 \cdot \log_{10}\left(\frac{1}{3.84}\right)\text{dB} \approx -54.3\ \text{dBm}$$

in frequency domains where they are measured with a 1 MHz filter, above the value and

$$-48.5\ \text{dBm} + 10 \cdot \log_{10}\left(\frac{0.03}{3.84}\right)\text{dB} \approx -69.6\ \text{dBm}$$

in frequency domains where they are measured with a 30 kHz filter, above the value.
Signals with smaller powers always pass the entire limit check.
The complete spectrum emission mask is (for band II) shown in the figure below.



Spectrum emission mask (band II)

9.2 WCDMA GUI Reference

The following sections provide detailed reference information on the parameters of the WCDMA application. The R&S CMW 500 provides the following WCDMA measurements:

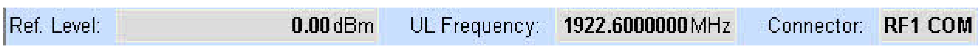
- Multi Evaluation

9.2.1 WCDMA Multi Evaluation: Parameters and Settings

The WCDMA multi-evaluation measurement is configured using the following groups of settings:

- Measurement Control
- Signal Routing and Analyzer Settings
- UE Signal Info
- Multi Evaluation Settings
- Trigger Settings
- Limits

The most important measurement settings are also displayed in the measurement dialog.



The measurement dialog provides all Measurement Results.

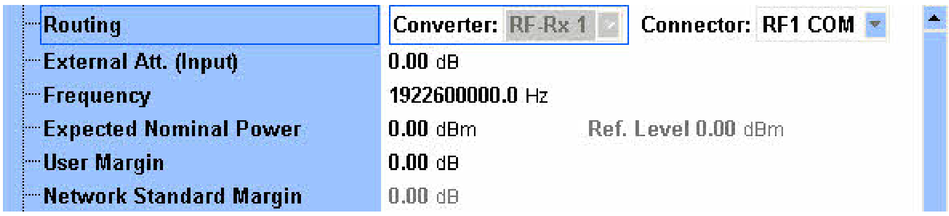
9.2.1.1 Measurement Control

The measurement is turned on or off using the "Multi Evaluation" measurement control softkey and the ON | OFF or RESTART | STOP front panel keys.

Multi Evaluation (Softkey)
Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via remote control.
GPIB command:
`INITiate:WCDMa:MEASurement<i>:MEValuation`
`ABORt:WCDMa:MEASurement<i>:MEValuation`
`STOP:WCDMa:MEASurement<i>:MEValuation`
`FETCh:WCDMa:MEASurement<i>:MEValuation:STATe?`
`FETCh:WCDMa:MEASurement<i>:MEValuation:STATe:ALL?`

9.2.1.2 Signal Routing and Analyzer Settings

The measurement is configured using the parameters in the "Multi Evaluation Configuration" dialog. The following parameters configure the RF input path.



Multi evaluation configuration: Signal routing and analyzer settings

RF Routing
Selects the input connector for the measured RF signal; see connector selection.
GPIB command:
`ROUTe:WCDMa:MEASurement<i>:RFSettings:CONNector`

External Attenuation (Input)
Defines the value of an external attenuation (or gain, if the value is negative) in the input path.
The external attenuation also enters into the internal calculation of the maximum input power that the R&S CMW 500 can measure (see "Expected Nominal Power" below).
GPIB command:
`CONFigure:WCDMa:MEASurement<i>:RFSettings:EATTenuation`

Frequency
Center frequency of the RF analyzer. Set this frequency to the frequency of the measured RF signal to obtain a meaningful measurement result.
GPIB command: `CONFigure:WCDMa:MEASurement<i>:RFSettings:FREQuency`

Expected Nominal Power
Defines the nominal powerof the RF signal to be measured. An appropriate value for WCDMA signals is the peak output power at the DUT during the measurement interval (see "Network Standard Margin" below). The "Ref. Level" is calculated as the expected peak power at the output of the DUT:
Reference power = Expected Nominal Power + User Margin + Network Standard Margin

Maximum input power
The actual input power at the connectors (i.e. the "Reference Level" minus the "External Attenuation (Input)" value, if all power settings are configured correctly) must be within the level range of the selected RF input connector; refer to the "Specifications".

GPIB command: `CONFigure:WCDMa:MEASurement<i>:RFSettings:ENPower`

User Margin
Margin that the R&S CMW 500 adds to the "Expected Nominal Power" in order to determine its reference power; see above. The "User Margin" is typically used to account for the known variations of the RF input signal power, e.g. the variations due to a specific channel configuration.
The appropriate values depend on the configuration of the UL WCDMA signal, e.g. on the active channels and gain factors. For a 12.2 kbps Reference Measurement Channel (RMC), a value of 5 dB is appropriate.
GPIB command: `CONFigure:WCDMa:MEASurement<i>:RFSettings:UMARgin`

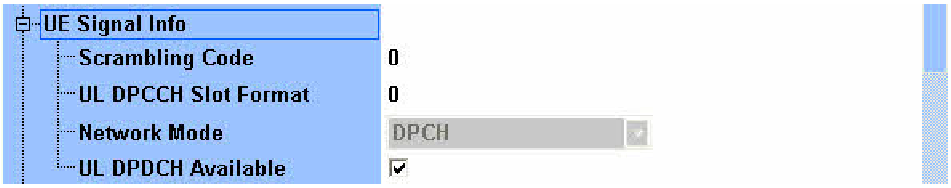
Network Standard Margin

Display of an appropriate correction factor for the reference power, accounting for an expected crest factor of the RF input signal. The network margin depends on the typical signal shape and the typical power measurements in the network.

In general, it is not possible to predict the crest factor for WCDMA UL signals and WCDMA conformance tests with good accuracy. Consequently, no network margin (corresponding to a value of 0 dB) is used. It is recommended to choose the "Expected Nominal Power" as the peak power of the measured signal; see above.

9.2.1.3 UE Signal Info

The "UE Signal Info" parameters describe properties of the measured uplink WCDMA signal that the R&S CMW 500. needs for synchronization and decoding.



Multi evaluation configuration: UE Signal Info

Scrambling Code
Number of the long code that is used to scramble the uplink WCDMA signal. The scrambling code number must be in the range 0 to FFFFFF (hex) corresponding to 0 to 16777215 decimal.
GPIB command: CONFigure:WCDMa:MEASurement<i>:UESignal:SCODe

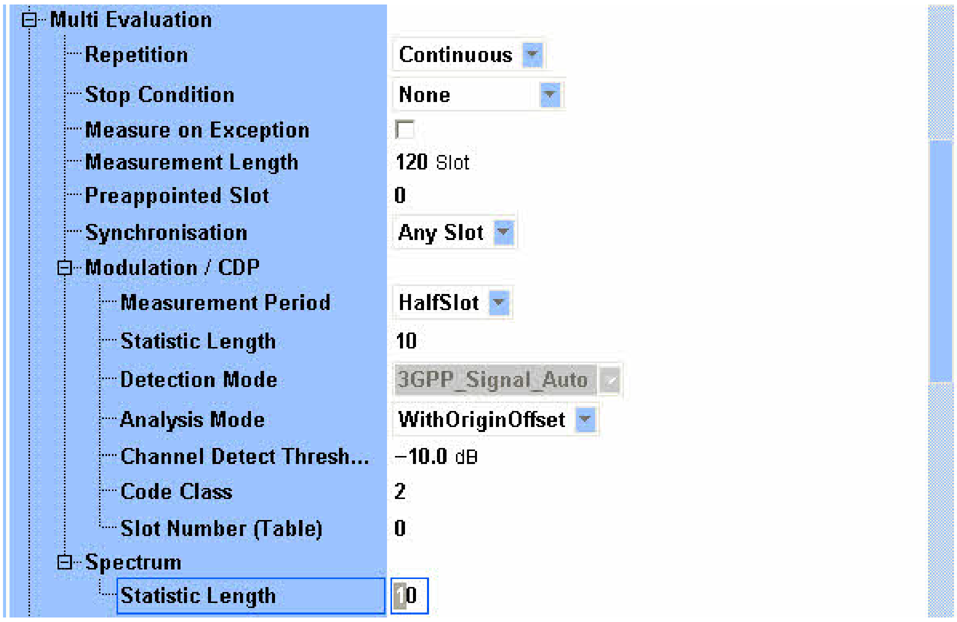
UL DPCCH Slot Format
Uplink DPCCH slot format in the range between 0 and 5. The slot format defines the length of the individual data fields in the DPCCH. The multi-evaluation measurement can be performed with arbitrary UL slot formats, including the slot formats with variable transport format (1, 3, 4).
GPIB command: CONFigure:WCDMa:MEASurement<i>:UESignal:SFORmat

Network Mode
Active channel types in the UL WCDMA signal. The R&S CMW 500 can measure a signal carrying a single DPCH according to standard 3GPP/FDD, release 99.
GPIB command: CONFigure:WCDMa:MEASurement<i>:UESignal:ACHannels?

UL DPDCH Available
Presence of a DPDCH in the UL DPCH signal. The R&S CMW 500 can measure a signal containing a single DPCCH (box cleared) or one DPCCH plus one DPDCH (box selected).
GPIB command: CONFigure:WCDMa:MEASurement<i>:UESignal:DPDCh

9.2.1.4 Multi Evaluation Settings

The "Multi Evaluation" parameters configure the scope of the measurement.



Multi evaluation configuration: scope

Repetition

Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.
- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.

The "Repetition" mode is set via softkey/hotkey combination: "Multi Evaluation > Repetition...".

GPIB command:

`CONFigure:WCDMa:MEASurement<i>:MEValuation:REPetition`

Stop Condition

Specifies the conditions for an early termination of the measurement.

None	The measurement is performed according to its "Repetition" mode and "Statistic Length" (see Statistical Settings), irrespective of the limit check results.

On Limit Failure The measurement is stopped as soon as one of the limits is exceeded, irrespective of the repetition mode set. If no limit failure occurs, it is performed according to its "Repetition" mode and "Statistic Length". Use this setting for measurements that are essentially intended for checking limits, e.g. production tests.

GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:SCONdition`

Measure on Exception

Specifies whether measurement results that the R&S CMW 500 identifies as faulty or inaccurate are rejected. A faulty result occurs e.g. when an overload is detected. In remote control, the cause of the error is indicated by the reliability indicator.

Off Faulty results are rejected. The measurement is continued; the statistical counters are not re-set. Use this mode to ensure that a single faulty result does not affect the entire measurement.

On Results are never rejected. Use this mode e.g. for development purposes, if you want to analyze the reason for occasional wrong transmissions.

GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:MOEXception`

Multi Evaluation – Measurement Length

Defines the number of consecutive slots that form a single measurement interval; see Defining the Scope of the Measurement. The measured slots are displayed in the "Error Vector Magnitude", "Magnitude Error", and "Phase Error" diagrams.

GPIB command: `CONFigure:WCDMa:MEASurement<i>:MEValuation:MSCount`

Multi Evaluation – Preappointed Slot

Selects the slot to be used for the ACLR and spectrum emission measurement. See "Defining the Scope of the Measurement" on page 303.

GPIB command: `CONFigure:WCDMa:MEASurement<i>:MEValuation:PSLot`

Multi Evaluation – Synchronization

Selects a slot number within the UL WCDMA frames (0 to 14) that the R&S CMW 500 will display as the first slot in the measurement interval. "Any" means that the measurement is not synchronized to the UL WCDMA frame structure; the measurement will start as fast as possible, beginning with the first captured slot.

GPIB command: `CONFigure:WCDMa:MEASurement<i>:MEValuation:MSLot`

Multi Evaluation – Modulation /CDP – Measurement Period

Selects a half-slot or a full-slot measurement.

Full Slot The modulation measurement results are based on the entire WCDMA slots (667 µs), excluding a 25 µs guard period at the beginning and at the end. The modulation diagrams in the measurement dialog show one value per slot. This measurement is appropriate for signal configurations where the UE power is not expected to change within the slot (e.g. a pure DPCH without HSDPA channels).

Half Slot The modulation measurement results are based on half the WCDMA slot (333 µs), excluding a 25 µs guard period at the beginning and at the end of each half slot. The modulation diagrams in the measurement dialog show two values per slot. This measurement is appropriate for signal configurations where the UE power changes within the slot (e.g. a DPCH + HSDPA channel configuration with appropriate timing offset).

GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:MPERiod:MODulation`

Multi Evaluation – Modulation /CDP – Statistic Length
Multi Evaluation – Spectrum – Statistic Length

Defines the number of measurement intervals per measurement cycle (single shot measurement); see Statistical Settings. This value is also relevant for continuous measurements, because the averaging procedures depend on the statistic count; see Statistical Results.

In the WCDMA multi-evaluation measurement, the measurement interval is completed when the R&S CMW 500 has measured the full sequence of "Measured Slots". The measurement provides two independent statistic lengths for the modulation and spectrum results. In single shot mode and with a shorter spectrum statistic length, the ACLR evaluation is stopped while the R&S CMW 500 still continues providing new modulation results.

GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:SCOunt:MODulation`
`CONFigure:WCDMa:MEASurement<i>:MEValuation:SCOunt:SPECtrum`

Multi Evaluation – Modulation /CDP – Detection Mode

In the "3GPP Signal Auto" detection mode, the R&S CMW 500 uses the scrambling code and slot format information to synchronize to the received signal, irrespective of the channel configuration.

GPIB command:`CONFigure:WCDMa:MEASurement<i>:DMODe:MODulation`

Multi Evaluation – Modulation /CDP – Analysis Mode

Defines whether a possible origin offset is included in the measurement results or subtracted out; see I/Q Offset and I/Q Imbalance in chapter "System Overview".

With Origin Offset The results for the EVM, phase error and magnitude error include a possible origin offset. This mode conforms to 3GPP specifications.

No Origin Offset The origin offset is subtracted out.

I/Q Imbalance
The analysis mode affects the EVM, magnitude and phase error results.

GPIB command:
CONFigure:WCDMa:MEASurement<i>:MEValuation:AMODe:MODulation

Multi Evaluation – Modulation /CDP – Channel Detection Threshold
Minimum signal strength of the DPDCH in the WCDMA signal (if present) to be detected and evaluated. The threshold corresponds to the ratio of the DPDCH power to the DPCCH power in dB. Channels with a power below the threshold are not considered for the calculation of modulation and CDP results.
The channel detection threshold is important to distinguish the DPDCH from unwanted signals, e.g. noise or non-orthogonal components that may be detected as fictitious DPDCHs. A high threshold value represents a weaker selection criterion and increases the risk of detecting unwanted signals. On the other hand a low threshold may prevent the detection of real DPDCH signals.
GPIB command:
CONFigure:WCDMa:MEASurement<i>:MEValuation:CDTHreshold:MODulation

Multi Evaluation – Modulation /CDP – Slot Number (Table)
Selects a particular slot within the "Measurement Length" where the R&S CMW 500 evaluates the statistical measurement results.See "Defining the Scope of the Measurement" on page 303
GPIB command:
CONFigure:WCDMa:MEASurement<i>:MEValuation:SSCalar:MODulation

9.2.1.5 WCDMA Multi Evaluation Configuration: Trigger

The "Trigger" parameters configure the trigger system for the WCDMA multi-evaluation measurement.

Multi evaluation configuration: Trigger

Trigger Source
Selects the source of the trigger events.

Free Run(Standard) Trigger provided by analyzed RF signal: The R&S CMW 500 decodes the signal to derive its slot and frame timing. This procedure is repeated after each measurement cycle.

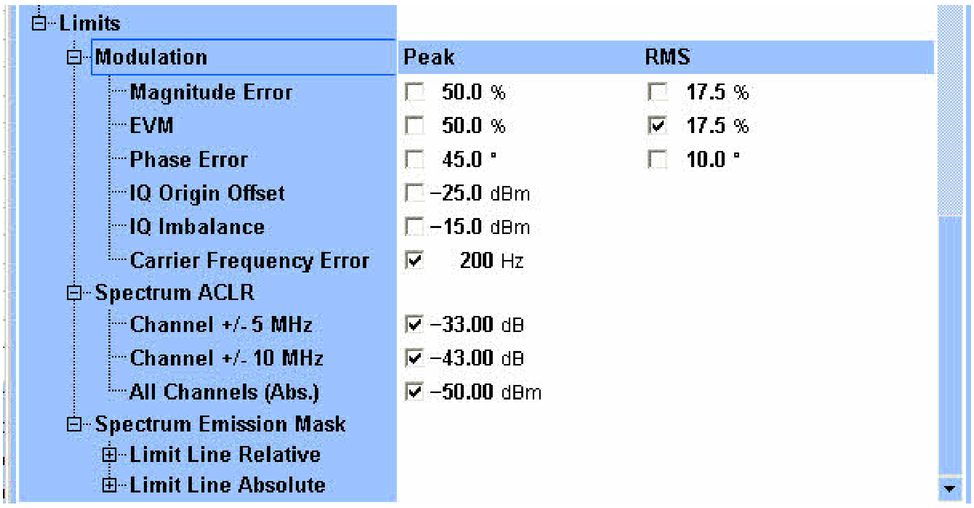
Free Run(Fast Sync) Similar to "Free Run (Standard)", however, the R&S CMW 500 assumes that the frame period of the detected signal is close to the nominal 10 ms WCDMA frame length. The frame timing is only corrected after each measurement cycle using a faster algorithm.
This synchronization method may fail if the actual UE frame timing is too far away from the nominal WCDMA frame length.

The "Trigger Timeout" setting is valid for both trigger sources.
GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:TRIGger:SOURce`

Trigger Timeout
Sets a time after whih the initiated measurement is automatically stopped if it does not receive a trigger event.
GPIB command:
`CONFigure:WCDMa:MEASurement<i>:MEValuation:TRIGger:TOUT`

9.2.1.6 Limits

The "Limits" in the "Multi Evaluation Configuration" dialog define upper limits for the modulation and spectrum results including the spectrum emission mask. See also Conformance Requirements and Limit Settings.



