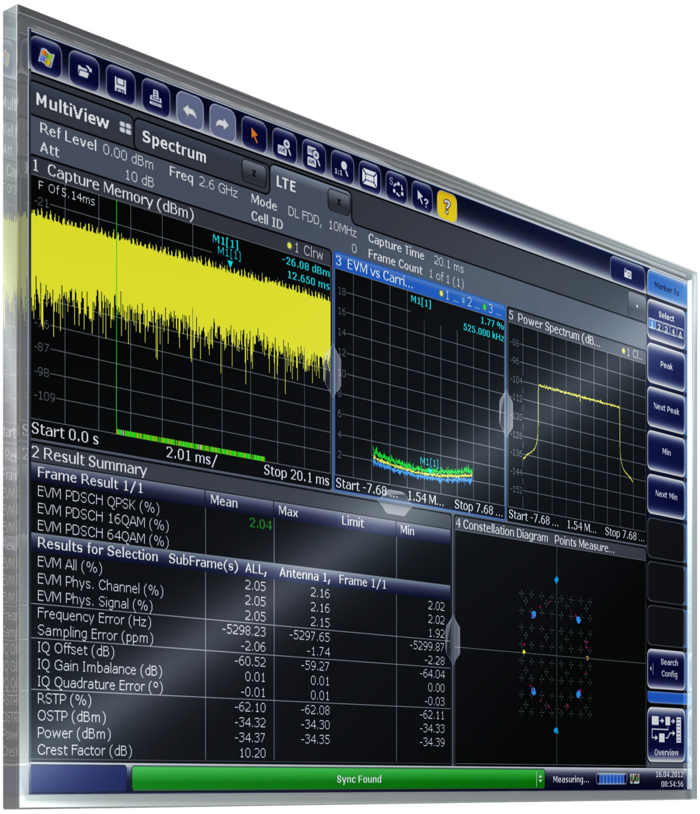
R&S®FPS-K10x (LTE Downlink) LTE Downlink Measurement Application

User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FPS models with firmware version 1.30 and higher:

- R&S®FPS4 (1319.2008K04)
- R&S®FPS7 (1319.2008K07)
- R&S®FPS13 (1319.2008K13)
- R&S®FPS30 (1319.2008K30)
- R&S®FPS40 (1319.2008K40)

The following firmware options are described:

- R&S FPS-K100 (LTE FDD DL) (order no. 1321.4227.02)
- R&S FPS-K104 (LTE TDD DL) (order no. 1321.4233.02)

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

Contents

1 Preface

1.1 About this Manual

This LTE User Manual provides all the information **specific to the operating mode**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FPS User Manual.

The main focus in this manual is on the LTE measurement results and the tasks required to obtain them. The following topics are included:

- **Welcome to the LTE Application**
  Introduction to and getting familiar with the application
- **Measurements and Result Displays**
  Details on supported LTE measurements and their result types
- **Measurement Basics**
  Background information on basic terms and principles in the context of LTE measurements
- **Configuration and Analysis**
  A concise description of all functions and settings available to configure and analyze LTE measurements with their corresponding remote control command
- **Optimizing and Troubleshooting the Measurement**
  Hints and tips on how to handle errors and optimize the test setup
- **Remote Commands for LTE Measurements**
  Remote commands required to configure and perform LTE measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FPS User Manual)
- **List of remote commands**
  Alpahabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S FPS consists of the following parts:

- Printed Getting Started manual
- Online Help system on the instrument
- Documentation CD-ROM with:
  – Getting Started
  – User Manuals for base unit and firmware applications
  – Service Manual
  – Release Notes

– Data sheet and product brochures

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. Online help is available using the ? icon on the toolbar of the R&S FPS.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

The Getting Started manual in various languages is also available for download from the Rohde & Schwarz website, on the R&S FPS product page at http://www2.rohde-schwarz.com/product/FPS.html.

User Manuals

User manuals are provided for the base unit and each additional (firmware) application.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FPS in general, and the Spectrum application in particular. Furthermore, the software functions that enhance the basic functionality for various applications are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual application manuals, the specific instrument functions of the application are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FPS is not included in the application manuals.

All user manuals are also available for download from the Rohde & Schwarz website, on the R&S FPS product page at http://www2.rohde-schwarz.com/product/FPS.html.

Service Manual

This manual is available in PDF format on the Documentation CD-ROM delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FPS by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

The most recent release notes are also available for download from the Rohde & Schwarz website, on the R&S FPS product page at http://www2.rohde-schwarz.com/product/FPS.html > Downloads > Firmware.

1.3 Typographical Conventions

The following text markers are used throughout this documentation:

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

2 Welcome to the LTE Measurement Application

The R&S FPS-K100, -K102 and -K104 are firmware applications that add functionality to perform measurements on LTE signals according to the 3GPP standard to the R&S FPS.

This user manual contains a description of the functionality that the application provides, including remote control operation. Functions that are not discussed in this manual are the same as in the Spectrum application and are described in the R&S FPS User Manual. The latest versions of the manuals are available for download at the product homepage.

http://www2.rohde-schwarz.com/product/FPS.html.

Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S FPS.

2.1 Starting the LTE Measurement Application

The LTE measurement application adds a new application to the R&S FPS.

Manual operation via an external monitor and mouse

Although the R&S FPS does not have a built-in display, it is possible to operate it interactively in manual mode using a graphical user interface with an external monitor and a mouse connected.

It is recommended that you use the manual mode initially to get familiar with the instrument and its functions before using it in pure remote mode. Thus, this document describes in detail how to operate the instrument manually using an external monitor and mouse. The remote commands are described in the second part of the document.

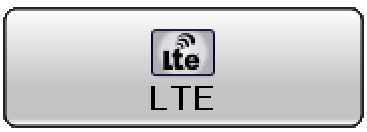
For details on manual operation see the R&S FPS Getting Started manual.

To activate the application

1. Press the MODE key on the front panel of the R&S FPS.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FPS.

2. Select the "LTE" item.



1. The R&S FPS opens a new measurement channel for the LTE measurement application.

The measurement is started immediately with the default settings. It can be configured in the "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu.

For more information see chapter 5, "Configuration", on page 56.

2.2 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.

1 = Toolbar
2 = Channel bar
3 = Diagram header
4 = Result display
5 = Subwindows (if more than one MIMO data stream is displayed at the same time)
5 = Status bar
6 = Softkeys

MSRA operating mode

In MSRA operating mode, additional tabs and elements are available. A colored background of the screen behind the measurement channel tabs indicates that you are in MSRA operating mode. Frequency sweep measurements are not available in MSRA operating mode.

For details on the MSRA operating mode see the R&S FPS MSRA User Manual.

Channel bar information

In the LTE measurement application, the R&S FPS shows the following settings:

Table 2-1: Information displayed in the channel bar in the LTE measurement application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Freq	Frequency
Mode	LTE standard
MIMO	Number of Tx and Rx antennas in the measurement setup
Capture Time	Signal length that has been captured
Frame Count	Number of frames that have been captured
Selected Subframe	Subframe considered in the signal analysis

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. transducer or trigger settings). This information is displayed only when applicable for the current measurement. For details see the R&S FPS Getting Started manual.

Window title bar information

The information in the window title bar depends on the result display.

The "Constellation Diagram", for example, shows the number of points that have been measured.

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

Regarding the synchronization state, the application shows the following labels.

- Sync OK
  The synchronization was successful. The status bar is green.
- Sync Failed
  The synchronization was not successful. The status bar is red.
  There can be three different synchronization errors.
  – Sync Failed (Cyclic Prefix): The cyclic prefix correlation failed.
  – Sync Failed (P-SYNC): The P-SYNC correlation failed.
  – Sync Failed (S-SYNC): The S-SYNC correlation failed.

3 Measurements and Result Displays

The LTE measurement application measures and analyzes various aspects of an LTE signal.

It features several measurements and result displays. Measurements represent different ways of processing the captured data during the digital signal processing. Result displays are different representations of the measurement results. They may be diagrams that show the results as a graph or tables that show the results as numbers.

Selecting measurements

► Press the MEAS key.

The application opens a dialog box that contains several buttons.
Each button represents a set of result displays that thematically belong together and that have a particular display configuration. If these predefined display configurations do not suit your requirements you can add or remove result displays as you like. For more information about selecting result displays see "Selecting result displays" on page 13.

Depending on what button you select, the application changes the way the R&S FPS capture and processes the raw signal data.

- When you select "EVM" or "Time Alignment Error", the application processes the I/Q data of the signal. For more information on available I/Q result displays see chapter 3.1, "I/Q Measurements", on page 16 and chapter 3.2, "Time Alignment Error Measurements", on page 31.
When you select one of the result displays available for I/Q measurements, you can combine the result displays available for I/Q measurements in any way.
- When you select "Transmit On/Off Power", the application records I/Q data without demodulating the data. For more information see chapter 3.3, "Transmit On / Off Power Measurement", on page 33.
- When you select "Channel Power ACLR" or "Spectrum Emission Mask", the application performs a frequency sweep. For more information see chapter 3.4, "Frequency Sweep Measurements", on page 36.
When you select one of the frequency sweep measurements, you can combine the result displays available for the frequency sweep measurements in any way. Note that you can not display the ACLR and SEM at the same time.

Selecting result displays

► Select the icon in the toolbar or press the "Display Config" softkey in the "Measurement" menu.

The application enters the SmartGrid configuration mode.
For more information on the SmartGrid functionality see the R&S FPS Getting Started.

In the default state of the application, it shows several conventional result displays.

- Capture Buffer
- EVM vs Carrier
- Power Spectrum
- Result Summary
- Constellation Diagram

From that predefined state, add and remove result displays as you like from the evaluation bar.

Note that you can customize the contents of some numerical result displays. For more information see chapter 6.1, "Configuring Tables / Numerical Results", on page 108.

MIMO measurements

When you capture more than one data stream, each result display is made up out of several tabs.

The first tab shows the results for all data streams. The other tabs show the results for each individual data stream. By default, the tabs are coupled to one another - if you select a particular data stream in one display, the application also selects this data stream in the other result displays (see Subwindow Coupling).

The number of tabs depends on the number of data streams.

Performing measurements

By default, the application measures the signal continuously. In "Continuous Sweep" mode, the application captures and analyzes the data again and again. The amount of data depends on the capture time (I/Q measurements) or the sweep time (frequency sweep measurements). In "Single Sweep" mode, the application stops measuring after it has captured the data once. The amount of data again depends on the capture time or the sweep time.

You can also repeat a measurement based on the data that has already been captured with the "Refresh" function. This is useful if you want to apply different modulation settings to the same I/Q data, for example.

For more information see the documentation of the R&S FPS.

Selecting the operating mode

The LTE application is supported by the Multi Standard Radio Analyzer (MSRA).

► Press the MODE key.

► Select the "Multi-Standard Radio Analyzer Tab".

The R&S FPS enters MSRA mode.

The MSRA mode supports all I/Q measurements and result displays available with the LTE application, except the frequency sweep measurements (SEM and ACLR).

In MSRA operating mode, only the MSRA Master actually captures data. The application receives an extract of the captured data for analysis, referred to as the **application data**. The application data range is defined by the same settings used to define the signal capture in Signal and Spectrum Analyzer mode. In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval.

If a signal contains multiple data channels for multiple standards, separate applications are used to analyze each data channel. Thus, it is of interest to know which application is analyzing which data channel. The MSRA Master display indicates the data covered by each application by vertical blue lines labeled with the application name. The blue lines correspond to the channel bandiwdth which is variable in case of LTE signals.

However, the individual result displays of the application need not analyze the complete data range. The data range that is actually analyzed by the individual result display is referred to as the **analysis interval**.

The analysis interval is automatically determined according to the Capture Time you have defined. The analysis interval can not be edited directly in the LTE application, but is changed automatically when you change the evaluation range. The currently used analysis interval (in seconds, related to capture buffer start) is indicated in the window header for each result display.

A frequent question when analyzing multi-standard signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced. The analysis line is a common time marker for all MSRA applications. It can be positioned in any MSRA application or the MSRA Master and is then adjusted in all other applications. Thus, you can easily analyze the results at a specific time in the measurement in all applications and determine correlations.

If the marked point in time is contained in the analysis interval of the application, the line is indicated in all time-based result displays, such as time, symbol, slot or bit diagrams. By default, the analysis line is displayed, however, it can be hidden from view manually. In all result displays, the "AL" label in the window title bar indicates whether or not the analysis line lies within the analysis interval or not:

- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval

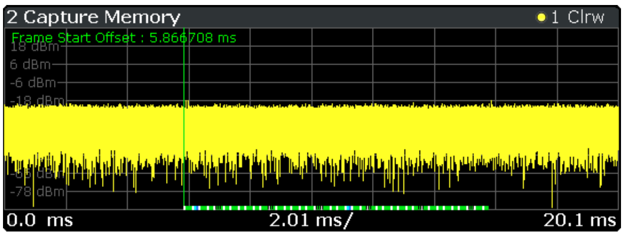
For details on the MSRA operating mode see the R&S FPS MSRA documentation.

3.1 I/Q Measurements

You can select the result displays from the evaluation bar and arrange them as you like with the SmartGrid functionality.

Capture Buffer

The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).



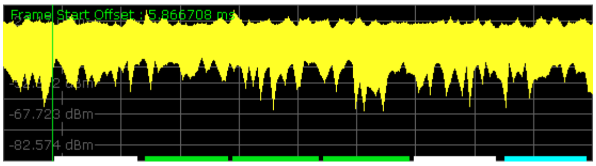
The bar at the bottom of the diagram represents the frame that is currently analyzed. Different colors indicate the OFDM symbol type.

- Indicates the data stream.
- Indicates the reference signal and data.
- Indicates the P-SYNC and data.

- Indicates the S-SYNC and data.

A green vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CBUF
Querying results: TRACe:DATA?
Querying the subframe start offset: `FETCh:SUMMary:TFRame?` on page 158

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

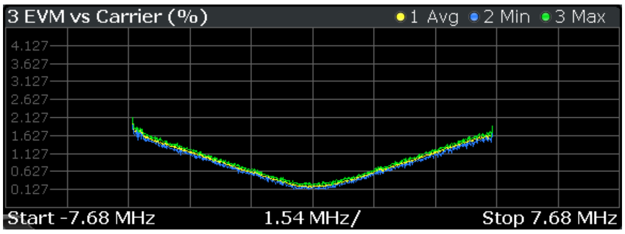
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed subframe in the capture buffer.

If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the subcarrier EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 109

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVCA
Querying results: TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed subframe.