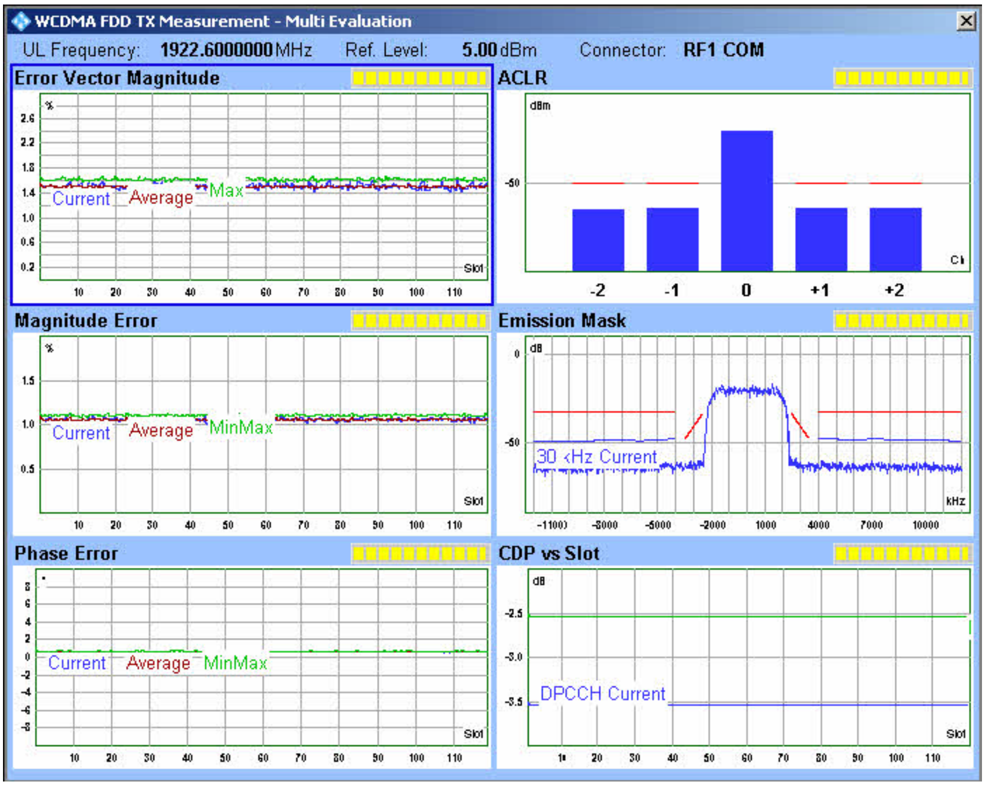
Multi evaluation configuration: Limit settings

GPIB commands:

CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:EVMagnitude
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:MERRor
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:PERRor
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:IQOFfset
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:IQIMbalance
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:CFERror
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:ACLR:RELative
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:ACLR:ABSolute
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:EMASk:RELative
CONFigure:WCDMa:MEASurement<i>:MEValuation:LIMit:EMASk:ABSolute

9.2.1.7 WCDMA Multi Evaluation: Results

The results of the WCDMA multi-evaluation measurement are displayed in several different views; see detailed description in section WCDMA Multi Evaluation: Results.
The multi-evaluation measurement provides an overview dialog and a detailed view for each diagram in the overview. Each dialog shows the most important RF and analyzer settings.
The overview dialog shows the modulation, spectrum, and code domain power results as traces or histograms.

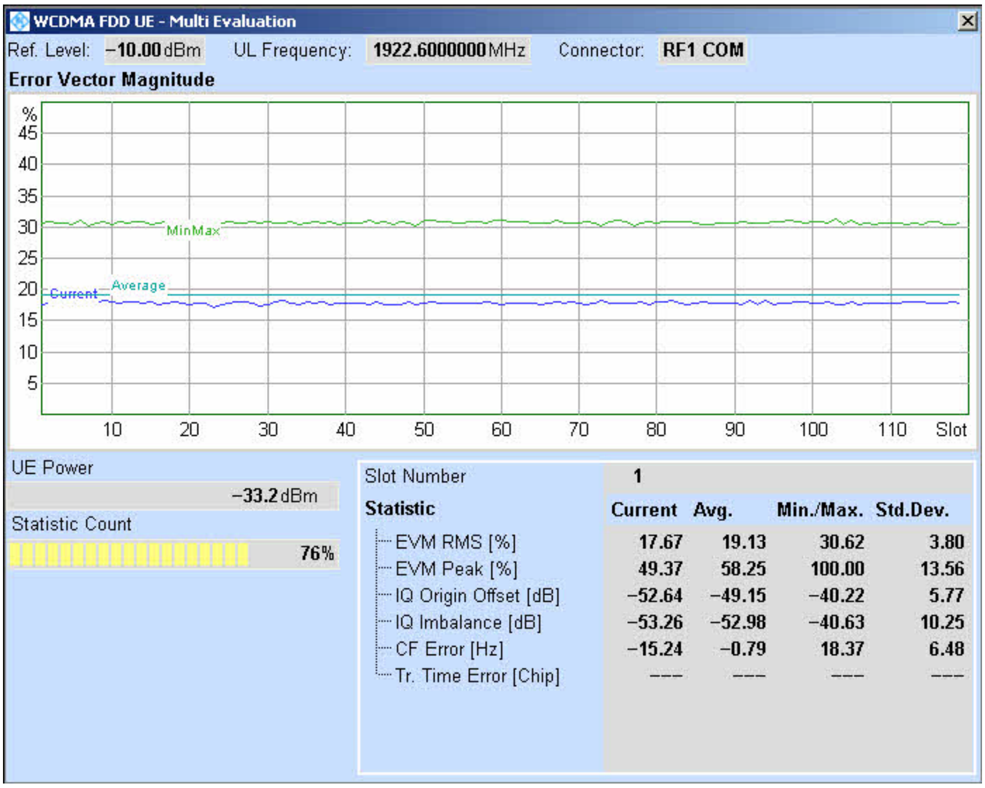


WCDMA Multi Evaluation: Overview

GPIB commands:

FETCh:WCDMa:MEASurement<i>:MEValuation:TRACe:EVMagnitude:RMS:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:MEValuation:TRACe:MERRor:RMS:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:MEValuation:TRACe:PERRor:RMS:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:SPECtrum:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:MEValuation:TRACe:EMASk:MFLeft:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:MEValuation:TRACe:CDP:DPCCh:CURRent? etc.

Each of the detailed views shows a diagram and a statistical overview of single-slot results.



WCDMA Multi Evaluation: EVM

GPIB commands:
FETCh:WCDMa:MEASurement<i>:MEValuation:MODulation:CURRent? etc.
FETCh:WCDMa:MEASurement<i>:MEValuation:CDP:CURRent? etc.

9.3 WCDMA Programming

The following sections provide programming examples for the WCDMA firmware applications.

- Multi Evaluation Measurement

The examples have been tested with the aid of a simple software tool.

9.3.1 Programming the WCDMA Multi Evaluation Measurement

The following examples show how to configure the WCDMA Multi Evaluation measurement via a remote-control program and retrieve measurement results.

- Key Features
- Specifying General Measurement Settings
- Specifying Required Settings
- Specifying Additional Measurement-Specific Settings
- Configuring the Trigger System
- Specifying Limits
- Performing a Single-Shot Measurement
- Single Shot and Continuous Multi Evaluation Measurements

For an introduction to instrument programming refer to Remote Control, in particular to section Measurement Control.

9.3.1.1 Key Features

The WCDMA multi-evaluation measurement is programmed as follows:

- The measurement is controlled by SCPI commands with the following syntax: `...WCDMA:MEASurement:MEValuation...`
- Use general commands of the type `...:WCDMA:MEASurement...` (no `:MEValuation` mnemonic) to define the signal routing and perform RF and analyzer settings.
- After a `*RST`, the measurement is switched off. Use `READ:WCDMA:MEASurement:MEValuation?` to initiate a single-shot measurement and retrieve the results.
- For synchronization and proper decoding, some UE signal settings must be in accordance with the measured signal; see Specifying Required Settings.

Advanced settings, speed considerations

You can also run the measurement in continuous mode and retrieve the results using `FETCh:WCDMA:MEASurement:MEValuation...?`. A reliability indicator is returned with each measurement result.

9.3.1.2 Specifying General Measurement Settings

FPRINT ***

```
FPRINT System-Reset
FPRINT ***************************************************************
*RST; *OPC?
*CLS; *OPC?

FPRINT ***************************************************************
FPRINT Define signal routing, perform RF and analyzer settings
FPRINT for a WCDMA uplink signal (operating band I, channel no. 9815,
FPRINT corresponding to a carrier frequency of 1963 MHz) with a
FPRINT peak power of 7 dBm, allowing for a 5 dB user margin
FPRINT ***************************************************************
ROUTe:WCDMA:MEASurement:RFSettings:CONNector RF1C
CONFigure:WCDMA:MEASurement:RFSettings:EATTenuation 2

CONFigure:WCDMA:MEASurement:RFSettings:ENPower 7
CONFigure:WCDMA:MEASurement:RFSettings:UMARgin 5
CONFigure:WCDMA:MEASurement:RFSettings:FREQuency 1963E+6

WAITKEY >Signal routing and analyzer settings completed, press
"OK" to continue<
```

9.3.1.3 Specifying Required Settings

```
FPRINT ***************************************************************
FPRINT Specify required UE signal settings: presence of a DPDCH,
FPRINT Sot format 1, Scrambling code 5, query channel configuration
FPRINT (single DPCH without HSDPA and HSUPA channels )
FPRINT ***************************************************************
CONFigure:WCDMa:MEASurement:UESignal:DPDCh ON
CONFigure:WCDMa:MEASurement:UESignal:SFORmat 1
CONFigure:WCDMa:MEASurement:UESignal:SCODe 5 CMW:
CONFigure:WCDMa:MEASurement:UESignal:ACHannels?

WAITKEY >Required settings completed, press "OK" to define
additional settings<
```

9.3.1.4 Specifying Additional Measurement-Specific Settings

```
FPRINT ***************************************************************
FPRINT Define stop condition (stop on limit failure) and error handling,
FPRINT select a measurement length of 30 slots (2 WCDMA frames),
FPRINT starting with slot 0 and using slot no. 3 as the preappointed slot.
FPRINT ***************************************************************
```

```
CONFigure:WCDMa:MEASurement:MEValuation:SCONdition SLFail
CONFigure:WCDMa:MEASurement:MEValuation:MOEXception ON
CONFigure:WCDMa:MEASurement:MEValuation:MSCount 30
CONFigure:WCDMa:MEASurement:MEValuation:PSLot 3
CCONFigure:WCDMa:MEASurement:MEValuation:MSLot SL0
```

FPRINT ***
FPRINT Specifiy modulation/CDP settings:
FPRINT Full slot measurement over 20 statistics cycles, analysis
FPRINT without origin offset, channel detection threshold -5 dB,
FPRINT statistical results in slot 4
FPRINT query detection mode (A3G, 3GPP Signal Auto)
FPRINT ***

```
CONFigure:WCDMa:MEASurement:MEValuation:MPERiod:MODulation FULL
CONFigure:WCDMa:MEASurement:MEValuation:SCOunt:MODulation 20
CONFigure:WCDMa:MEASurement:MEValuation:AMODe:MODulation NOOF
CONFigure:WCDMa:MEASurement:MEValuation:CDTHreshold:MODulation -
5
CONFigure:WCDMa:MEASurement:MEValuation:SSCalar:MODulation 4
CONFigure:WCDMa:MEASurement:MEValuation:DMODe:MODulation?
```

FPRINT ***
FPRINT Specify spectrum settings:
FPRINT select a measurement length of 30 slots (2 WCDMA frames)
FPRINT ***

```
CONFigure:WCDMa:MEASurement:MEValuation:SCOunt:SPECtrum 20
WAITKEY >General configuration completed, press "OK" to define
trigger<
```

9.3.1.5 Configuring the Trigger System

FPRINT ***
FPRINT Use fast synchronization to the RF input signal and a trigger timeout of 1 s.
FPRINT ***

```
CONFigure:WCDMa:MEASurement:TRIGger:SOURce FFRun
CONFigure:WCDMa:MEASurement:TRIGger:TOUT 1.0E+3

WAITKEY >Trigger settings completed, press "OK" to define
limits<
```

9.3.1.6 Specifying Limits

FPRINT ***
FPRINT Define all modulation limits

```
FPRINT ***************************************************************
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:MERRor 20,
OFF
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:EVMagnitude
20, 40
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:PERRor 20,
OFF
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:IQOFfset -20
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:IQIMbalance
ON
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:CFERror 150

FPRINT ***************************************************************
FPRINT Define all ACLR limits
FPRINT ***************************************************************
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:ACLR:ABSolute
ON
CMW: CONFigure:WCDMa:MEASurement:MEValuation:LIMit:ACLR:RELative
-35, -47

FPRINT ***************************************************************
FPRINT Define spectrum emission mask
FPRINT ***************************************************************
CMW:
CONFigure:WCDMa:MEASurement:MEValuation:LIMit:EMASk:ABSolute -
50, -13, -15
CMW:
CONFigure:WCDMa:MEASurement:MEValuation:LIMit:EMASk:RELative -
50.5, -47.5, -37.5, -33.5, -48.275, -33.725

WAITKEY >Limit settings completed, press "OK" to start single-
shot measurement<
```

9.3.1.7 Performing Single Shot Measurements

```
FPRINT ***************************************************************
FPRINT Start single-shot measurement, return magnitude error trace.
FPRINT Query the measurement state (should be "RDY").
FPRINT ***************************************************************
READ:WCDMa:MEASurement:MEValuation:TRACe:EVMagnitude:RMS:AVERage
?

WAITKEY >Single-slot measurement completed, press "OK" to query
state and return all measurement results<
```

```
FETCh:WCDMa:MEASurement:MEValuation:STATe?

FPRINT ***************************************************************
FPRINT Read the current traces obtained in the last measurement
FPRINT without re-starting the measurement
FPRINT ***************************************************************
FETCh:WCDMa:MEASurement:MEValuation:TRACe:CDP:DPCCh:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:CDP:DPCCh:SDEViation?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:CDP:DPDCh:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:CDP:DPDCh:SDEViation?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EMASk:MFLeft:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EMASk:MFRight:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EMASk:KFILter:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EVMagnitude:RMS:CURRen
t?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EVMagnitude:RMS:SDEVia
tion?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:MERRor:RMS:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:MERRor:RMS:SDEViation?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:PERRor:RMS:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:PERRor:RMS:SDEViation?

FPRINT ***************************************************************
FPRINT Read all current statistical results obtained in the last measurement
FPRINT without re-starting the measurement
FPRINT ***************************************************************
FETCh:WCDMa:MEASurement:MEValuation:CDP:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:SPECtrum:CURRent?
FETCh:WCDMa:MEASurement:MEValuation:MODulation:CURRent?

WAITKEY >All resuts returned, press "OK" to proceed to single
shot and continuous measurements<
```

9.3.1.8 Single Shot and Continuous Measurements

```
FPRINT ***************************************************************
FPRINT Start single-shot measurement, return magnitude error trace.
FPRINT Return maximum magnitude error trace and maximum phase (without
repeating
FPRINT the measurement. Query the measurement state (should be "RDY").
FPRINT ***************************************************************
INIT:WCDMA:MEASurement:MEValuation
FETCh:WCDMA:MEASurement:MEValuation:TRACe:MERRor:RMS:CURRent?
```

```
FETCh:WCDMa:MEASurement:MEValuation:TRACe:MERRor:RMS:MAXimum?
FETCh:WCDMa:MEASurement:MEValuation:TRACe:PERRor:RMS:MAXimum?

FETCh:WCDMa:MEASurement:MEValuation:STATe?

FPRINT ************************************************************
FPRINT Start continuous measurement; wait for 5 ms and return average result.
FPRINT Query measurement state and substates (should be "RUN,ADJ,ACT").
FPRINT ************************************************************
CONFigure:WCDMa:MEASurement:MEValuation:REPetition CONTinuous
Pause 5000
FETCh:WCDMa:MEASurement:MEValuation:TRACe:EVMagnitude:RMS:AVERag
e?
FETCh:WCDMa:MEASurement:MEValuation:STATe:ALL?
```

9.4 WCDMA Command Reference

The following sections provide detailed reference information on the remote control commands of the WCDMA application. The commands are organized as follows:

- General Measurement Settings
- Multi-Evaluation Measurement Commands

For an overview of all commands refer to the Alphabetical List of Commands.

9.4.1 General Measurement Settings

The commands valid for all WCDMA measurements are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Analyzer Settings
- Signal Routing
- UE Signal Info

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

9.4.1.1 Command Groups (General Measurement Settings)

9.4.1.2 Analyzer Settings

The following commands configure the RF input path.

CONFigure:WCDMa:MEAS<i>:RFSettings:ENPower <Exp Nom Power>

Sets the expected nominal power of the measured RF signal.

<Exp Nom Power> Range: –47 dBm to +34 dBm at RF 1 COM and RF 2 COM (increment 0.01 dBm; please notice also the ranges quoted in the "Specifications")
Def. value: 0.00 dBm
Def. unit: dBm

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:RFSettings:UMARgin <User Margin>

Sets the margin that the R&S CMW 500 adds to the expected nominal power (`CONFigure:...:MEAS<i>:RFSettings:ENPower`) minus the external input attenuation (`CONFigure:...:MEAS<i>:RFSettings:EATTenuation`) in order to determine its reference power. The reference power must be within the power range of the selected input connector; refer to the "Specifications".

<User Margin> Range: 0.00 dB to +50.00 dB at RF 1 COM (increment 0.01 dB)
Def. value: 0.00 dB

Def. unit: dB

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:RFSettings:FREQuency <Frequency>

Selects the center frequency of the RF analyzer.

<Frequency> Range: 100 MHz to 3300 MHz (increment 0.1 Hz)
Def. value 1922.600 MHz
Def. unit: Hz

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

9.4.1.3 Signal Routing

The following commands select the connector and define an external attenuation value.

ROUTe:WCDMa:MEAS<i>:RFSettings:CONNector <Input Connector>

Selects the input connector for the measured RF signal.

<Input Connector> **RF1C:** RF 1 COM
RF2C: RF 2 COM
Def. value: RF1C

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:RFSettings:EATTenuation <External Att>

Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF input connector (`ROUTe:...:MEAS<i>:RFSettings:CONNector`).

<External Att> Range: –50.00 dB to +90.00 dB (increment 0.01 dB)
Def. value: 0.00 dB
Def. unit: dB

Example See Specifying General Measurement Settings

Characteristics Firmware version V1.00

9.4.1.4 UE Signal Info

The following commands define the (expected) properties of the UE signal. The R&S CMW 500 must know these properties in order to analyze the UE signal.