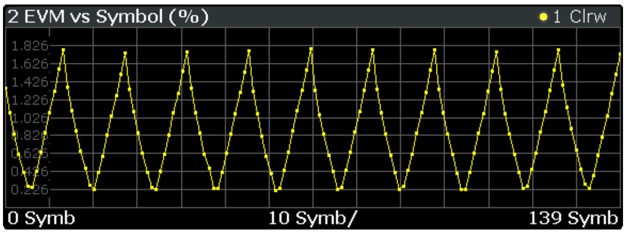
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the OFDM symbol EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 109

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FPS could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSY
Querying results: TRACe:DATA?

EVM vs RB

Starts the EVM vs RB result display.

This result display shows the Error Vector Magnitude (EVM) for all resource blocks that can be occupied by the PDSCH.

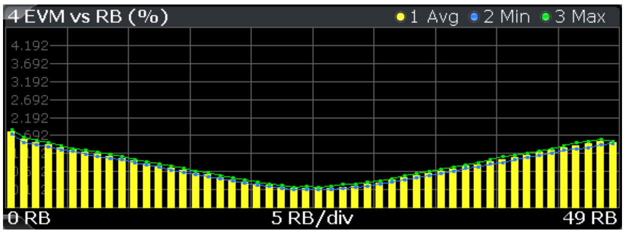
The results are based on an average EVM that is calculated over all resource elements in the resource block. This average resource block EVM is determined for each analyzed subframe.

If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the resource block EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) resource block EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) resource block EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the resource block EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 109

The x-axis represents the PDSCH resource blocks. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVRP
Querying results: TRACe:DATA?

EVM vs Subframe

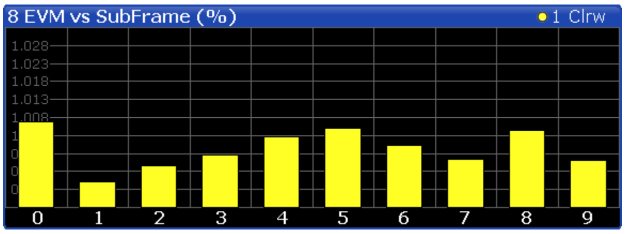
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSU
Querying results: TRACe:DATA?

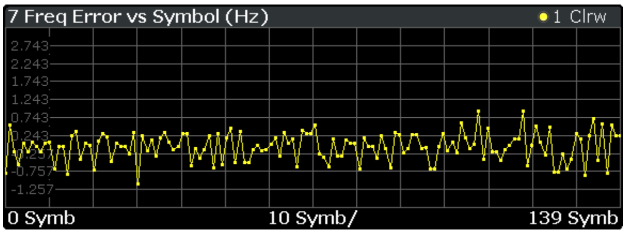
Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FPS could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.

Note that the variance of the measurement results in this result display may be much higher compared to the frequency error display in the Result Summary, depending on the PDSCH and control channel configuration. The potential difference is caused by the number of available resource elements for the measurement on symbol level.



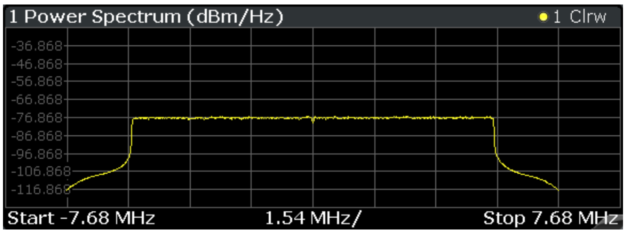
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,FEVS
Querying results: TRACe:DATA?

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 61.

The x-axis represents the frequency. On the y-axis the power level is plotted.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PSPE
Querying results: TRACe:DATA?

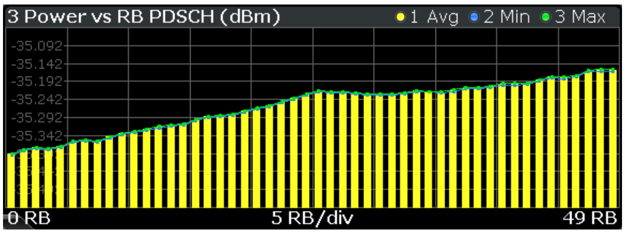
Power vs Resource Block PDSCH

Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource element averaged over one resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PVRP
Querying results: TRACe:DATA?

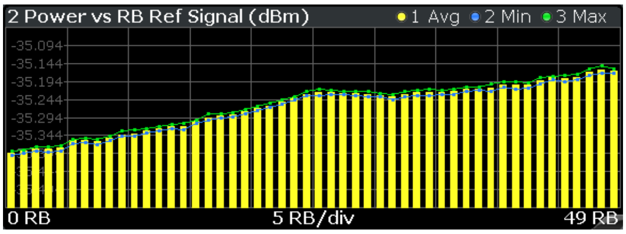
Power vs Resource Block RS

Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource element averaged over one resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



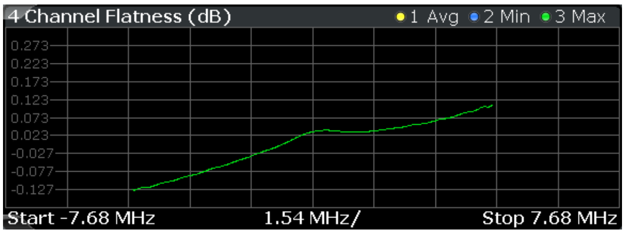
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PVRR
Querying results: TRACe:DATA?