CONFigure:WCDMa:MEAS<i>:UESignal:SCODe <Scrambling Code>

Selects the number of the long code that is used to scramble the received uplink WCDMA signal.

<Scrambling Code>	Range: #H0 to #HFFFFFF Def. value: 0
Example	See Specifiying Required Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:UESignal:SFORmat <Slot Format>

Selects the slot format for the UL DPCCH.

<Slot Format>	Range: 0 to 5 Def. value: 0
Example	See Specifiying Required Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:UESignal:ACHannels?

Queries the active channel types in the UE signal.

Returned value	**DPCH:** UL DPCH (no additional HSDPA or HSUPA channels) Def. value: –
Example	See Specifiying Required Settings
Characteristics	Firmware version V1.00 SCPI: Query only

CONFigure:WCDMa:MEAS<i>:UESignal:DPDCh <State>

Defines whether the UL DPCH contains a DPDCH.

<State>	**ON:** DPCCH plus DPCCH **OFF:** DPCCH only Def. value: ON
Example	See Specifiying Required Settings
Characteristics	Firmware version V1.00

9.4.2 WCDMA Multi Evaluation Measurement Commands

The commands valid for the WCDMA "Multi Evaluation" measurement are divided into the groups listed below. For an overview of the commands refer to Command Groups.

Commands for control and configuration:

- Measurement Control and States
- Measurement Parameters
- Statistical Settings (Modulation)
- Statistical Settings (Spectrum)
- Trigger Settings
- Limits (Modulation)
- Limits (Spectrum)

Commands for retrieval of measurement results:

- EVM Measurement Results (Traces)
- Magnitude Error Measurement Results (Traces)
- Phase Error Measurement Results (Traces)
- Spectrum Emission Measurement Results (Traces)
- CDP vs Slot Measurement Results (Traces)
- Spectrum Measurement Results
- Measurement Results (Single Values)
- CDP vs Slot Measurement Results (Single Values)

The following general measurement settings also affect the WCDMA multi-evaluation measurement:

- Signal Routing
- Analyzer Settings
- UE Signal Info

Issues of special interest for all commands:

MEAS<i>	Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference. It is possible to use up to four instances of the same firmware application in parallel. For further information refer to Firmware Applications.

Issues of special interest in the context of result retrieval:

`FETCh` and `READ` commands	Both commands can be used to retrieve measurement results: ◆ `FETCh...` returns the results of the current measurement cycle (single shot measurement) after they are valid. `FETCh...` must be used after the measurement has been started (`INITiate...`, measurement states RUN or RDY). ◆ `READ...` starts a new single shot measurement and returns the results. For further information refer to Retrieving Measurement Results.

Current and statistical values	The R&S CMW 500 repeats measurements according to the selected statistic count and repetition mode. Consecutive measurement values are stored and used to calculate statistical results, e.g. average, minimum, maximum and standard deviation. For a description of the statistical methods refer to Statistical Results.
Number of trace values	The number of measured values of a trace depends on the number of measured slots (`CONFigure:...:MEAS<i>:MEValuation:MSCount`). The trace contains one value per measured slot for full slot measurements and two values per measured slot for half slot measurements (`CONFigure:...:MEAS<i>:MEValuation:MPERiod:MODulation`).

Global Reliability Indicator

The common reliability indicator is the first value in the output arrays of the `FETCh...?` and `READ...?` queries.
e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`
Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement values)
In the present firmware version, the common reliability indicator is always set to zero.

9.4.2.1 Command Groups (Multi Evaluation)

Measurement Control and States **Page**

Measurement Parameters **Page**

Statistical Settings (Modulation) **Page**

Statistical Settings (Spectrum) **Page**

Trigger Settings **Page**

Limits (Modulation) **Page**

Limits (Spectrum) **Page**

EVM Measurement Results (Traces) **Page**

Magnitude Error Measurement Results (Traces) **Page**

Phase Error Measurement Results (Traces) **Page**

Spectrum Emission Measurement Results (Traces) **Page**

CDP vs Slot Measurement Results (Traces) **Page**

Spectrum Measurement Results **Page**

Measurement Results (Single Values) **Page**

CDP vs Slot Measurement Results (Single Values) **Page**

9.4.2.2 Measurement Control and States

The following commands control the measurement and return the current measurement state.

INITiate:WCDMa:MEAS<i>:MEValuation
ABORt:WCDMa:MEAS<i>:MEValuation
STOP:WCDMa:MEAS<i>:MEValuation

Starts, stops, or aborts the measurement; see Measurement Control:

- `INITiate...` starts or restarts the measurement; the R&S CMW 500 enters the "RUN" state.
- `ABORt...` causes a running measurement to stop immediately; the R&S CMW 500 enters the "OFF" state.
- `STOP...` causes a running measurement to stop after the current evaluation period is terminated and valid results are available; the R&S CMW 500 enters the "RDY" state.

Use `FETCh...STATe?` to query the current measurement state.

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: No query

FETCh:WCDMa:MEAS<i>:MEValuation:STATe?

Queries the main measurement state; see Measurement Control. Use `FETCh:...:MEAS<i>:...:STATe:ALL?` to query the measurement state including the substates. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State>	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

FETCh:WCDMa:MEAS<i>:MEValuation:STATe:ALL?

Queries the main measurement state and the measurement substates. Both measurement substates are relevant for running measurements only. Use `FETCh:...:MEAS<i>:...:STATe?` to query the main measurement state only. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State>,	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF
<Sync State>,	**PEND:** waiting for resource allocation, adjustment, hardware switching ("pending") **ADJ:** all necessary adjustments finished, measurement running ("adjusted") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")

<Resources State> **QUE:** measurement without resources, no results available ("queued")
ACT: resources allocated, acquisition of results in progress but not complete ("active")
INV: not applicable because <main_state>: OFF or RDY ("invalid")

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: Query only

9.4.2.3 Measurement Parameters

The following commands define general settings for the multi-evaluation measurement.

CONFigure:WCDMa:MEAS<i>:MEValuation:REPetition <Mode>

Specifies the repetition mode of the measurement; see Statistical Settings. The repetition mode specifies whether the measurement is stopped after a single shot or repeated continuously. Use `CONFigure:...:MEAS<i>:...:SCOunt` to determine the number of measurement intervals per single shot.

<Mode> **SINGleshot**: Single shot measurement
CONTinuous: Continuous measurement
Def. value: SINGleshot

Example See Single Shot and Continuous Measurements

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:SCONdition <Stop Condition>

Qualifies whether the measurement is stopped after a failed limit check or continued. `SONerror` means that the measurement is stopped (`STOP: ... MEAS<i>...`) and reaches the `RDY` state as soon as one of the results exceeds the limits.

<Stop Condition> **NONE:** Continue measurement irrespective of the limit check
SLFail: Stop measurement on limit failure
Def. value: NONE

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:MOEXception <Error Handling>

Defines whether the measurement shall be continued when an exception occurs.

<Meas on Exception>	**ON:** continue **OFF:** stop Def. value: OFF
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:MSCount <Meas Length>

Selects the number of slots that are measured to determine the "Error Vector Magnitude", "Magnitude Error", and "Phase Error".

<Meas Length>	Range: 1 to 120 Def. value: 120
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:PSLot <Preapp. Slot>

Selects the slot where the R&S CMW 500 calculates ACLR and emission mask results. The preappointed slot must be smaller than the number of measured slots (`CONFigure:WCDMa:MEAS<i>:MEValuation:MSCount`).

<Preapp. Slot>	Range: 0 to 119 Def. value: 0
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:MSLot <Synchronization>

Selects a slot number within the UL WCDMA frames (0 to 14) that the R&S CMW 500 will display as the first slot in the measurement interval.

<Synchronization>	**ANY:** No frame synchronization **SL0:** Slot 0 ... **SL14:** Slot 14 Def. value: ANY
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

9.4.2.4 Statistical Settings (Modulation)

The following commands specify the scope of the modulation measurement.

CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation <Meas. Period>

Selects the width of the basic measurement period within each measured slot. Use `CONFigure:WCDMa:MEAS<i>:MEValuation:MSCount` to define the number of measured slots.

<Meas Period>	**FULLslot:** Full slot measurement **HALFslot:** Half slot measurement Def. value: HALFslot
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:SCOunt:MODulation <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count>	Number of measurement intervals. A measurement interval comprises a single power/frequency step. Range: 1 to 1000 Def. value: 10
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:DMODe:MODulation <Detection Mode>

Selects the detection mode for uplink WCDMA signals.

<Detection Mode>	**A3G:** 3GPP Signal Auto Def. value: A3G
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:AMODe:MODulation <Analysis Mode>

Defines whether a possible origin offset is included in the measurement results

(WOOFfset) or subtracted out (NOOFfset).

<Analysis Mode>	**WOOFfset:** With origin offset **NOOFfset:** No origin offset Def. value: WOOFfset
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:CDTHreshold:MODulation <Threshold>

Defines the minimum relative signal strength of the DPDCH in the WCDMA signal (if present) to be detected and evaluated.

<Threshold>	Range: –25 dB to +10 dB Def. value: –10 dB Def. unit: dB
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:SSCalar:MODulation <Slot No. (Table)>

Selects a particular slot within the "Measurement Length" where the R&S CMW 500 evaluates the statistical measurement results. The slot no. must be smaller than the number of measured slots (`CONFigure:WCDMa:MEAS<i>:MEValuation:MSCount`).

<Slot No. (Table)>	Range: 0 to 119 Def. value: 0
Example	See Specifying Measurement-Specific Settings
Characteristics	Firmware version V1.00

9.4.2.5 Statistical Settings (Spectrum)

The following commands specify the scope of the spectrum measurement.

CONFigure:WCDMa:MEAS<i>:MEValuation:SCOunt:SPECtrum <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count> Number of measurement intervals. A measurement interval comprises a single power/frequency step.
Range: 1 to 1000
Def. value: 10

Example See Specifying Measurement-Specific Settings

Characteristics Firmware version V1.00

9.4.2.6 Trigger Settings

The following commands define the trigger parameters.

CONFigure:WCDMa:MEAS<i>:TRIGger:SOURce <Trigger Source>

Selects the source of the trigger events.

<Trigger Source> **SFRun:** Free run (standard)
FFRun: Free run (fast sync)
Def. value: SFRun

Example See Configuring the Trigger System

Characteristics Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:TRIGger:TOUT <Trigger Timeout>

Selects the maximum time that the R&S CMW 500 will wait for a trigger event before it stops the measurement.

<Trigger Timeout> Range: 0 ms to 10000 ms
Def. value: 2000 ms
Def. unit: ms

Example See Configuring the Trigger System

Characteristics Firmware version V1.00

9.4.2.7 Limits (Modulation)

The following commands define limits for results which characterize the modulation accuracy.

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:MERRor
<Limit RMS>, <Limit Peak>

Defines upper limits for the RMS and peak values of the magnitude error.

<Limit RMS>,	Range: 0.0 % to 99.0 % Def. value: 17.5 % Def. unit: % Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
<Limit Peak	Range: 0.0 % to 99.0 % Def. value: 50.0 % Def. unit: % Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:EVMagnitude <Limit RMS>, <Limit Peak>

Defines upper limits for the RMS and peak values of the error vector magnitude (EVM).

<Limit RMS>,	Range: 0.0 % to 99.0 % Def. value: 17.5 % Def. unit: % Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
<Limit Peak>	Range: 0.0 % to 99.0 % Def. value: 50.0 % Def. unit: % Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:PERRor <Limit RMS>, <Limit Peak>

Defines symmetric limits for the RMS and peak values of the phase error. The limit check fails the UE if the absolute value of the measured phase error exceeds the specified values.

<Limit RMS>,	Range: 0.0 deg to 45.0 deg Def. value: 10.0 deg Def. unit: deg Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)

<Limit Peak>	Range: 0.0 deg to 45.0 deg Def. value: 45.0 deg Def. unit: deg Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:IQOFfset <Limit>

Defines an upper limit for the I/Q origin offset.

<Limit>	Range: –80.0 dB to 0.0 dB Def. value: –25.0 dB Def. unit: dB Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:IQIMbalance <Limit>

Defines an upper limit for the I/Q imbalance.

<Limit>	Range: –99.0 dB to 0.0 dB Def. value: –15.0 dB Def. unit: dB Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:CFERror <Limit>

Defines an upper limit for the carrier frequency error.

<Limit>	Range: 0 Hz to 4000 Hz Def. value: 200 Hz Def. unit: Hz Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

9.4.2.8 Limits (Spectrum)

The following commands define limits for the Adjacent Channel Leakage Power Ratio (ACLR) and the spectrum emission mask.

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:ACLR:ABSolute <Absolute Limit>

Defines the absolute upper limit for the ACLR. Channel-dependent upper limits can be defined relative to this limit using `CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:ACLR:RELative`.

<Absolute Limit>	Range: –80 dBm to 33 dBm Def. value: –50 dBm Def. unit: dBm Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:ACLR:RELative <Channel 1>, <Channel 2>

Defines upper limits for the ACLR in channels 1 (at ±5 MHz from the carrier) and 2 (at ±10 MHz from the carrier) relative to the absolute limit defined by `CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:ACLR:ABSolute`.

<Channel1>,	Range: –80 dB to 0.0 dB Def. value: –33 dB Def. unit: dB
<Channel2>	Range: –80 dB to 0.0 dB Def. value: –43 dB Def. unit: dB Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:EMASk:ABSolute <Limit 3.84 MHz>, <Limit 1 MHz>, <Limit 30 kHz>

Defines absolute limits for the spectrum emission curves.

<Limit 3.84 MHz>,	Absolute limit referenced to a 3.84 MHz filter Range: –80 dBm to 33 dBm Def. value: –48.5 dBm Def. unit: dBm Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
<Limit 1 MHz>,	Absolute limit referenced to a 1MHz filter Range: –80 dBm to 33 dBm Def. value: –13 dBm Def. unit: dBm Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
<Limit 30 kHz>	Absolute limit referenced to a 30 kHz filter Range: –80 dBm to 33 dBm Def. value: –15 dBm Def. unit: dBm Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

CONFigure:WCDMa:MEAS<i>:MEValuation:LIMit:EMASk:RELative <Limit Point A>, <Limit Point B>, <Limit Point C>, <Limit Point D>, <Limit Point E>, <Limit Point F>

Defines relative limits for the spectrum emission curves.

<Limit Point A>, <Limit Point B>, <Limit Point C>, <Limit Point D>, <Limit Point E>, <Limit Point F>	Range: –90 dB to 0 dB Def. values for points A to F [dB]: -47.5, -47.5, -37.5, -33.5, -48.275, -33.725 Def. unit: dB Additional parameters: OFF | ON (disables the limit check | enables the limit check using the previous/default limit values)
Example	See Specifying Limits
Characteristics	Firmware version V1.00

9.4.2.9 EVM Measurement Results (Traces)

The following commands return the EVM trace results of the multi-evaluation measurement.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:CURRent?

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:MAXimum?

Returns the values of the RMS EVM traces for up to 120 slots. Each value is averaged over a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<EVM 1>, ..., <EVM 120/240>	RMS EVM trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 100 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:RMS:SDEViation?

Returns the standard deviation EVM trace values for up to 120 slots. Each standard deviation is calculated from all "Current" RMS values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev 120/240>	EVM standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 50 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:MAXimum?

Returns the values of the peak EVM traces for up to 120 slots. Each value is determined for a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<EVM 1>, ..., <EVM 120/240>	Peak EVM trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 100 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EVMagnitude:PEAK:SDEViation?

Returns the standard deviation EVM trace values for up to 120 slots. Each standard deviation is calculated from all "Current" peak values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev 120/240>	EVM standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 50 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.10 Magnitude Error Measurement Results (Traces)

The following commands return the magnitude error trace results of the multi-evaluation measurement.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:MAXimum?

Returns the values of the RMS magnitude error traces for up to 120 slots. Each value is averaged over a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Mag Err 1>, ..., <Mag Err 120/240>	RMS magnitude error trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: –100 % to +100 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:RMS:SDEViation?

Returns the standard deviation magnitude error trace values for up to 120 slots. Each standard deviation is calculated from all "Current" RMS values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev 120/240>	Magnitude error standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 50 % Def. unit: %

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:MAXimum?

Returns the values of the peak magnitude error traces for up to 120 slots. Each value is determined for a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Mag Err 1>, ..., <Mag Err 120/240>	Peak magnitude error trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: –100 % to +100 % Def. unit: %

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:MERRor:PEAK:SDEViation?

Returns the standard deviation magnitude error trace values for up to 120 slots. Each standard deviation is calculated from all "Current" peak values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator

<Std Dev 1>, ..., <Std Dev 120/240>	Magnitude error standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 % to 50 % Def. unit: %
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.11 Phase Error Measurement Results (Traces)

The following commands return the phase error trace results of the multi-evaluation measurement.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:MAXimum?

Returns the values of the RMS phase error traces for up to 120 slots. Each value is averaged over a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Phase Err 1>, ..., <Phase Err 120/240>	RMS phase error trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: -180 deg to +180 deg Def. unit: deg
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:RMS:SDEViation?

Returns the standard deviation phase error trace values for up to 120 slots. Each standard deviation is calculated from all "Current" RMS values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev 120/240>	Phase error standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 deg to +90 deg Def. unit: deg
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:MAXimum?

Returns the values of the peak phase error traces for up to 120 slots. Each value is determined for a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Phase Err 1>, ..., <Phase Err 120/240>	Peak phase error trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: -180 deg to +180 deg Def. unit: deg
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:PERRor:PEAK:SDEViation?

Returns the standard deviation phase error trace values for up to 120 slots. Each standard deviation is calculated from all "Current" peak values of a half slot or a full slot measured since the start of the measurement. This trace can not be displayed at the GUI.

Returned values

<Reliability>,	Reliability indicator
<Std Dev 1>, ..., <Std Dev 120/240>	Phase error standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 deg to +90 deg Def. unit: deg
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.12 Spectrum Emission Measurement Results (Traces)

The following commands return the spectrum emission trace results of the multi-evaluation measurement.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:MAXimum?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFLeft:MAXimum?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:MFRight:MAXimum?

Returns the values of the spectrum emission 1 MHz traces. The left section and the right section of each trace are retrieved by separate commands (dinstinguished by the terms MFLeft and MFRight). The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>, Reliability indicator

<Value 1>,
...,
<Value 179>
These values correspond to test points that are separated by 45 MHz. The covered frequency ranges are:
Left section: –12003.75 MHz to –3993.75 MHz from the carrier
Right section: +3993.75 MHz to +12003.75 MHz from the carrier
Range: -100 dB to 0 dB
Def. unit: dB

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:EMASk:KFILter:MAXimum?

Returns the values of the spectrum emission 30 kHz traces. The results of the current, average and maximum traces can be retrieved.

Returned values

<Reliability>, Reliability indicator

<Value 1>,
...,
<Value 2135>
These values correspond to test points that are separated by 11.25 MHz and cover the frequency range between –12.003.75 MHz and +12003.75 MHz from the carrier.
Range: -100 dB to 0 dB
Def. unit: dB

Example See Performing Single Shot Measurements

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.13 CDP vs Slot Measurement Results (Traces)

The following commands return the code domain power (CDP) vs. slot trace results of the multi-evaluation measurement.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:MINimum?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:MAXimum?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:MINimum?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:MINimum?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:MAXimum?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:MINimum?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:MAXimum?

Returns the values of the RMS CDP vs. slot traces for up to 120 slots. Each value is averaged over a half slot or a full slot, depending on the measurement period (`CONFigure:WCDMa:MEAS<i>:MEValuation:MPERiod:MODulation`). The results of the current, average, minimum and maximum traces can be retrieved for the DPCCH and the DPDCH.

Returned values

<Reliability>,	Reliability indicator
<CDP 1>, ..., <CDP 120/240>	RMS CDP trace results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: -100 dB to +100 dB Def. unit: dB
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:SDEViation?
FETCh:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:SDEViation?

READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPCCh:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:TRACe:CDP:DPDCh:SDEViation?

Returns the standard deviation CDP trace values for up to 120 slots. Each standard deviation is calculated from all "Current" RMS values of a half slot or a full slot measured since the start of the measurement. These traces can not be displayed at the GUI. The results of the traces can be retrieved for the DPCCH and the DPDCH.

Returned values

<Reliability>,	Reliability indicator
<CDP 1>, ..., <CDP 120/240>	CDP standard deviation results: 120 values for a "full slot measurement" and 240 values for a "half slot measurement" Range: 0 dB to 50 dB Def. unit: dB
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.14 Spectrum Measurement Results

FETCh:WCDMa:MEAS<i>:MEValuation:SPECtrum:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:SPECtrum:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:SPECtrum:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:SPECtrum:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:SPECtrum:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:SPECtrum:MAXimum?

Returns the Adjacent Channel Leakage power Ratio (ACLR) results and the spectrum emission mask results of the multi-evaluation measurement.

Returned values

<Reliability>,	Reliability indicator
<Carrier Power>,	Power at the nominal carrier frequency (UL Frequency) Range: -100 dBm to +60 dBm Def. unit: dBm
<Adjacent -2>, <Adjacent -1>, <Adjacent +1>, <Adjacent +2>,	Power of the adjacent channels (±1st adjacent channels at ±5 MHz from the UL frequency, ±2nd adjacent channels at ±10 MHz from the UL frequency) Range: -100 dBm to +60 dBm Def. unit: dBm
<OBW>,	Occupied bandwidth Range: 0 MHz to 10 MHz Def. unit: Hz

<Margin AB>, <Margin BC>, <Margin CD>, <Margin EF>, <Margin FE>, <Margin DC>, <Margin CB>, <Margin BA>,	Limit line margin values in the 8 limit line areas Range: -100 dB to 0 dB Def. unit: dB
<UE Power>	User equipment power Range: -100 dBm to +60 dBm Def. unit: dBm
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.15 Measurement Results (Single Values)

The following commands return the results of the multi-evaluation measurement, measured in a selected slot (`CONFigure:WCDMa:MEAS<i>:MEValuation:SSCalar:MODulation`).

FETCh:WCDMa:MEAS<i>:MEValuation:MODulation:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:MODulation:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:MODulation:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:MODulation:MAXimum?

Returns the current and minimum/maximum single value results.

Returned values

<Reliability>,	Reliability indicator
<EVM RMS>, <EVM Peak>,	Error vector magnitude RMS and peak value Range: 0 % to 100 % Def. unit: %
<Mag Err RMS>, <Mag Err Peak>,	Magnitude error RMS and peak value Range: -100 % to +100 % Def. unit: %
<Phase Err RMS>, <Phase Err Peak>,	Phase error RMS and peak value Range: -180 deg to +180 deg Def. unit: deg

<IQ Origin Offset>,	I/Q origin offset Range: -100 dB to 0 dB Def. unit: dB
<IQ Imbalance>,	I/Q imbalance Range: -100 dB to 0 dB Def. unit: dB
<Carr Freq Error>,	Carrier frequency error Range: -5000 Hz to +5000 Hz Def. unit: Hz
<Trans Time Err>,	Transmit time error Range: -500 chips to 500 chips Def. unit: chip
<UE Power>,	User equipment power Range: -100 dBm to +60 dBm Def. unit: dBm
<Slot>	Measured slot Range: 0 to 119 Def. unit: -
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:MODulation:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:MODulation:AVERage?

Returns the average single value results.

Returned values

<Reliability>,	Reliability indicator
<EVM RMS>, <EVM Peak>,	Error vector magnitude RMS and peak value Range: 0 % to 100 % Def. unit: %
<Mag Err RMS>, <Mag Err Peak>,	Magnitude error RMS and peak value Range: 0 % to 100 % Def. unit: %
<Phase Err RMS>, <Phase Err Peak>,	Phase error RMS and peak value Range: 0 deg to +180 deg Def. unit: deg

<IQ Origin Offset>,	I/Q origin offset Range: -100 dB to 0 dB Def. unit: dB
<IQ Imbalance>,	I/Q imbalance Range: -100 dB to 0 dB Def. unit: dB
<Carr Freq Error>,	Carrier frequency error Range: -5000 Hz to +5000 Hz Def. unit: Hz
<Trans Time Err>,	Transmit time error Range: -500 chips to 500 chips Def. unit: chip
<UE Power>,	User equipment power Range: -100 dBm to +60 dBm Def. unit: dBm
<Slot>	Measured slot Range: 0 to 119 Def. unit: -
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:MODulation:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:MODulation:SDEViation?

Returns the standard deviation single value results.

Returned values

<Reliability>,	Reliability indicator
<EVM RMS>, <EVM Peak>,	Error vector magnitude RMS and peak value Range: 0 % to 50 % Def. unit: %
<Mag Err RMS>, <Mag Err Peak>,	Magnitude error RMS and peak value Range: 0 % to 50 % Def. unit: %
<Phase Err RMS>, <Phase Err Peak>,	Phase error RMS and peak value Range: 0 deg to 90 deg Def. unit: deg

<IQ Origin Offset>,	I/Q origin offset Range: 0 dB to 50 dB Def. unit: dB
<IQ Imbalance>,	I/Q imbalance Range: 0 dB to 50 dB Def. unit: dB
<Carr Freq Error>,	Carrier frequency error Range: 0 Hz to 2500 Hz Def. unit: Hz
<Trans Time Err>,	Transmit time error Range: 0 chips to 250 chips Def. unit: chip
<UE Power>,	User equipment power Range: 0 dBm to 50 dBm Def. unit: dBm
<Slot>	Measured slot Range: 0 to 119 Def. unit: -
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.2.16 CDP vs Slot Measurement Results (Single Values)

The following commands return the results of the code domain power (CDP) vs. slot measurement, measured in a selected slot (`CONFigure:WCDMa:MEAS<i>:MEValuation:SSCalar:MODulation`).

FETCh:WCDMa:MEAS<i>:MEValuation:CDP:CURRent?
FETCh:WCDMa:MEAS<i>:MEValuation:CDP:AVERage?
FETCh:WCDMa:MEAS<i>:MEValuation:CDP:MINimum?
FETCh:WCDMa:MEAS<i>:MEValuation:CDP:MAXimum?

READ:WCDMa:MEAS<i>:MEValuation:CDP:CURRent?
READ:WCDMa:MEAS<i>:MEValuation:CDP:AVERage?
READ:WCDMa:MEAS<i>:MEValuation:CDP:MINimum?
READ:WCDMa:MEAS<i>:MEValuation:CDP:MAXimum?

Returns the RMS CDP vs. slot values measured in a selected slot. In addition to the current value statistical values are returned (average, minimum and maximum).

Returned values

<Reliability>,	Reliability indicator
<DPCCH>, <DPDCH>	RMS CDP values for the DPCCH and the DPDCH Range: -100 dB to +100 dB Def. unit: dB
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WCDMa:MEAS<i>:MEValuation:CDP:SDEViation?
READ:WCDMa:MEAS<i>:MEValuation:CDP:SDEViation?

Returns the standard deviation CDP vs. slot values measured in a selected slot.

Returned values

<Reliability>,	Reliability indicator
<DPCCH>, <DPDCH>	Standard deviation CDP values for the DPCCH and the DPDCH Range: 0 dB to 50 dB Def. unit: dB
Example	See Performing Single Shot Measurements
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

9.4.3 Alphabetical List of Commands (WCDMA)

Command **Page**

10 WiMAX Applications

The WiMAX firmware applications provide fast and flexible tests on uplink OFDMA signals. The tests cover the following transmitter properties of a WiMAX subscriber station:

- Average burst power and crest factor
- Center frequency error
- Modulation accuracy (EVM, I/Q offset, I/Q imbalance)
- Spectral flatness

The transmitter tests can be performed in accordance with standard IEEE 802.16™-2004/Cor 1-2005, IEEE 802.16e-2005, "OFDMA physical layer mode". For basic information about WiMAX signals refer to standard IEEE Std 802.16™-2004, "IEEE standard for local and metropolitan area networks".

The R&S CMW 500 provides the following WiMAX firmware applications:

- WiMAX Multi-Evaluation Measurement

10.1 WiMAX TX Measurements

WiMAX TX measurements determine the power, crest factor, frequency error, modulation accuracy, and spectral flatness of an uplink OFDMA signal. All WiMAX TX measurements are combined in a single multi-evaluation measurement.

10.1.1 WiMAX Multi Evaluation Measurement

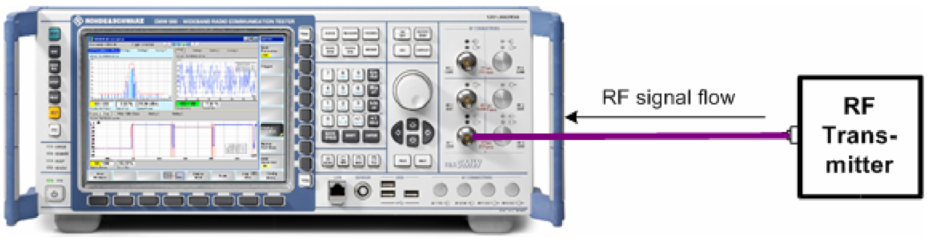
The WiMAX "Multi Evaluation" measurement captures an uplink (UL) OFDMA signal and provides the TX measurement results in a selectable zone and burst.

The following sections describe how to perform and configure the measurement. For a description of the method of measurement refer to Signal Processing.

- Test Setup
- How to Measure an UL OFDMA Signal
- Frame Settings and Burst Selection
- Measurement Results

10.1.1.1 Test Setup

The external RF signal source (mobile phone transmitter, signal generator etc.) is connected to one of the RF input connectors RF 1 COM or RF 2 COM at the front panel of the R&S CMW 500. The input level ranges of the connectors are identical; see RF Connectors. No additional cabling and no external trigger is needed.



10.1.1.2 How to Measure an UL OFDMA Signal

After connecting your WiMAX subscriber station to the R&S CMW 500 as shown above, you have to adjust the following analyzer settings to the properties of the analyzed signal:

- The analyzer "Frequency"
- The "Expected Nominal Power" and (optional) a "User Margin" and "External Attenuation".

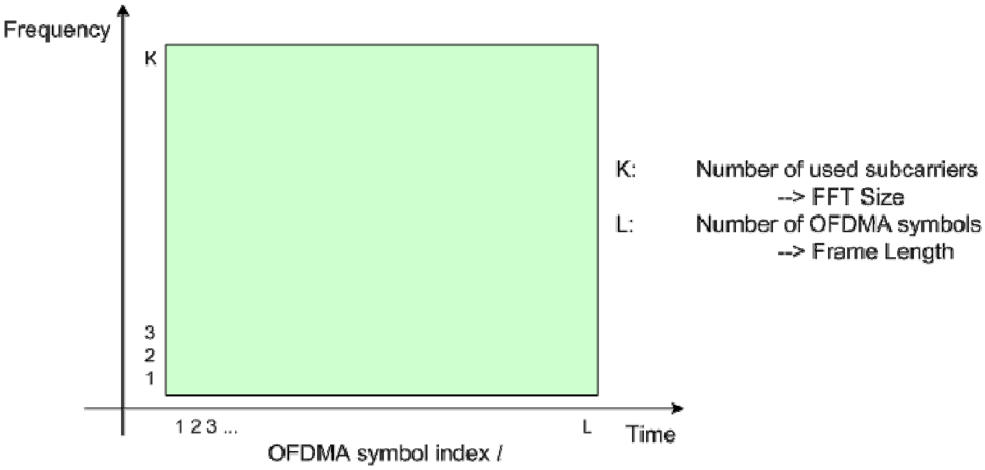
For proper signal decoding, the settings in the "Measurement Parameters" section of the configuration menu and its subsections must be compatible with the measured signal. The settings are grouped as follows:

- The "Measurement Parameters" specify the size of the uplink frame.
- The "Zone Definition" parameters specify how sub-carriers are assigned to logical sub-channels.
- The "Map of Bursts" settings select the logical sub-channels and slots which belong to the analyzed burst.

A power trigger synchronizes the measurement to the measured bursts.

10.1.1.3 Frame Settings and Burst Selection

An OFDMA uplink signal is a periodic sequence of UL frames; each of which can be depicted as a rectangle in the frequency/time plane. The "Frame Length" (frame duration) corresponds to the number of OFDMA symbols per frame times the symbol duration. The covered frequency interval depends on the number of used subcarriers and the subcarrier spacing Δf; it must not exceed the nominal bandwidth of the OFDMA channel. Inverse Fast Fourier Transform creates the OFDMA waveform; the "FFT Size" must be adjusted to the number of used subcarriers.

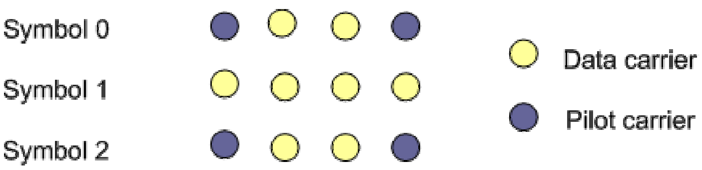


In the simplest case, one UL frame contains a single UL-PUSC "permutation zone" which is divided into several bursts. Each burst has its individual coding and modulation scheme (burst profile). The bursts can be transmitted in parallel and can vary in size.

The assignment of subcarriers to bursts is a two-stage process:

1. Mapping of subcarriers to logical sub-channels:" Zone Definition"

The UL channel is partitioned into "tiles", each consisting of 12 adjacent subcarrier/symbol instances (which we will call "subcarriers" for simplicity). Four of the subcarriers are configured as pilot subcarriers, the remaining 8 subcarriers are data carriers.

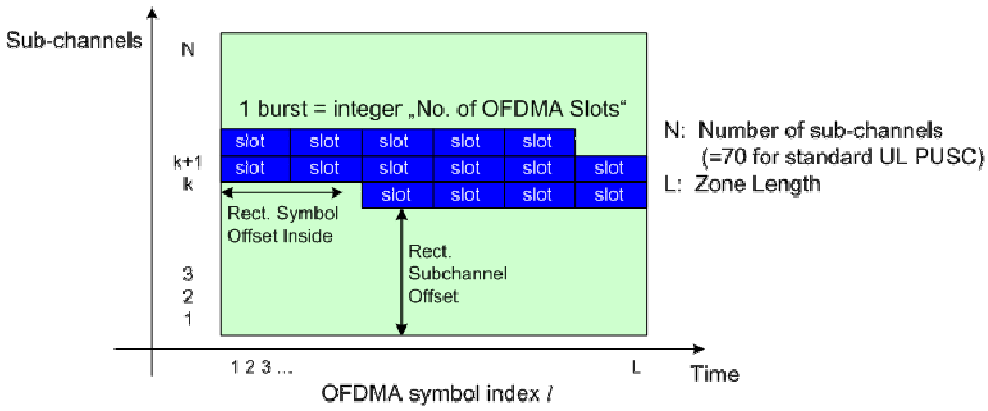


To create a logical sub-channel (also termed a slot), the physical tiles are renumbered (permutated) and combined. The permutation rule depends on the "Perm Base" parameter; the number of tiles for each logical sub-channel is 6. Permutation of tiles ensures that each sub-channel uses non-adjacent sub-carriers, which reduces the impact of interferences and multipath fading on the transmission.

A segment is a group of sub-channels that is used for deploying a single instance of the MAC. Segments are identified by their "Segment No" and "PRBS ID".

2. Assignment of sub-channels to bursts: "Map of Bursts"

The sub-channels (slots) provide an alternative description of the UL frame as a rectangle in the sub-channel/time plane. A burst contains an integer number of sub-channels and corresponds to a contiguous area within this UL frame. According to the tile definition reported above, the number of symbols per UL sub-channel is equal to 3, so the number of symbols in the burst must be an integer multiple of 3.



The position and size of the burst is defined by the "Map of Bursts" parameters.

10.1.1.4 Measurement Results

The results of the multi-evaluation measurement are displayed in the measurement menu; for a detailed description refer to section Measurement Results.
The measurement assesses the modulation accuracy (EVM, I/Q Offset, I/Q Imbalance), frequency error, power, crest factor, and spectral flatness in the selected burst. Moreover, it provides a statistical evaluation over a configurable number of subsequent bursts; see Statistical Results.