Channel Flatness
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.



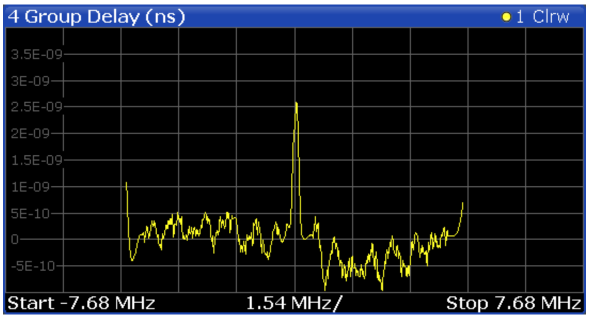
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,FLAT
Querying results: TRACe:DATA?

Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



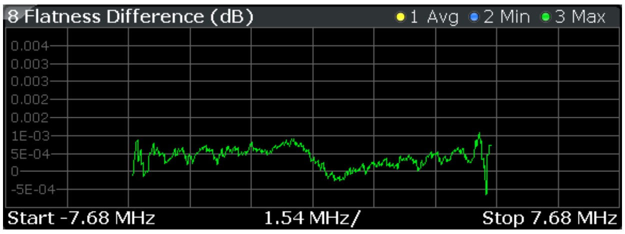
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,GDEL
Querying results: TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.

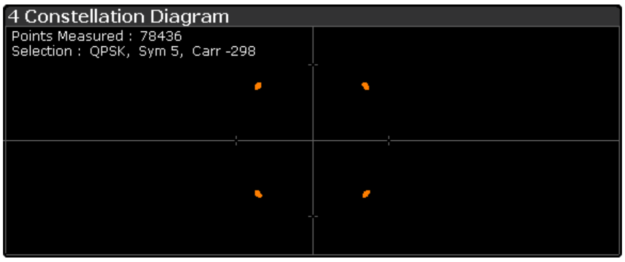


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,FDIF
Querying results: TRACe:DATA?

Constellation Diagram
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data. You can filter the results by changing the evaluation range.



The constellation diagram also contains information about the current evaluation range. In addition, it shows the number of points that are displayed in the diagram.

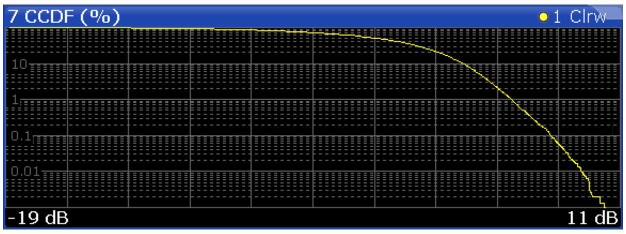
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CONS
Querying results: TRACe:DATA?

CCDF

Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CCDF
Querying results: TRACe:DATA?

Allocation Summary

Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.

1 Allocation Summary

Sub-Frame	Allocation ID	No. of RBs	Rel. Power/dB	Modulation	Power per RE/[dBm]	EVM [%]
0	RS-Ant1		0.00	QPSK	-35.33	0.98
	P-SYNC		0.00	CAZAC	-35.29	0.22
	S-SYNC		0.00	RBPSK	-35.29	0.20
	PBCH		-0.00	QPSK	-35.30	0.24
	PCFICH		0.00	QPSK	-35.35	1.28
	PHICH			MIXTURE	-35.36	2.05
	PDCCH		-0.00	QPSK	-35.33	1.19
	PDSCH 0	50	0.00	QPSK	-35.33	1.00

The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the following information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the corresponding PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.

Note that no power is calculated for the PHICH if Boosting Estimation has been turned on. For more information see PHICH Rel Power.

- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Note: PDSCH allocation with beamforming

The allocation summary shows two entries for a PDSCH allocation that uses "Beam-forming (UE spec. RS)" as the precoding method.

The second entry shows the measurement results of the UE specific reference signal.

Note: Contents of the Allocation Summary

The number of columns shown in the Allocation Summary is variable. To add or remove a column, click on the header row of the table *once*. The application opens a dialog box to select the columns which you'd like to display.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,ASUM
Querying results: TRACe:DATA?

Bit Stream

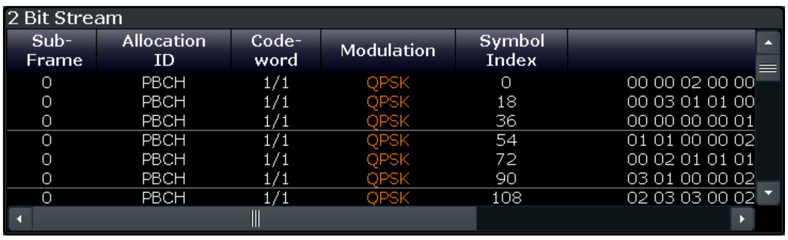
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belong-ing to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.



The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**

Modulation type of the channels.
- **Symbol Index** or **Bit Index**
  Shows the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,BSTR
Querying results: TRACe:DATA?

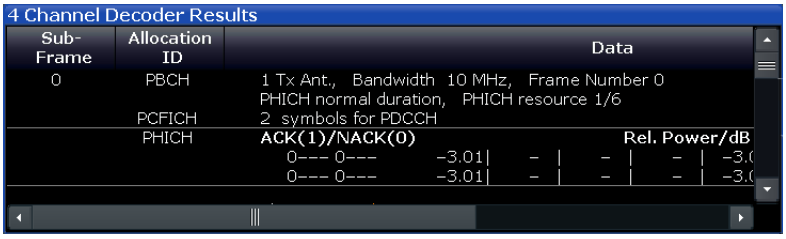
Channel Decoder Results
The Channel Decoder result display is a numerical result display that shows the characteristics of various channels for a particular subframe.

- Protocol information of the PBCH, PCFICH and PHICH.
- Information about the DCIs in the PDCCH.
- Decoded bitstream for each PDCCH.
- Decoded bitstream for each PDSCH.

The size of the table thus depends on the number of subframes in the signal.

Note that a complete set of results for the control channels is available only under certain circumstances.

- The corresponding control channel (PBCH, PCFICH or PHICH) has to be present and enabled.
- Each channel must have a certain configuration (see list below).



For each channel, the table shows a different set of values.
- PBCH
  For the PBCH, the Channel Decoder provides the following results.
  – the MIMO configuration of the DUT (1, 2 or 4 TX antennas)
  – the Transmission bandwidth
  – the Duration of the PHICH (normal or extended)
  – the PHICH resource which is the same as PHICH N_g (1/6, 1/2, 1 or 2)
  – System frame number

  If the CRC is not valid, a corresponding message is shown instead of the results.
  Results for the PBCH can only be determined if the PHICH Duration or the PHICH N_g are automatically determined ("Auto") or if automatic decoding of all control channels is turned on.
- PCFICH
  For the PCFICH, the Channel Decoder provides the number of OFDM symbols that are used for PDCCH at the beginning of a subframe.
- PHICH

The PHICH carries the hybrid-ARQ ACK/NACK. Multiple PHICHs mapped to the same set of resource elements are a PHICH group. The PHICHs within one group are separated by different orthogonal sequences.
For the PHICH, the Channel Decoder provides the ACK/NACK pattern for the PHICH group and the relative power for each PHICH in the PHICH group. Each line in the result table represents one PHICH group. The columns on the left show the ACK/NACK pattern of the PHICH group. The columns on the right show the relative powers for each PHICH.
If a PHICH is not transmitted, the table contains a "-" sign. Otherwise, the ACK/NACK pattern is either a "1" (acknowledgement) or a "0" (not acknowledged). The relative power is a numeric value in dB.

- PDCCH
  For each PDCCH that has been detected, the Channel Decoder shows several results. Each line in the table represents one PDCCH.
  – RNTI
  – DCI Format
    Shows the Downlink Control Information (DCI) format. The DCI contains information about the resource assignment for the UEs.
    The following DCI formats are supported: 0, 1, 1A, 1B, 1C, 2, 2A, 2C, 2D, 3, 3A.
    The DCI format is determined by the length of the DCI. Because they have the same length, the Channel Decoder is not able to distinguish formats 0, 3 and 3A. Note that a DCI that consist of only zero bits cannot be decoded.
  – PDCCH format used to transmit the DCI
  – CCE Offset
    The CCE Offset represents the position of the current DCI in the PDCCH bit stream.
  – Rel. Power
    Relative power ofthe corresponding PDCCH.

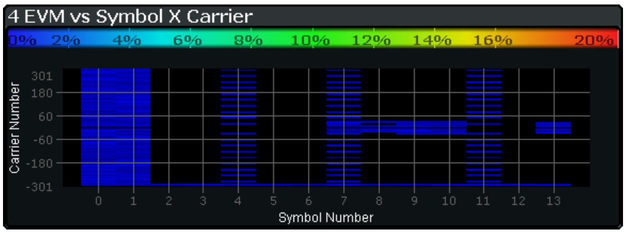
  Results for the PDCCH can only be determined if the PDSCH subframe configuration is detected by the "PDCCH Protocol" or if automatic decoding of all control channels is turned on.
- PDSCH
  For each decoded PDSCH allocation there is a PDCCH DCI. The DCI contains parameters that are required for the decoding process. If the channel could be decoded successfully, the result display shows the bit stream for each codeword.
  If the Cyclic Redundancy Check (CRC) fails, the result display shows an error message instead.
  Results for the PDSCH can only be determined if the PDSCH subframe configuration is detected by the "PDCCH Protocol" or if automatic decoding of all control channels is turned on.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CDEC
Querying results: TRACe:DATA?

EVM vs Sym x Carr

The EVM vs Symbol x Carrier shows the EVM for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the EVM. The color map for the power levels is provided above the diagram area.