	Current	Min	Max	Average	
EVM All Carriers	−39.22	−39.22	−39.22	−39.22	dB
EVM Data Carriers	−38.28	−38.28	−38.28	−38.28	dB
EVM Pilot Carriers	−42.13	−42.13	−42.13	−42.13	dB
IQ Offset	−30.89	−30.89	−30.89	−30.89	dB
Gain Imbalance	−0.01	−0.01	−0.01	−0.01	dB
Quadrature Error	0.02	0.02	0.02	0.02	°
Center Frequency Ei	12.07	12.07	12.07	12.07	Hz
Burst Power	−25.46	−25.46	−25.46	−25.46	dBm
Crest Factor	9.52	9.52	9.52	9.52	dB
CINR	65.06	65.06	65.06	65.06	dB
S. Flatness O. L.	−0.42	−0.42	−0.42	−0.42	dB
S. Flatness O. U.	0.44	0.44	0.44	0.44	dB
S. Flatness I. L.	−0.30	−0.30	−0.30	−0.30	dB
S. Flatness I. U.	0.21	0.21	0.21	0.21	dB
S. Flatness Neighbo	0.08	0.08	0.08	0.08	dB

WiMAX Multi Evaluation results

The CINR is not available in the present firmware version.

10.1.1.5 Signal Processing

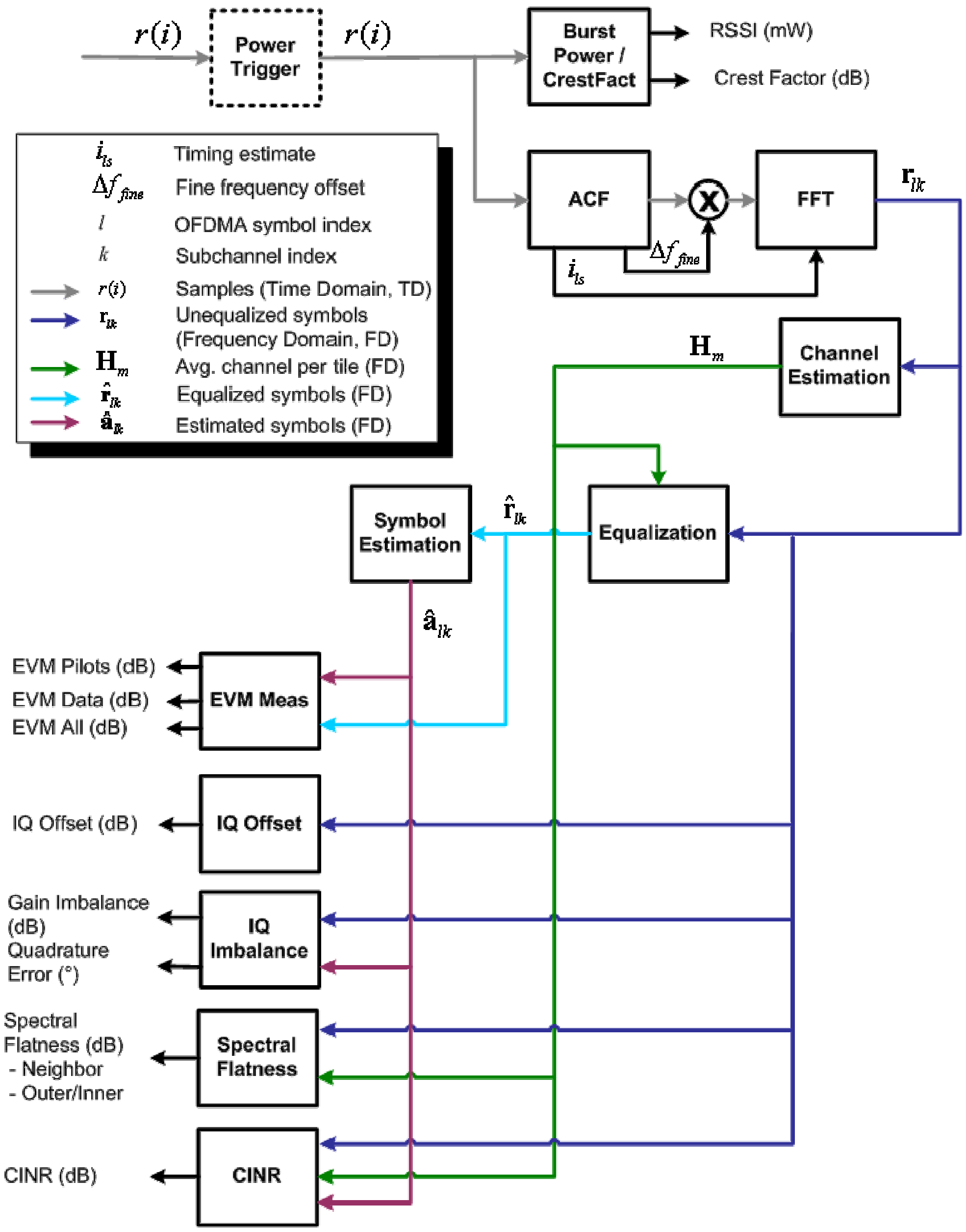
The following description provides a brief overview of the signal processing stages used to derive the WiMAX Multi Evaluation results from the received UL OFDMA signal. The received RF signal is first down-converted to an IF signal, filtered and sampled using an Analog to Digital converter. The digital IF signal is processed in line with the procedure that the standard (IEEE Std 802.16-2004) specifies for transmitter tests on OFDMA signals.

Digital IF signal processing comprises four major stages:

- Data capturing
- Synchronization and Frequency Compensation
- Channel and Symbol Estimation
- Result Calculation

Data Capturing, Block Diagram

The block diagram below shows the signal flow for the WiMAX multi-evaluation measurement from the capture buffer containing the I/Q data to the actual analysis block. Outcome of the fully compensated reference path (plum) are the estimates $\hat{a}_{lk}$ of the transmitted data symbols a_{lk} (not shown in the diagram; see Channel and Symbol Estimation), where the index l numbers the OFDMA symbols and k numbers the sub-carriers. The received samples r_{lk} of the measurement path (indigo) still contain the transmitted signal impairments of interest. The analysis blocks, such as EVM, I/Q Imbalance etc., reveal these impairments by comparing the reference and the measurement path. Prior to the analysis, several synchronization and channel estimation tasks have to be accomplished.



WiMAX multi-evaluation measurement: block diagram

The different stages in the block diagram (ACF, FFT, Channel Estimation, Equalization) are described in the sections below. The measurement results EVM, IQ Offset are calculated in terms of the symbol vectors $\hat{a}_{lk}$, a_{lk}, and r_{lk}.

Synchronization and Frequency Compensation

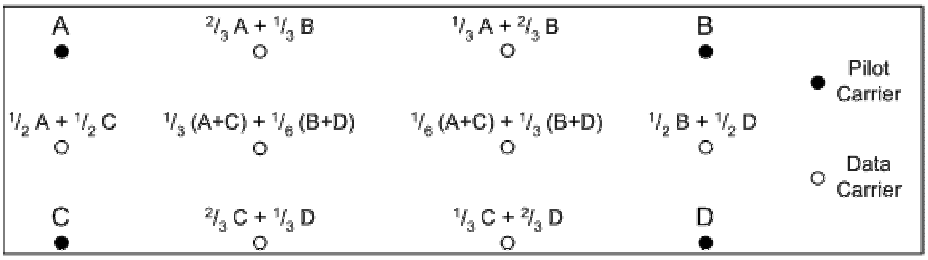
In order to establish time-synchronization with the received signal, the R&S CMW 500 must detect areas of sufficient power within the captured I/Q data stream. This is done within the power trigger module. The auto correlation stage (ACF) determines the fine timing and the frequency offset.

The frequency estimation is performed in two steps. The first, coarse frequency

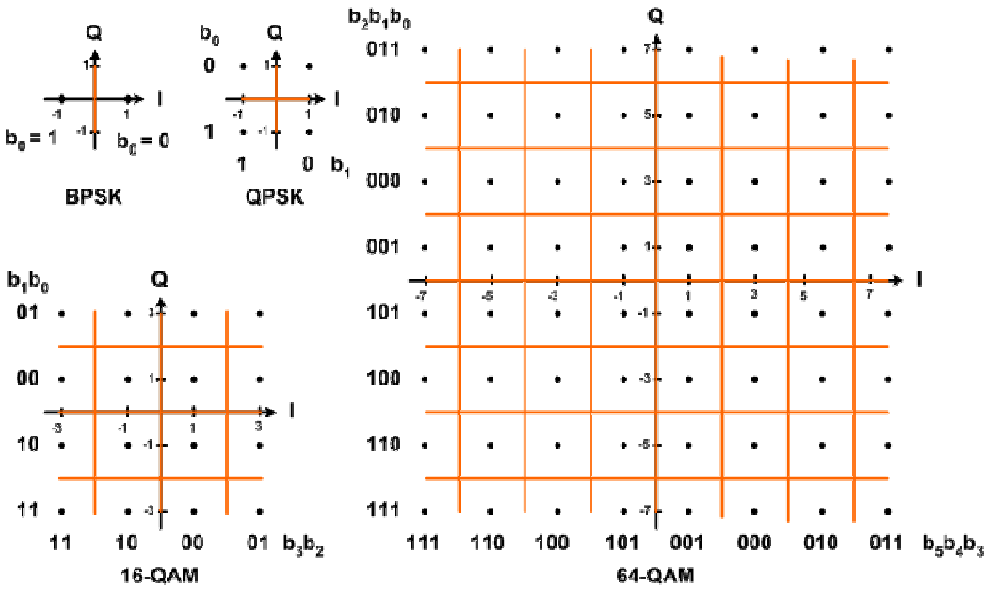
estimation is fed into the ACF stage. The phase at the maximum of the auto correlation function is a measure for the fine frequency offset Δf_{fine}.
The fine frequency offset is used to correct the time-domain samples prior to the Fast Fourier Transform block (FFT).

Channel and Symbol Estimation

The channel estimation block determines the channel transfer function H_{lk} for all symbols and subcarriers. The channel transfer function is needed to calculate the spectral flatness.
Channel estimation for the uplink (UL) signal is based on the transmitted pilot symbols. The received signal is tapped behind the FFT block. An UL subchannel is composed of "tiles" with four pilot subcarriers and eight data subcarriers as shown below (see Frame Settings and Burst Selection). The channel transfer function is first estimated for the known pilot symbols (training symbols). Based on these values, the channel transfer function for data symbols is obtained by linear interpolation in both time (symbol) and frequency (sub-carrier) direction. The average channel transfer function $H_{\underline{m}}$ for tile no. m can then be calculated as the average of the interpolated values over the second (central) line, corresponding to the second symbol in the tile. This average channel transfer function is calculated tile by tile.



The R&S CMW 500 is able to decode the three different modulation schemes used in the OFDMA UL signal: QPSK, 16-QAM and 64-QAM. Decoding involves an assignment of the estimated symbol points $\hat{a}_{lk}$ to the ideal constellation points a_{lk}. The assignment is based on the decision lines shown in the figures below. The hard-decided symbols a_{lk} are used as a reference for further calculations.



WiMAX modulation schemes

10.2 WiMAX GUI Reference

The following sections provide detailed reference information on the parameters of the WiMAX application. The R&S CMW 500 provides the following WiMAX measurements:

- Multi Evaluation

10.2.1 WiMAX Multi Evaluation: Parameters and Settings

The WiMAX multi-evaluation measurement is configured using the following groups of settings:

- Measurement Control
- Signal Routing and Analyzer Settings
- Control Settings
- Measurement Parameters
- Zone Definition
- Map of Bursts
- Trigger Settings

The most important measurement settings are also displayed in the measurement dialog.

The measurement dialog provides all Measurement Results.

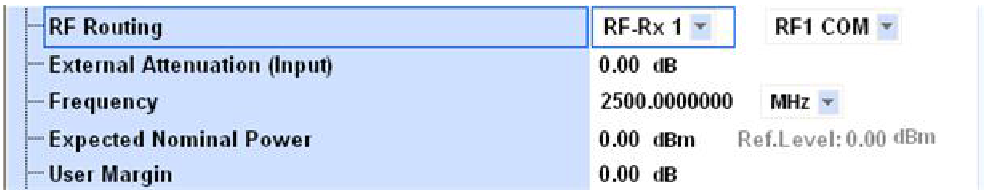
10.2.1.1 Measurement Control

The measurement is turned on or off using the "Multi Evaluation" measurement control softkey and the ON | OFF or RESTART | STOP front panel keys.

Multi Evaluation (Softkey)
Turns the measurement on or off; see Measurement Control. The measurement state is shown in the softkey. Additional measurement substates may be retrieved via remote control.
GPIB command:
`INITiate:WIMax:MEASurement<i>:MEValuation` etc.
`FETCh:WIMax:MEASurement<i>:MEValuation:STATe?`
`FETCh:WIMax:MEASurement<i>:MEValuation:STATe:ALL?`

10.2.1.2 Signal Routing and Analyzer Settings

The measurement is configured using the parameters in the "Multi Evaluation Configuration" dialog. The following parameters configure the RF input path.



Multi evaluation configuration: Signal routing and analyzer settings

RF Routing
Selects the input connector for the measured RF signal; see connector selection.
GPIB command:
`ROUTe:WIMax:MEASurement<i>:RFSettings:CONNector`

External Attenuation (Input)
Defines the value of an external attenuation (or gain, if the value is negative) in the input path.
The external attenuation also enters into the internal calculation of the maximum input power that the R&S CMW 500 can measure (see "Expected Nominal Power" below).
GPIB command:
`CONFigure:WIMax:MEASurement<i>:RFSettings:EATTenuation`

Frequency
Center frequency of the RF analyzer. Set this frequency to the frequency of the measured RF signal to obtain a meaningful measurement result.
GPIB command: `CONFigure:WIMax:MEASurement<i>:RFSettings:FREQuency`

Expected Nominal Power
Defines the nominal power of the RF signal to be measured. The nominal power is the average output power at the DUT during the measurement intervals where the RF transmitter is on. The "Ref. Level" is calculated as the expected peak power at the output of the DUT:
Reference power = Expected Nominal Power + User Margin

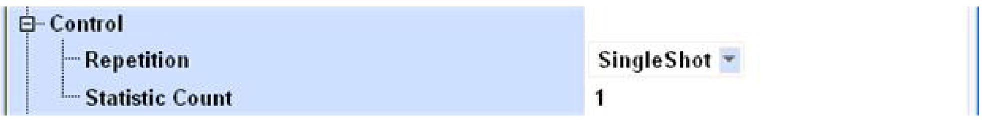
Maximum input power
The actual input power at the connectors (i.e. the "Reference Level" minus the "External Attenuation (Input)" value, if all power settings are configured correctly) must be within the level range of the selected RF input connector; refer to the "Specifications".

GPIB command: `CONFigure:WIMax:MEASurement<i>:RFSettings:ENPower`

User Margin
Margin that the R&S CMW 500 adds to the "Expected Nominal Power" in order to determine its reference power; see above. The "User Margin" is typically used to account for the known variations of the RF input signal power, e.g. the variations due to a specific channel configuration.
For OFDMA signals, the appropriate values depend on the modulation scheme.
GPIB command: `CONFigure:WIMax:MEASurement<i>:RFSettings:UMARgin`

10.2.1.3 Multi Evaluation Configuration: Control

The "Control" parameters configure the scope of the measurement.



Multi evaluation configuration: scope

Control – Repetition
Defines how often the measurement is repeated if it is not stopped explicitly; see Statistical Settings.

- A "Continuous" measurement is continued until it is explicitly terminated; the results are periodically updated.

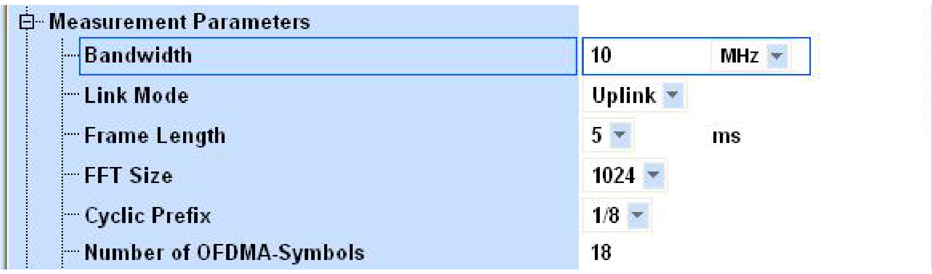
- A "Single Shot" measurement is stopped after one statistics cycle, i.e. after the number of measurement intervals defined by the "Statistic Count".

Single shot is preferable if only a single measurement result is required under fixed conditions, which is typical for remote-controlled measurements. Continuous mode is suitable for monitoring the evolution of the measurement results in time and observe how they depend on the measurement configuration, which is typically done in manual control. The repetition modes for remote and manual control and the reset/preset values are therefore independent from each other.
GPIB command:
CONFigure:WIMax:MEASurement<i>:MEValuation:REPetition

Control – Statistic Count
Defines the number of measurement intervals per measurement cycle (single shot measurement); see Statistical Settings. This value is also relevant for continuous measurements, because the averaging procedures depend on the statistic count; see Statistical Results.
In the WiMAX multi-evaluation measurement, the measurement interval is completed when the R&S CMW 500 has measured a burst and acquired a full set of measurement results.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:SCOunt

10.2.1.4 Multi Evaluation Configuration: Measurement Parameters

The "Measurement Parameters" specify the size of the measured uplink frame. The settings must be in line with the received signal.



Multi Evaluation Configuration: Measurement Parameters

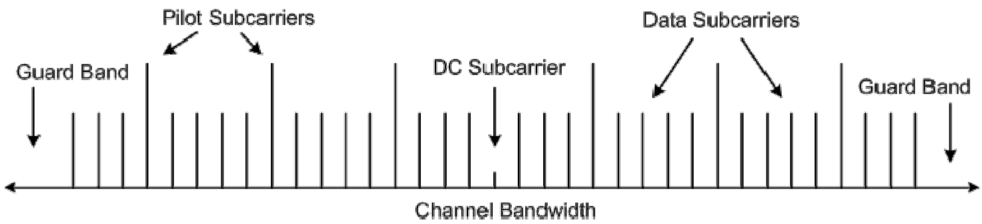
Measurement Parameters > Bandwidth
Selects the bandwidth of the measurement filter (IF filter). Set this parameter in accordance with the channel bandwidth of the measured OFDMA signal.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:BWIDth

Measurement Parameters > Link Mode
Selects the link and the sub-channel allocation mode. The R&S CMW 500 can analyze UL signals with partial usage of sub-channels (UL-PUSC, Partially Used Sub-Carrier).