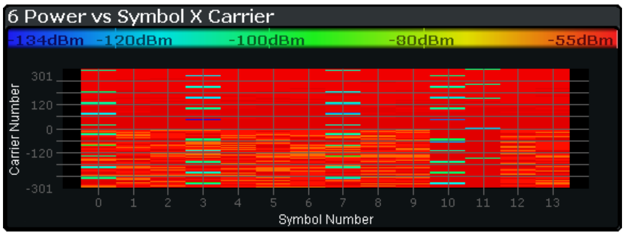


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSC
Querying results: TRACe:DATA?

Power vs Symbol x Carrier

The Power vs Symbol x Carrier shows the power for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the power. The color map for the power levels is provided above the diagram area.

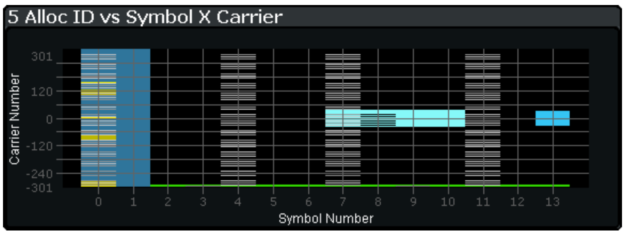


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PVSC
Querying results: TRACe:DATA?

Allocation ID vs Symbol x Carrier

The Allocation ID vs. Symbol X Carrier display shows the allocation ID of each carrier in each symbol of the received signal.

Each type of allocation is represented by a different color. Use a marker to get more information about the type of allocation.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,AISC
Querying results: TRACe:DATA?

UE RS Weights (Magnitude)
Starts the UE RS Weights Magnitude result display.

This result display shows the magnitude of the measured weights of the UE specific reference signal carriers. You can use it to calculate the magnitude difference between different antenna ports.

The x-axis represents the frequency, with the unit depending on your selection. The y-axis shows the amplitude of each reference signal in dB.

The results correspond to the data of one subframe. Thus, the result display shows results if you have selected a particular subframe (→ Subframe Selection).

You can select the antenna port to be measured via the Beamforming Selection softkey. Note that you can select the antenna port only if the UE RS weights phase measurement is selected.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,URWM
Querying results: TRACe:DATA?

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

Remote command:

LAY:ADD ? '1',LEFT,RSUM

Contents of the result summary

1 Result Summary				
Frame Result 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.98			
EVM PDSCH 16QAM (%)				
EVM PDSCH 64QAM (%)				
Results for Selection Subframe(s) ALL, Selection Antenna 1, Frame Result 1/1				
EVM All (%)	1.00	1.01		0.99
EVM Phys. Channel (%)	1.00	1.01		0.99
EVM Phys. Signal (%)	0.95	0.99		0.86
Frequency Error (Hz)	-1997.42	-1997.29		-1997.51
Sampling Error (ppm)	-2.00	-1.95		-2.04
IQ Offset (dB)	-71.88	-70.88		-72.54
IQ Gain Imbalance (dB)	0.00	0.00		0.00
IQ Quadrature Error (°)	0.02	0.02		0.01
RSTP (%)	-35.39	-35.39		-35.39
OSTP (dBm)	-7.60	-7.60		-7.60
Power (dBm)	-7.66	-7.65		-7.68
Crest Factor (dB)	10.30			

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

EVM PDSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cci>]:SUMMary:EVM:DSQP[:AVERage]?` on page 151
EVM PDSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cci>]:SUMMary:EVM:DSST[:AVERage]?` on page 152
EVM PDSCH 64QAM	Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cci>]:SUMMary:EVM:DSSF[:AVERage]?` on page 152

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the subframes.

The header row of the table contains information about the selection you have made (like the subframe).

EVM All	Shows the EVM for all resource elements in the analyzed frame. `FETCh[:CC<cci>]:SUMMary:EVM[:ALL][:AVERage]?` on page 154
EVM Phys Channel	Shows the EVM for all physical channel resource elements in the analyzed frame. A physical channel corresponds to a set of resource elements carrying information from higher layers. PDSCH, PBCH or PDCCH, for example, are physical channels. For more information see 3GPP 36.211. `FETCh[:CC<cci>]:SUMMary:EVM:PCHannel[:AVERage]?` on page 154
EVM Phys Signal	Shows the EVM for all physical signal resource elements in the analyzed frame. The reference signal, for example, is a physical signal. For more information see 3GPP 36.211. `FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal[:AVERage]?` on page 154
Frequency Error	Shows the difference in the measured center frequency and the reference center frequency. `FETCh[:CC<cci>]:SUMMary:FERRor[:AVERage]?` on page 155
Sampling Error	Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate. `FETCh[:CC<cci>]:SUMMary:SERRor[:AVERage]?` on page 158
I/Q Offset	Shows the power at spectral line 0 normalized to the total transmitted power. `FETCh[:CC<cci>]:SUMMary:IQOFfset[:AVERage]?` on page 156
I/Q Gain Imbalance	Shows the logarithm of the gain ratio of the Q-channel to the I-channel. `FETCh[:CC<cci>]:SUMMary:GIMBalance[:AVERage]?` on page 155
I/Q Quadrature Error	Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees. `FETCh[:CC<cci>]:SUMMary:QUADerror[:AVERage]?` on page 157

RSTP

Shows the reference signal transmit power as defined in 3GPP TS 36.141. It is required for the "DL RS Power" test.