In the UL-PUSC sub-channelization scheme, sub-channels are generated from six contiguous tiles, each comprising three symbol periods and four subcarriers; see Frame Settings and Burst Selection.
GPIB command: `CONFigure:WIMax:MEASurement<i>:MEValuation:LMODe`

Measurement Parameters > Frame Length
Specifies the duration of the UL frame in ms; see Frame Settings and Burst Selection.
GPIB command: `CONFigure:WIMax:MEASurement<i>:MEValuation:FLENgth`

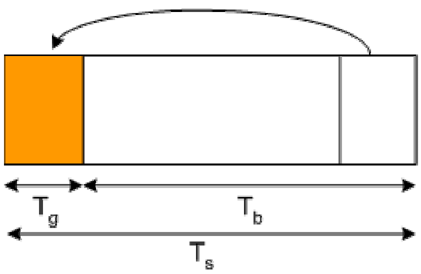
Measurement Parameters > FFT Size
Specifies the FFT length used to recover the OFDMA signal in the frequency domain. The FFT size is determined by the number of subcarriers (including data subcarriers, pilot subcarriers, and null subcarriers for the guard bands, the DC subcarrier, and no transmission at all) in the measured UL OFDMA signal. It is set equal to the smallest power of two greater than the number of used subcarriers.



FFT Size

GPIB command: `CONFigure:WIMax:MEASurement<i>:MEValuation:FFTSize`

Measurement Parameters > Cyclic Prefix
Specifies the length of the cyclic prefix (guard interval) preceding each symbol relative to the effective OFDM symbol length.
Cyclic Prefix = G = T_g / T_b
Total Symbol Time = Guard Period + Useful Symbol Time = T_g + T_b



Cyclic Prefix

GPIB command: `CONFigure:WIMax:MEASurement<i>:MEValuation:CPRefix`

10.2.1.5 Multi Evaluation Configuration: Zone Definition

The "Zone Definition" parameters define the logical sub-channels for the measured UL (PUSC) permutation zone. The multi-evaluation measurement analyzes a burst which consists of several sub-channels; refer to the Map of Bursts settings.

Multi Evaluation Configuration: Zone Definition

Measurement Parameters > Zone Definition > Segment No.
Specifies the segment number associated with the sub-channels. The total set of UL sub-channels is grouped into three segments. One segment is used for deploying a single instance of the MAC.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:ZDSNo

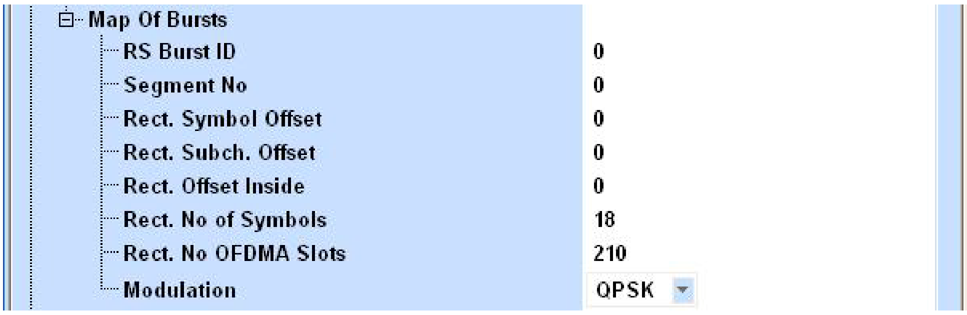
Measurement Parameters > Zone Definition > Zone Length
Specifies the duration of the measured zone as an integer number of OFDMA symbols; see Frame Settings and Burst Selection. The R&S CMW 500 uses a fixed 18-symbol zone length.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:ZLENgth

Measurement Parameters > Zone Definition > Perm Base
Specifies the UL_PermBase parameter which defines the assignment of tiles to sub-channels; see Frame Settings and Burst Selection.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:PBASe

Measurement Parameters > Zone Definition > No. of Bursts
Specifies the number of bursts within the measured UL permutation zone. The R&S CMW 500 measures a single burst.
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:NOBursts

10.2.1.6 Multi Evaluation Configuration: Map of Bursts

The "Map of Bursts" parameters define the properties of the analyzed burst within the UL PUSC permutation zone including the sub-channel and slot allocation. For background information refer to Frame Settings and Burst Selection.



Multi Evaluation Configuration: Map of Bursts

Measurement Parameters > Map of Bursts > Rect. Subch. Offset
Specifies the start of the burst on the sub-channel axis. The logical sub-channels are numbered starting from zero; an offset n means that sub-channel no. n is the first logical sub-channel of the burst.
GPIB command:
CONFigure:WIMax:MEASurement<i>:MEValuation:RSUBoffset

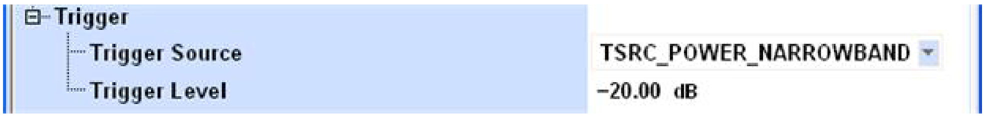
Measurement Parameters > Map of Bursts > Rect. Offset Inside
Specifies the start of the burst (in symbol periods) on the time axis as an integer number of symbol periods. The value must be an integer multiple of 3 (the number of symbols per UL slot).
GPIB command: CONFigure:WIMax:MEASurement<i>:MEValuation:ROINside

Measurement Parameters > Map of Bursts > Rect. No of OFDMA Slots
Specifies the number of OFDMA slots (3-symbol periods comprising a single logical sub-channel) within the measured burst.
GPIB command:
CONFigure:WIMax:MEASurement<i>:MEValuation:RNOofdmaslot

Measurement Parameters > Map of Bursts > Modulation
Specifies the modulation scheme of the analyzed burst. OFDMA symbols are modulated according to one of the following modulation schemes: BPSK, QPSK, 16QAM, 64QAM.
GPIB command:
CONFigure:WIMax:MEASurement<i>:MEValuation:MODulation

10.2.1.7 Multi Evaluation Configuration: Trigger Settings

The "Trigger" settings configure the measurement trigger for the multi-evaluation measurement.



Multi-evaluation configuration: trigger settings

Trigger – Trigger Source

Selects the source of the trigger event.

TSRC_POWER_NARROWBAND The measurement is triggered by the RF input power. The "Trigger Level" setting is valid for this trigger mode; it should be adjusted to the measured RF signal.

GPIB command:

```
CONFigure:WIMax:MEASurement<i>:MEValuation:TRIGger:SOURce
```

Trigger – Trigger Level

Defines the trigger threshold for the "TSRC_POWER_NARROWBAND" trigger relative to the "Expected Nominal Power". The trigger threshold defines the measured input signal power where the trigger condition is satisfied and a trigger event is generated.

GPIB command:

```
CONFigure:WIMax:MEASurement<i>:MEValuation:TRIGger:LEVel
```

10.2.1.8 WiMAX Multi Evaluation: Results

The results of the WiMAX multi-evaluation measurement are displayed in a single view.

Table of Results

The measurement diagram shows the most important "General Settings" of the measurement; refer to WiMAX Multi Evaluation: Parameters. Below, a table contains quantities to assess the modulation accuracy, frequency error, power, crest factor, and spectral flatness in the measured burst. Moreover, it provides a statistical evaluation over a configurable number of successive bursts; see Statistical Results.

	Current	Min	Max	Average	
EVM All Carriers	−39.22	−39.22	−39.22	−39.22	dB
EVM Data Carriers	−38.28	−38.28	−38.28	−38.28	dB
EVM Pilot Carriers	−42.13	−42.13	−42.13	−42.13	dB
IQ Offset	−30.89	−30.89	−30.89	−30.89	dB
Gain Imbalance	−0.01	−0.01	−0.01	−0.01	dB
Quadrature Error	0.02	0.02	0.02	0.02	°
Center Frequency Er	12.07	12.07	12.07	12.07	Hz
Burst Power	−25.46	−25.46	−25.46	−25.46	dBm
Crest Factor	9.52	9.52	9.52	9.52	dB
CINR	65.06	65.06	65.06	65.06	dB
S. Flatness O. L.	−0.42	−0.42	−0.42	−0.42	dB
S. Flatness O. U.	0.44	0.44	0.44	0.44	dB
S. Flatness I. L.	−0.30	−0.30	−0.30	−0.30	dB
S. Flatness I. U.	0.21	0.21	0.21	0.21	dB
S. Flatness Neighbo	0.08	0.08	0.08	0.08	dB

WiMAX Multi Evaluation measurement results

The following modulation results of the WiMAX multi-evaluation measurement are analogous to the results discussed in section Modulation Accuracy, however, the formulas are modified to account for the necessary averaging over subcarriers and symbols.

Error Vector Magnitude (EVM)

The Error Vector Magnitude for each subcarrier k and symbol l is the normalized magnitude of the error vector:

$$EVM_{l,k} = \frac{|\hat{r}_{lk} - a_{lk}|}{|a_{lk}|}$$

The individual EVM values are RMS-averaged in order to obtain average EVM values (in percent) for the pilot symbols, the data symbols, and all symbols in the measured burst:

$$EVM_{Pilot} = \sqrt{\frac{1}{L \cdot K\_Pilot} \sum_{l}^{L} \sum_{k\_Pilot}^{K\_Pilot} |EVM_{l,k\_Pilot}|^2}$$

$$EVM_{Data} = \sqrt{\frac{1}{L \cdot K\_Data} \sum_{l}^{L} \sum_{k\_Data}^{K\_Data} |EVM_{l,k\_Data}|^2}$$

$$EVM_{All} = \sqrt{\frac{1}{L \cdot (K\_Pilot + K\_Data)} \sum_{l}^{L} \left\{ \sum_{k}^{K\_Pilot} |EVM_{l,k\_Pilot}|^2 + \sum_{k}^{K\_Data} |EVM_{l,k\_Data}|^2 \right\}}$$

The EVM percentage values are converted into dB values in the usual way:

EVM [dB] = 20 log EVM [%],
which, owing to the percentage of pilot symbols in the uplink burst (2* K_Pilot = K_Data) results in the relation:

$$EVM_{All}[dB] = 10 \cdot \log\left[\frac{1}{3}10^{EVM_{Pilot}[dB]/10} + \frac{2}{3}10^{EVM_{Data}[dB]/10}\right]$$

GPIB commands:
`FETCh:WIMax:MEASurement<i>:MEValuation:EVM:ALL:CURRent?` etc.

I/Q Offset

The I/Q offset is estimated from the distribution of the constellation points; see I/Q Offset, I/Q Imbalance.
GPIB commands:
`FETCh:WIMax:MEASurement<i>:MEValuation:IQOFfset:CURRent?` etc.

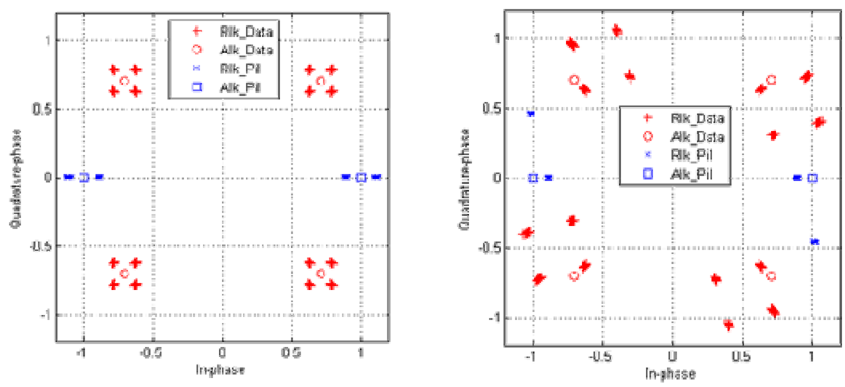
Gain Imbalance and Quadrature Error

The I/Q imbalance ΔQ is estimated from the distribution of constellation points; see I/Q Offset, I/Q Imbalance. From this estimate the R&S CMW 500 derives the following additional results:

- Modulator gain imbalance = |1 + ΔQ|
- Quadrature mismatch = arg (1 + ΔQ)

The presence of sub-carrier pairs on the negative and positive frequency axis is crucial to let the ΔQ algorithm converge. The I/Q imbalance evaluation is skipped if the number of these pairs does not exceed a minimum number.
The following examples show constellation diagrams for QPSK-modulated signals with different values of the modulator gain imbalance and quadrature mismatch:

- Left side: Modulator gain imbalance = 0.8, quadrature mismatch = 0 (no mismatch)
- Right side: Modulator gain imbalance = 1 (no imbalance), quadrature mismatch = 30 deg



Modulator gain imbalance and quadrature mismatch

GPIB commands:
`FETCh:WIMax:MEASurement<i>:MEValuation:GIMBalance:CURRent?`
`FETCh:WIMax:MEASurement<i>:MEValuation:QERRor:CURRent?` etc.

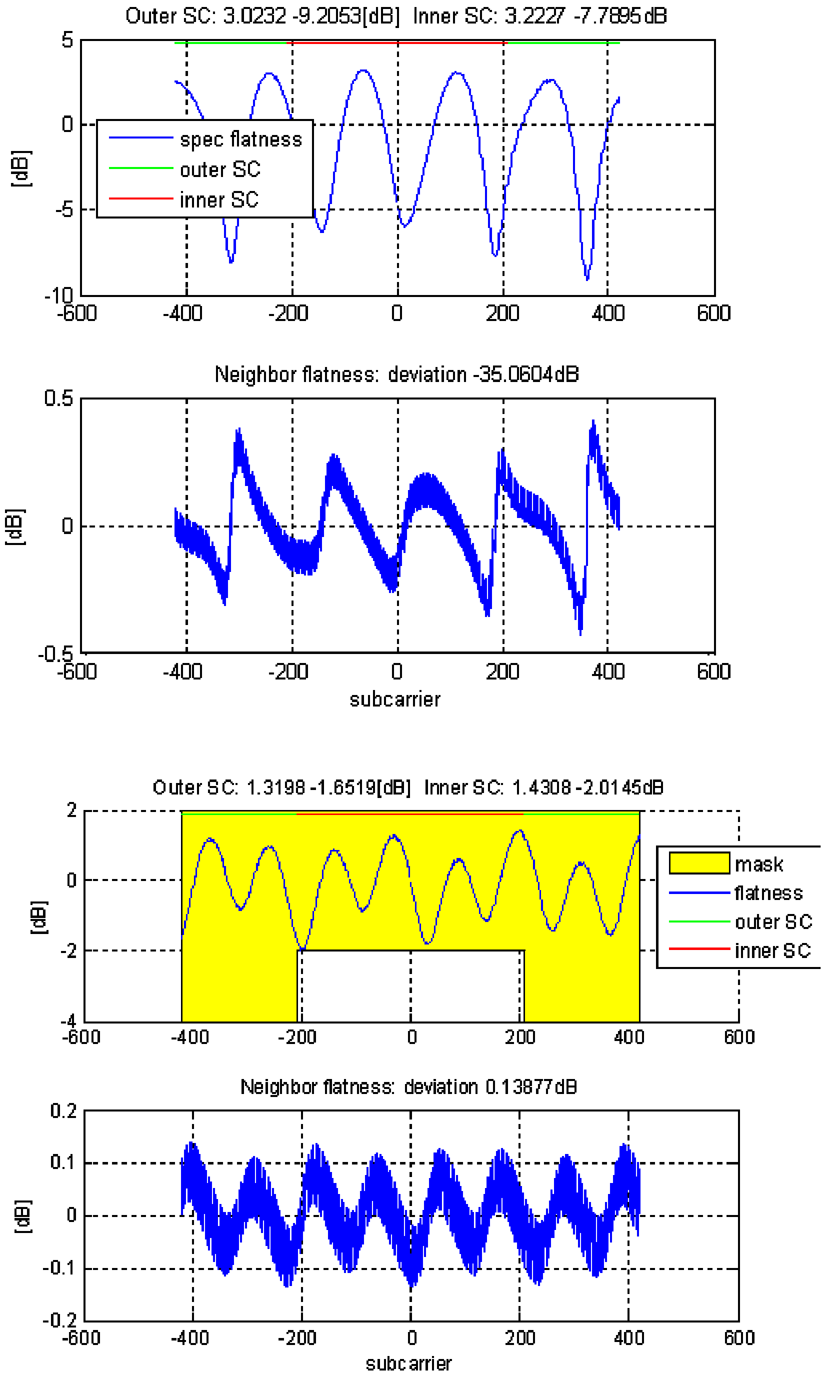
Frequency Error, Burst Power, Crest Factor

The "Frequency Error" is defined in the usual way as the difference between the offset

of the measured carrier frequency from the nominal RF frequency of the measured radio channel. The "Burst Power" is the received signal power, averaged over all symbols of the burst. The "Crest Factor" is the ratio of the highest symbol power in the burst to the "Burst Power".
GPIB commands:
`FETCh:WIMax:MEASurement<i>:MEValuation:CFERror:CURRent?`
`FETCh:WIMax:MEASurement<i>:MEValuation:BPOWer:CURRent?`
`FETCh:WIMax:MEASurement<i>:MEValuation:CFACtor:CURRent?` etc.

The WiMAX multi-evaluation measurement provides additional results that characterize OFDM(A) systems:

Spectral flatness
The spectral flatness indicates to which degree the signal power is equally distributed among the sub-carriers. A high spectral flatness means that the power is similar in all subcarriers, a low spectral flatness indicates that the spectral power is concentrated in a subset of sub-carriers, e.g. due to frequency-selective fading.
To obtain the spectral flatness, the R&S CMW 500 calculates the absolute value of the channel transfer function $|H_m|$ for each tile, see Channel and Symbol Estimation. The channel transfer function is normalized to the mean power of the pilot subcarriers. Furthermore, it calculates the ratios, the maximum and the minimum of the inner and outer active subcarriers.
For active subcarriers with active neighbors, it is also possible to calculate the differential flatness (neighbor flatness, "Spectral Flatness Neighbor"), defined as the ratio of H_m/H_{m-1}.
The figures below show the spectral flatness of a SUI-3 channel model [802163c-01_29], fs=11.2MHz and omni-directional antenna. For the inner and outer subcarriers, the maximum and minimum values are shown. The third figure also contains the allowed tolerances (spectral mask).



Spectral Flatness

GPIB commands:

`FETCh:WIMax:MEASurement<i>:MEValuation:SFOupper:CURRent?` etc.

Carrier to Interference Noise Ratio (CINR)

The CINR is not available in the current firmware version.

10.3 WiMAX Command Reference

The following sections provide detailed reference information on the remote control commands of the WiMAX application. The commands are organized as follows:

- General Measurement Settings
- Multi-Evaluation Measurement Commands

For an overview of all commands refer to the Alphabetical List of Commands.

10.3.1 General Measurement Settings

The commands valid for all WiMAX measurements are divided into the groups listed below. For an overview of the commands refer to Command Groups.

- Analyzer Settings
- Signal Routing

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.
For further information refer to Firmware Applications.

10.3.1.1 Command Groups (General Measurement Settings)

10.3.1.2 Analyzer Settings

The following commands configure the RF input path.

CONFigure:WIMax:MEAS<i>:RFSettings:ENPower <Exp Nom Power>

Sets the expected nominal power of the measured RF signal.

<Exp Nom Power>	Range: –47 dBm to +34 dBm at RF 1 COM and RF 2 COM (increment 0.01 dBm; please notice also the ranges quoted in the "Specifications") Def. value: 0.00 dBm Def. unit: dBm
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:RFSettings:UMARgin <User Margin>

Sets the margin that the R&S CMW 500 adds to the expected nominal power (`CONFigure:...:MEAS<i>:RFSettings:ENPower`) minus the external input attenuation (`CONFigure:...:MEAS<i>:RFSettings:EATTenuation`) in order to determine its reference power. The reference power must be within the power range of the selected input connector; refer to the "Specifications".

<User Margin>	Range: 0.00 dB to +50.00 dB at RF 1 COM (increment 0.01 dB) Def. value: 0.00 dB Def. unit: dB
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:RFSettings:FREQuency <Frequency>

Selects the center frequency of the RF analyzer.

<Frequency>	Range: 100 MHz to 3300 MHz (increment 0.1 Hz) Def. value 2500.000 MHz Def. unit: Hz
Characteristics	Firmware version V1.00

10.3.1.3 Signal Routing

The following commands select the connector for the generator and define an external attenuation value.

ROUTe:WIMax:MEAS<i>:RFSettings:CONNector <Input Connector>

Selects the input connector for the measured RF signal.

<Input Connector>	**RF1C:** RF 1 COM

RF2C: RF 2 COM
Def. value: RF1C

Characteristics Firmware version V1.00

CONFigure:WIMax:MEAS<i>:RFSettings:EATTenuation <External Att>

Defines an external attenuation (or gain, if the value is negative), to be applied to the selected RF input connector (`ROUTe:...:MEAS<i>:RFSettings:CONNector`).

<External Att> Range: –50.00 dB to +90.00 dB (increment 0.01 dB)
Def. value: 0.00 dB
Def. unit: dB

Characteristics Firmware version V1.00

10.3.2 WiMAX Multi Evaluation Measurement Commands

The commands valid for the WiMAX "Multi Evaluation" measurement are divided into the groups listed below. For an overview of the commands refer to Command Groups.

Commands for control and configuration:

- Measurement Control and States
- Statistical Settings
- Measurement Parameters
- Zone Definition
- Map of Bursts
- Trigger Settings

Commands for retrieval of measurement results:

- Error Vector Magnitude
- I/Q Offset, Gain Imbalance, Quadrature Mismatch
- Center Frequency Error, Burst Power, Crest Factor, CINR
- Spectral Flatness

The following general measurement settings also affect the WiMAX multi-evaluation measurement:

- Analyzer Settings
- Signal Routing

Issues of special interest for all commands:

MEAS<i> Abbreviation of "MEASurement<instance>". For better readability only the abbreviated form (which is also accepted by the instrument) is given in the command reference.
It is possible to use up to four instances of the same firmware application in parallel.

For further information refer to Firmware Applications.

Issues of special interest in the context of result retrieval:

`FETCh` and `READ` commands	Both commands can be used to retrieve measurement results: ◆ `FETCh...` returns the results of the current measurement cycle (single shot measurement) after they are valid. `FETCh...` must be used after the measurement has been started (`INITiate...`, measurement states RUN or RDY). ◆ `READ...` starts a new single shot measurement and returns the results. For further information refer to Retrieving Measurement Results.
Current and statistical values	The R&S CMW 500 repeats measurements according to the selected statistic count and repetition mode. Consecutive measurement values are stored and used to calculate statistical results, e.g. average, minimum, maximum and standard deviation. For a description of the statistical methods refer to Statistical Results.

Global Reliability Indicator

The common reliability indicator is the first value in the output arrays of the `FETCh...?` and `READ...?` queries.
e.g. `FETCh:GPRF:MEASurement<i>:EPSensor:CURRent?`
Response: 0, 10.22, 10.15, 10.01, 10.29, 100 (reliability: 0, 5 numeric measurement values)
In the present firmware version, the common reliability indicator is always set to zero.

10.3.2.1 Command Groups (Multi Evaluation)

Zone Definition **Page**

Map of Bursts **Page**

Trigger Settings **Page**

Measurement Results (EVM) **Page**

Measurement Results (I/Q Offset, Gain Imbalance, Quadrature Mismatch) Page

Measurement Results (Center Frequency Error, Burst Power, Crest Factor, CINR) Page

Measurement Results (Spectral Flatness) **Page**

10.3.2.2 Measurement Control and States

The following commands control the measurement and return the current measurement state.

INITiate:WIMax:MEAS<i>:MEValuation
ABORt:WIMax:MEAS<i>:MEValuation
STOP:WIMax:MEAS<i>:MEValuation

Starts, stops, or aborts the measurement; see Measurement Control:

- `INITiate...` starts or restarts the measurement; the R&S CMW 500 enters the "RUN" state.
- `ABORt...` causes a running measurement to stop immediately; the R&S CMW 500 enters the "OFF" state.
- `STOP...` causes a running measurement to stop after the current evaluation period is terminated and valid results are available; the R&S CMW 500 enters the "RDY" state.

Use `FETCh...STATe?` to query the current measurement state.

Characteristics Firmware version V1.00
SCPI: No query

FETCh:WIMax:MEAS<i>:MEValuation:STATe?

Queries the main measurement state; see Measurement Control. Use `FETCh:...:MEAS<i>:...:STATe:ALL?` to query the measurement state including the substates. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State> **OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`)
RDY: measurement has been terminated, valid results may be available
RUN: measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates)
Def. value: OFF

Characteristics Firmware version V1.00
SCPI: Query only

FETCh:WIMax:MEAS<i>:MEValuation:STATe:ALL?

Queries the main measurement state and the measurement substates. Both measurement substates are relevant for running measurements only. Use `FETCh:...:MEAS<i>:...:STATe?` to query the main measurement state only. Use `INITiate...`, `STOP...`, `ABORt...` to change the measurement state.

Returned values:

<Main State>,	**OFF:** measurement switched off, no resources allocated, no results available (when entered after `STOP...`) **RDY:** measurement has been terminated, valid results may be available **RUN:** measurement running (after `INITiate...`, `READ...`), synchronization pending or adjusted, resources active or queued (see Measurement Substates) Def. value: OFF
<Sync State>,	**PEND:** waiting for resource allocation, adjustment, hardware switching ("pending") **ADJ:** all necessary adjustments finished, measurement running ("adjusted") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")
<Resources State>	**QUE:** measurement without resources, no results available ("queued") **ACT:** resources allocated, acquisition of results in progress but not complete ("active") **INV:** not applicable because <main_state>: OFF or RDY ("invalid")

Characteristics Firmware version V1.00
SCPI: Query only

10.3.2.3 Statistical Settings

The following commands specify the scope of the multi-evaluation measurement.

CONFigure:WIMax:MEAS<i>:MEValuation:REPetition <Mode>

Specifies the repetition mode of the measurement; see Statistical Settings. The repetition mode specifies whether the measurement is stopped after a single shot or repeated continuously. Use `CONFigure:..:MEAS<i>:...:SCOunt` to determine the number of measurement intervals per single shot.

<Mode>	**SINGleshot**: Single shot measurement **CONTinuous**: Continuous measurement Def. value: SINGleshot
Characteristics	Firmware version V1.00 **Note:** in the current firmware version, this command has no effect. The measurement is always performed in single shot mode.

CONFigure:WIMax:MEAS<i>:MEValuation:SCOunt <Count>

Specifies the statistic count of the measurement; see Statistical Settings. The statistic count is equal to the number of measurement intervals per single shot. Use `CONFigure:...:MEAS<i>:...:REPetition SINGleshot | CONTinuous` to select either single shot or continuous measurements.

<Count>	Number of measurement intervals. A measurement interval comprises a single power/frequency step. Range: 1 to 10000 Def. value: 10
Characteristics	Firmware version V1.00

10.3.2.4 Measurement Parameters

The following commands adjust the analyzer of the R&S CMW 500 to the properties of the analyzed signal.

CONFigure:WIMax:MEAS<i>:MEValuation:BWIDth <Bandwidth>

Sets the IF bandwidth of the R&S CMW 500. Set this parameter in accordance with the channel bandwidth of the measured OFDMA signal.

<Bandwidth>	Range: 3.5 MHz | 5 MHz | 7 MHz | 8.75 MHz | 10 MHz Def. value: 10 Unit: MHz
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:LMODe <Link Mode>

Selects the link and the sub-channel allocation mode. The R&S CMW 500 can analyze UL signals with partial usage of sub-channels (UL-PUSC).

<Link Mode>	**ULPusc:** UL-PUSC Def. value: ULPusc (no alternative settings)
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:FLENgth <Frame Length>

Adjusts the R&S CMW 500 to the frame duration of the analyzed signal. In the current firmware version, 5 ms frames are supported.

<Frame Length>	Range: 5 ms Def. value: 5 Unit: ms
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:FFTSize <FFT Size>

Specifies the FFT length used to recover the OFDMA signal in the frequency domain. The FFT size is determined by the number of subcarriers (including data, pilot, and null subcarriers) that the R&S CMW 500 can measure.

<FFT Size>	Range: 512 | 1024 Def. value: 1024
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:CPRefix <Cyclic Prefix>

Specifies the length of the cyclic prefix (guard interval) preceding each symbol relative to the effective OFDM symbol length. In the current firmware version, a value of 1/8 is supported.

<Cyclic Prefix>	Range: 8 (corresponds to cyclic prefix values of 1/4 and 1/8) Def. value: 8
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:NOOSymbols <OFDMA Symbols>

Specifies the length of the UL frame as a number of OFDMA symbols. The value must be an integer multiple of 3 (the number of symbols per UL slot).

<OFDMA Symbols>	Range: 3 | 6 | 9 | 12 | 15 | 18 Def. value: 3
Characteristics	Firmware version V1.00

10.3.2.5 Zone Definition

The following commands define the logical sub-channels for the measured UL (PUSC) permutation zone. The multi-evaluation measurement analyzes a burst which consists of several sub-channels; refer to the Map of Bursts settings.

CONFigure:WIMax:MEAS<i>:MEValuation:ZDSNo <Segment No>

Specifies the segment number associated with the sub-channels. The total set of UL sub-channels is grouped into three segments.

<Segment No>	Range: 0 | 1| 2 Def. value: 0
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:ZLENgth <Zone Length>

Specifies the duration of the measured zone as an integer number of OFDMA symbols. The R&S CMW 500 uses a fixed 18-symbol zone length.

<Zone Length>	Range: 18 Def. value: 18 (no alternative setting)
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:PBASe <Perm Base>

Specifies the UL_PermBase parameter which defines the assignment of tiles to sub-channels.

<Perm Base>	Range: 0 to 69 Def. value: 0
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:NOBursts <No of Bursts>

Specifies the number of bursts within the measured UL permutation zone. The R&S CMW 500 measures a single burst.

<No of Bursts>	Range: 1 (no alternative selection) Def. value: 1
Characteristics	Firmware version V1.00

10.3.2.6 Map of Bursts

The following commands define the properties of the analyzed burst within the UL PUSC permutation zone including the sub-channel and slot allocation.

CONFigure:WIMax:MEAS<i>:MEValuation:RSUBoffset <Sub-Channel>

Specifies the start of the burst on the sub-channel axis. The logical sub-channels are numbered starting from zero; an offset n means that sub-channel no. n is the first logical sub-channel of the burst.

<Sub-Channel> Range: 0 to 209
Def. value: 1

Characteristics Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:ROINside <Offset Inside>

Specifies the start of the burst (in symbol periods) on the time axis as an integer number of symbol periods. The value must be an integer multiple of 3 (the number of symbols per UL slot).

<Offset Inside> Range: 0 | 3 | 6 | 9 | 12 | 15
Def. value: 0

Characteristics Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:RNOofdmaslot <OFDMA Slots>

Specifies the number of OFDMA slots (3-symbol periods comprising a single logical sub-channel) within the measured burst.

<OFDMA Slots> Range: 1 to 210
Def. value: 1

Characteristics Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:MODulation <Modulation>

Specifies the modulation scheme of the analyzed burst.

<Modulation> **QPSK:** QPSK modulation
QAM16: 16QAM modulation
QAM64: 64QAM modulation
Def. value: QPSK

Characteristics Firmware version V1.00

10.3.2.7 Trigger Settings

The following commands define the trigger parameters.

CONFigure:WIMax:MEAS<i>:MEValuation:TRIGger:SOURce <Trigger Source>

Selects the source of the trigger events.

<Trigger Source>	**TPN:** IF Power Def. value: TPN
Characteristics	Firmware version V1.00

CONFigure:WIMax:MEAS<i>:MEValuation:TRIGger:LEVel <Trigger Threshold>

Defines the trigger threshold for the power trigger sources; see `CONFigure:...:MEASurement<i>:...:TRIGger:SOURce`).

<Trigger Threshold>	Range: –50 dB to 0 dB Def. value: –30 dB Def. unit: dB (full scale, i.e. relative to the expected nominal power of the power steps that generate the trigger events)
Characteristics	Firmware version V1.00

10.3.2.8 Measurement Results (EVM)

The following commands return the EVM results of the multi-evaluation measurement.

FETCh:WIMax:MEAS<i>:MEValuation:EVM:ALL:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:ALL:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:ALL:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:ALL:MINimum?

READ:WIMax:MEAS<i>:MEValuation:EVM:ALL:CURRent?
READ:WIMax:MEAS<i>:MEValuation:EVM:ALL:AVERage?
READ:WIMax:MEAS<i>:MEValuation:EVM:ALL:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:EVM:ALL:MINimum?

Returns the values of the RMS EVM measurement results, averaged over all data and pilot symbols; see Table of Results. The current, average, maximum and minimum results can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<EVM>	Range: –100.0 dB to 0.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:EVM:DATA:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:DATA:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:DATA:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:DATA:MINimum?

READ:WIMax:MEAS<i>:MEValuation:EVM:DATA:CURRent?
READ:WIMax:MEAS<i>:MEValuation:EVM:DATA:AVERage?
READ:WIMax:MEAS<i>:MEValuation:EVM:DATA:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:EVM:DATA:MINimum?

Returns the values of the RMS EVM measurement results, averaged over all data symbols; see Table of Results. The current, average, maximum and minimum results can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<EVM>	Range: –100.0 dB to 0.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:EVM:PILot:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:PILot:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:PILot:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:EVM:PILot:MINimum?

READ:WIMax:MEAS<i>:MEValuation:EVM:PILot:CURRent?
READ:WIMax:MEAS<i>:MEValuation:EVM:PILot:AVERage?
READ:WIMax:MEAS<i>:MEValuation:EVM:PILot:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:EVM:PILot:MINimum?

Returns the values of the RMS EVM measurement results, averaged over all pilot symbols; see Table of Results. The current, average, maximum and minimum results can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<EVM>	Range: –100.0 dB to 0.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

10.3.2.9 Measurement Results (I/Q Offset, Gain Imbalance, Quadrature Mismatch)

The following commands return systematic errors of the I/Q symbols.

FETCh:WIMax:MEAS<i>:MEValuation:IQOFfset:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:IQOFfset:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:IQOFfset:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:IQOFfset:MINimum?

READ:WIMax:MEAS<i>:MEValuation:IQOFfset:CURRent?
READ:WIMax:MEAS<i>:MEValuation:IQOFfset:AVERage?
READ:WIMax:MEAS<i>:MEValuation:IQOFfset:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:IQOFfset:MINimum?

Returns the I/Q offset of all symbols; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<I/Q Offset>	Range: –100.0 dB to 0.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:GIMBalance:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:GIMBalance:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:GIMBalance:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:GIMBalance:MINimum?

READ:WIMax:MEAS<i>:MEValuation:GIMBalance:CURRent?
READ:WIMax:MEAS<i>:MEValuation:GIMBalance:AVERage?
READ:WIMax:MEAS<i>:MEValuation:GIMBalance:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:GIMBalance:MINimum?

Returns the gain imbalance derived from the I/Q imbalance; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Gain Imbalance>	Range: –100.0 dB to 0.0 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:QERRor:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:QERRor:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:QERRor:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:QERRor:MINimum?

READ:WIMax:MEAS<i>:MEValuation:QERRor:CURRent?
READ:WIMax:MEAS<i>:MEValuation:QERRor:AVERage?
READ:WIMax:MEAS<i>:MEValuation:QERRor:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:QERRor:MINimum?

Returns the quadrature mismatch derived from the I/Q imbalance; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Quad Mismatch>	Range: –100.0 dB to 0.0 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

10.3.2.10 Measurement Results (Center Frequency Error, Burst Power, Crest Factor, CINR)

The following commands return the frequency error, burst power, crest factor.

FETCh:WIMax:MEAS<i>:MEValuation:CFERror:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:CFERror:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:CFERror:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:CFERror:MINimum?

READ:WIMax:MEAS<i>:MEValuation:CFERror:CURRent?
READ:WIMax:MEAS<i>:MEValuation:CFERror:AVERage?
READ:WIMax:MEAS<i>:MEValuation:CFERror:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:CFERror:MINimum?

Returns the center frequency error; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Frequency Error>	Range: –999.9 Hz to + 999.9 Hz Def. unit: Hz
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:BPOWer:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:BPOWer:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:BPOWer:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:BPOWer:MINimum?

READ:WIMax:MEAS<i>:MEValuation:BPOWer:CURRent?
READ:WIMax:MEAS<i>:MEValuation:BPOWer:AVERage?
READ:WIMax:MEAS<i>:MEValuation:BPOWer:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:BPOWer:MINimum?

Returns the average burst power; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Burst Power>	Range: –100.0 dBm to +57.0 dBm Def. unit: dBm
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:CFACtor:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:CFACtor:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:CFACtor:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:CFACtor:MINimum?

READ:WIMax:MEAS<i>:MEValuation:CFACtor:CURRent?
READ:WIMax:MEAS<i>:MEValuation:CFACtor:AVERage?
READ:WIMax:MEAS<i>:MEValuation:CFACtor:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:CFACtor:MINimum?

Returns the crest factor, i.e. the ratio of the peak power in the burst to the average burst power in dB; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Crest Factor>	Range: 0.0 dB to +100.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

10.3.2.11 Measurement Results (Spectral Flatness)

The following commands return the spectral flatness results.

FETCh:WIMax:MEAS<i>:MEValuation:SFOupper:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:SFOupper:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:SFOupper:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:SFOupper:MINimum?

READ:WIMax:MEAS<i>:MEValuation:SFOupper:CURRent?
READ:WIMax:MEAS<i>:MEValuation:SFOupper:AVERage?
READ:WIMax:MEAS<i>:MEValuation:SFOupper:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:SFOupper:MINimum?

Returns the spectral flatness of the outer upper sub-carriers; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Flatness Out Upp>	Range: –100.0 dB to +100.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:SFOLower:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:SFOLower:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:SFOLower:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:SFOLower:MINimum?

READ:WIMax:MEAS<i>:MEValuation:SFOLower:CURRent?
READ:WIMax:MEAS<i>:MEValuation:SFOLower:AVERage?

READ:WIMax:MEAS<i>:MEValuation:SFOLower:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:SFOLower:MINimum?

Returns the spectral flatness of the outer lower sub-carriers; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Flatness Out Low>	Range: –100.0 dB to +100.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:SFIupper:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:SFIupper:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:SFIupper:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:SFIupper:MINimum?

READ:WIMax:MEAS<i>:MEValuation:SFIupper:CURRent?
READ:WIMax:MEAS<i>:MEValuation:SFIupper:AVERage?
READ:WIMax:MEAS<i>:MEValuation:SFIupper:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:SFIupper:MINimum?

Returns the spectral flatness of the inner upper sub-carriers; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Flatness In Upp>	Range: –100.0 dB to +100.0 dB Def. unit: dB
Characteristics	Firmware version V1.00 SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:SFILower:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:SFILower:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:SFILower:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:SFILower:MINimum?

READ:WIMax:MEAS<i>:MEValuation:SFILower:CURRent?
READ:WIMax:MEAS<i>:MEValuation:SFILower:AVERage?
READ:WIMax:MEAS<i>:MEValuation:SFILower:MAXimum?

READ:WIMax:MEAS<i>:MEValuation:SFILower:MINimum?

Returns the spectral flatness of the inner lower sub-carriers; see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Flatness In Low>	Range: –100.0 dB to +100.0 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

FETCh:WIMax:MEAS<i>:MEValuation:SFNeighbor:CURRent?
FETCh:WIMax:MEAS<i>:MEValuation:SFNeighbor:AVERage?
FETCh:WIMax:MEAS<i>:MEValuation:SFNeighbor:MAXimum?
FETCh:WIMax:MEAS<i>:MEValuation:SFNeighbor:MINimum?

READ:WIMax:MEAS<i>:MEValuation:SFNeighbor:CURRent?
READ:WIMax:MEAS<i>:MEValuation:SFNeighbor:AVERage?
READ:WIMax:MEAS<i>:MEValuation:SFNeighbor:MAXimum?
READ:WIMax:MEAS<i>:MEValuation:SFNeighbor:MINimum?

Returns the spectral flatness compared to the neighbor sub-carrier (differential flatness); see Table of Results. The current, average, maximum and minimum values can be retrieved.

Returned values

<Reliability>,	Reliability indicator
<Flatness Neighb>	Range: –100.0 dB to +100.0 dB Def. unit: dB

Characteristics Firmware version V1.00
SCPI: Query only

For additional information concerning syntax elements and returned values refer to Multi Evaluation Measurement Commands.

10.3.3 Alphabetical List of Commands (WiMAX)

Command **Page**

11 Annexes

The following sections cover mostly hardware and service-related topics.

- Interfaces and Connectors
- Comparison of R&S CMW with R&S CMU commands

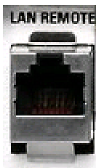
11.1 Interfaces and Connectors

This chapter provides a detailed description of the rear panel connectors of the R&S CMW 500. For a graphical overview of the rear panel refer to chapter "Preparing for Use".
The front panel is also described in chapter "Preparing for Use".

11.1.1 Rear Panel Connectors

The rear panel of the R&S CMW 500 provides various connectors for external devices and control signals.

11.1.1.1 LAN REMOTE



8-pin connector RJ-45 used to connect the R&S CMW 500 to a Local Area Network (LAN). Refer to Remote Control in a LAN and LAN Interface. The LAN connector is equivalent to the LAN connector on the front panel of the instrument. The pin assignment of the RF-45 connector supports category 5 UTP/STP (Unshielded/Shielded Twisted Pair) cables.

11.1.1.2 USB

Single or double Universal Serial Bus connectors of type A (master USB), used to connect e.g a keyboard, mouse or other pointing devices, a printer or an external storage device (USB stick, CD-ROM drive etc.). The USB interface can also be used for remote control of the instrument; see section Remote Control Operation in the "Remote Control" chapter.
The single USB connectors comply with standard USB 2.0, the double connectors to USB 1.1 connectors; refer to the "Specifications".

USB Connection
The length of passive connecting USB cables should not exceed 1 m. The maximum current per USB port is 500 mA.

11.1.1.3 REF IN, REF OUT 1

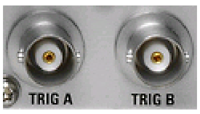
BNC connectors used as input and output connectors for the external or internal reference signals; see Reference Frequency Selftest.

The function of the connectors depends on the "Frequency Source" setting in the "Reference Frequency Selftest" menu:

- If the "Internal" reference frequency is active, REF OUT 1 is used as an output connector for the 10 MHz internal reference clock signal of the R&S CMW 500.
- If the "External" reference frequency is active, REF IN is used as an input connector for an external reference clock signal. The R&S CMW 500 is synchronized to the external reference signal. The external reference signal is also routed to the output connector REF OUT 1.

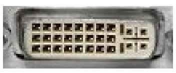
The external reference signal must meet the specifications of the data sheet.

11.1.1.4 TRIG A, TRIG B



BNC connectors for trigger input or output signals (for future applications).

11.1.1.5 DVI (Option R&S CMW-B620A)



Optional DVI-D Dual-link connector for external monitor connection; see Connecting a Monitor.

11.1.2 LAN Interface

To be integrated in a LAN, the instrument is equipped with a LAN interface, consisting of a connector, a network interface card and protocols (VXI–11). For details on the connector and its use refer to section "Rear Panel Connectors – LAN REMOTE". The network interface card supports IEEE 802.3 for a 10 MHz Ethernet and IEEE 802.3u for a 100 MHz Ethernet.

Instrument access via VXI-11 is usually achieved from high level programming platforms by using VISA as an intermediate abstraction layer. VISA encapsulates the low level VXI or even GPIB function calls and thus makes the transport interface transparent for the user. The necessary VISA library is available as a separate product. For details contact your local R&S sales representative.

11.1.2.1 VXI-11 Protocol

The VXI–11 standard is based on the RPC protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are pre-configured. 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.
Remote control of an instrument via a network is based on standardized protocols which follow the OSI reference model (see Fig. below).

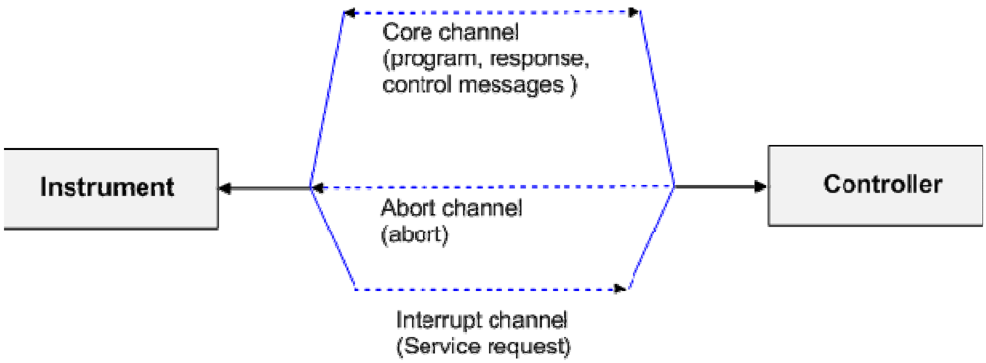
Application	SCPI
Presentation	XDR (VXI-11)
Session	ONC-RPC
Transport	TCP / UDP
Network	IP
Data Link	Ethernet/802.3
Physical	802.3/10BASE-

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 (VXI–11), 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:

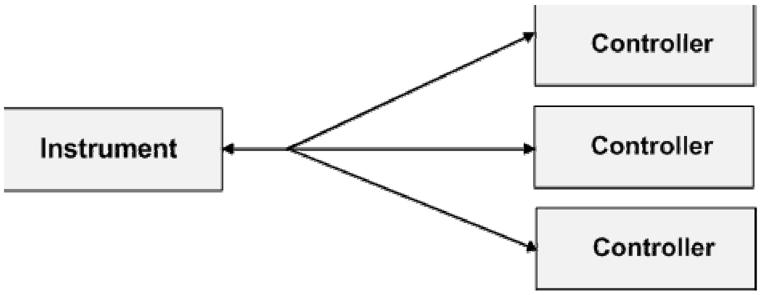
- Program messages (control command to the instrument)
- Response messages (values returned by the instrument)
- Service request (spontaneous queries of the instrument)
- Low–level control messages (interface messages)

A VXI–11 link between a controller and an instrument uses three channels: 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.



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 computer are identified by the instrument as two different controllers.



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.

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.

Command		Effect on the instrument
&ABO	(Abort)	Aborts processing of the commands just received.
&DCL	(Device Clear)	Aborts processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
&GTL	(Go to Local)	Transition to the "Local" state (manual control).
&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	Disables switchover from remote control to manual control by means of the front

Command		Effect on the instrument
	Lockout)	panel keys.
&POL	(Serial Poll)	Starts a serial poll.
&NREN	(Not Remote Enable)	Enables switchover from remote control to manual control by means of the front panel keys.

VXI-11 Interface Messages

11.1.3 GPIB Bus Interface

The instrument can be equipped with one or two GPIB bus (IEC/IEEE bus) interfaces which are available as options R&S CMW-B612A and R&S CMW-B612B, respectively. The two interface connectors labeled "IEEE 488 CH 1" and "IEEE 488 CH 2" are located on the rear panel of the instrument.

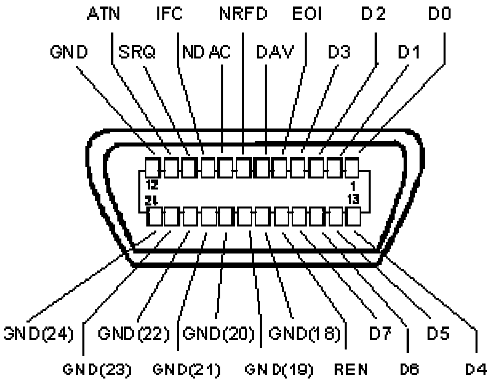
- The "IEEE 488 CH 1" connector is intended for remote control of the R&S CMW 500 from a controller.
- The "IEEE 488 CH 1" can be used to control further devices from the R&S CMW 500.

Always use a shielded cable to connect the GPIB bus interfaces.

Characteristics of the interface

- 8-bit parallel data transfer
- Bidirectional data transfer
- Three-line handshake
- High data transfer rate of max. 1 MByte/s
- Up to 15 devices can be connected
- Maximum length of the connecting cables 15 m. The length of a single connecting cable should not exceed 2 m, if many devices are used, it should not exceed 1 m.
- Wired OR if several instruments are connected in parallel

Pin assignment



Bus lines

- 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.
- Control bus with five 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.
- 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.

The R&S CMW 500 provides the following functions to communicate via GPIB bus:

- Interface functions
- Interface messages
- Instrument messages

11.1.3.1 Interface Functions

Instruments which can be controlled via GPIB bus can be equipped with different interface functions. The interface function for the R&S CMW 500 are listed in the following table.

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, de-addressed by MTA.
T6	Talker function, full capability, ability to respond to serial poll, deaddressed by 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

11.1.3.2 Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They serve to communicate between controller and instrument.

Universal Commands

Universal commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without pervious addressing.

Command	QuickBASIC 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))	The LOC/IEC ADDR key is disabled.
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

Addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Command	QuickBASIC command	Effect on the instrument
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 control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configures the instrument for parallel poll. Additionally, the QuickBASIC command executes PPE/PPD.
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.

11.1.3.3 Instrument Messages

Instrument messages (commands) are transferred on the data lines of the GPIB bus while the ATN line is not active. ASCII code is used.

Structure and syntax of the instrument messages are described the Command Reference chapter. The chapter also provides a detailed description of all messages implemented by the tester.

11.2 Comparison with R&S CMU

The R&S CMW 500 wideband radio communication tester and the R&S CMU 200 Universal Radio Communication Tester have part of their functionality in common. The enhanced flexibility of the R&S CMW 500 entails a different SCPI command structure, so that it is not possible to migrate remote program scripts without prior modification. The following sections give hints for the transcription of R&S CMU 200 programs for use on the R&S CMW 500. Please note the additional hints for program upgrades in order make full use of the measurement functionality of your R&S CMW 500.

- Segmentation, addressing and resource management
- Connection control
- Generator control
- Measurement control

11.2.1 Segmentation, Addressing and Resource Management

The R&S CMU and the R&S CMW 500 both use a modular concept, with the instrument functions grouped together in various "function groups" or "firmware applications". The chief difference between the instruments is that R&S CMW 500 does not use secondary addressing.

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
Select function group/FWA	SYSTem:REMote:ADDRess:SECondary <Addr>,<FGrp> *SEC <Addr>	e.g. SOURce:<Application>:GENerator<i>:STATe ON | OFF	<Application> mnemonic in each command identifies the generator type; no need for secondary addressing.
Activate multiple tasks of the same type	n/a	e.g. SOURce:<Application>:GENerator<i>:STATe ON	<i> suffix distinguishes between several tasks of the same type.
Task priority management	SYSTem:REMote:TPManagement ON | OFF	n/a	The dynamic behavior of the R&S CMW 500 is optimized for handling multiple tasks simultaneously. See Resource and Path Management.

11.2.2 RF Path Settings

The following settings control the routing of input and output signals, the correction of the generator level or input power, the RF analyzer and the trigger system. The R&S CMW 500 provides more flexibility for connection control settings.

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
Select input/output connector	INPut[:STATe] OUTPut[:STATe]	ROUTe:<Application>:MEASurement<i>:RFSettings:CONNector ROUTe:<Application>:GENerator<i>:RFSettings:CONNector	Independent settings for each firmware application .
Define external attenuation	[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude] SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude]	SOURce:<Application>:GENerator<i>:RFSettings:EATTenuation CONFigure:<Application>:MEASurement<i>:<Context>:RFSettings:EATTenuation	Independent settings for each firmware application.
Define analyzer	[SENSe:]LEVel:MAXimu	CONFigure:<Applicati	Independent analyzer

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
settings	m [SENSe:]RFANalyzer:FREQuency	on>:MEASurement<i>:<Context>:RFSettings:ENPower CONFigure:<Application>:MEASurement<i>:<Context>:RFSettings:UMARgin CONFigure:<Application>:MEASurement<i>:<Context>:RFSettings:FREQuency	settings for each firmware application
Define trigger settings	TRIGger[:SEQuence]:SOURce ...	CONFigure:<Application>:MEASurement<i>:<Context>:TRIGger:SOURce ...	Independent trigger settings for each measurement

11.2.3 Generator Control

Both the R&S CMU 200 and the R&S CMW 500 provide generators for general purpose RF measurements and for different network standards. All generators have a number of common features.

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
Switch generator on or off	INITiate:RFGenerator ABORt:RFGenerator STOP:RFGenerator	SOURce:<Application>:GENerator<i>:STATe ON | OFF	<Application> identifies the generator type; see Generator Control. More than a single generator instance can be active in parallel.
Query generator state	FETCh:RFGenerator:STATus?	SOURce:<Application>:GENerator<i>:STATe?	No extra command for generator state needed. Control commands unique across all firmware applications.

11.2.4 Measurement Control

The R&S CMU 200 and the R&S CMW 500 provides various mobile transmitter tests. All measurements are controlled in a similar way.

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
Switch	INITiate:<Context>	INITiate:<FWA>:<Cont	<Application> identifies the

Task	R&S CMU 200 command	R&S CMW 500 command	R&S CMW 500 upgrade hints
measurement on or off	`ABORt:<Context>` `STOP:<Context>`	`ext>` `ABORt:<FWA>:<Context>` `STOP:<FWA>:<Context>` with `<FWA> = <Application>:MEASurement<i>`	network or general purpose application for the measurement; see Measurement Control. More than a single measurement instance can be active in parallel.
Query measurement state	`FETCh:<CONText>:STATus?`	`FETCh:<FWA>:<Context>:STATe?`	Control commands unique across all firmware applications.
Measurement substates	n/a	`FETCh:<FWA>:<Context>:STATe:ALL?`	Substate also shows pending and queued measurements; see Measurement Substates.
Statistical settings	`CONFigure:<Context>:CONTrol:STATistics` `CONFigure:<Context>:CONTrol:REPetition`	`CONFigure:<FWA>:<Context>:<View>:SCOunt` `CONFigure:<FWA>:<Context>:REPetition`	Statistics can be set independently for each measurement context and view.
Measurement results	`READ:<CONText>:...?` `FETCh:<CONText>:...?`	`READ:<FWA>:<CONText>:...?` `FETCh:<FWA>:<CONText>:...?`	`READ...?` starts new single shot measurement, `FETCh...?` returns synchronized results.
Multi-evaluation measurements	n/a	`CONFigure:<FWA>:<Context>:...` `READ:<FWA>:<Context>:...?` `FETCh:<FWA>:<Context>:...?`	Multi-evaluation measurements offer maximum speed and performance because they provide a wide range of measurements at once. Different types of results can be retrieved separately.

Index

R

S