It is an average power and accumulates the powers of the reference symbols within a subframe divided by the number of reference symbols within a subframe.

FETCh[:CC<cci>]:SUMMary:RSTP[:AVERage]? on page 158

OSTP

Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.

It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.

FETCh[:CC<cci>]:SUMMary:OSTP[:AVERage]? on page 156

RSSI

Shows the Received Signal Strength Indicator. The RSSI is the complete signal power of the channel that has been measured, regardless of the origin of the signal.

FETCh[:CC<cci>]:SUMMary:RSSI[:AVERage]? on page 157

Power

Shows the average time domain power of the analyzed signal.

FETCh[:CC<cci>]:SUMMary:POWer[:AVERage]? on page 156

Crest Factor

Shows the peak-to-average power ratio of captured signal.

FETCh[:CC<cci>]:SUMMary:CRESt[:AVERage]? on page 153

Marker Table

Displays a table with the current marker values for the active markers.

4 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
1	M1		1	13.25 GHz	-200.0 dBm
1	D2	M1	1	-600.0 kHz	0.0 dB
1	D3	M1	1	600.0 kHz	0.0 dB
1	D4	M1	1	-2.0 MHz	0.0 dB

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see LAYout:ADD[:WINDow]? on page 125
Results:
CALCulate<n>:MARKer<m>:X on page 160
CALCulate<n>:MARKer<m>:Y? on page 161

3.2 Time Alignment Error Measurements

The Time Alignment Error measurement captures and analyzes new I/Q data when you select it.

Note that the Time Alignment Error measurement only work in a MIMO setup (2 or 4 antennas). Therefore, you have to mix the signal of the antennas into one cable that you can connect to the R&S FPS. For more information on configuring and performing a Time Alignment Error measurement see chapter 4.5, "Performing Time Alignment Measurements", on page 52.

In addition to the result displays mentioned in this section, the Time Alignment Error measurement also supports the following result displays described elsewhere.

- "Capture Buffer" on page 16
- "Power Spectrum" on page 20
- "Channel Flatness" on page 22
- "Channel Group Delay" on page 22
- "Channel Flatness Difference" on page 23
- "Marker Table" on page 31

You can select the result displays from the evaluation bar and arrange them as you like with the SmartGrid functionality.

Time Alignment Error

Starts the Time Alignment Error result display.

The time alignment is an indicator of how well the transmission antennas in a MIMO system and component carriers are synchronized. The Time Alignment Error is either the time delay between a reference antenna (for example antenna 1) and another antenna or the time delay between a reference component carrier and other component carriers.

More information.

The application shows the results in a table.

Each row in the table represents one antenna. The reference antenna is not shown.

For each antenna the maximum, minimum and average time delay that has been measured is shown. The minimum and maximum results are calculated only if the measurement covers more than one frame.

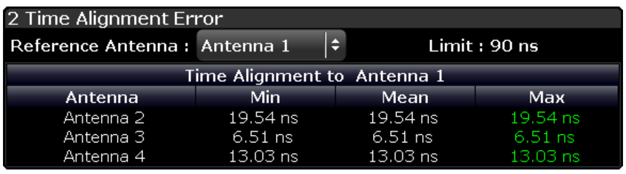
If you perform the measurement on a system with carrier aggregation, each row represents one antenna. The number of lines increases because of multiple carriers. The reference antenna of the main component carrier (CC1) is not shown.

In case of carrier aggregation, the Time Alignment measurement also evaluates the frequency error of the component carrier (CC2) relative to the main component carrier (CC1).

In any case, results are only displayed if the transmission power of both antennas is within 15 dB of each other. Likewise, if only one antenna transmits a signal, results will not be displayed (for example if the cabling on one antenna is faulty).

For more information on configuring this measurement see chapter 5.3, "Configuring Time Alignment Error Measurements", on page 101.

The "Limit" value shown in the result display is the maximum time delay that may occur for each antenna (only displayed for systems without carrier aggregation).


2 Time Alignment Error
Reference Antenna : Antenna 1 Limit : 90 ns

Time Alignment to Antenna 1			
Antenna	Min	Mean	Max
Antenna 2	19.54 ns	19.54 ns	19.54 ns
Antenna 3	6.51 ns	6.51 ns	6.51 ns
Antenna 4	13.03 ns	13.03 ns	13.03 ns

You can select the reference antenna from the dropdown menu in the result display. You can also select the reference antenna in the MIMO Setup - if you change them in one place, they are also changed in the other.

In the default layout, the application also shows the Capture Buffer and Power Spectrum result displays for each component carrier.

Remote command:
Selecting the result displays: LAY:ADD ? '1',LEFT,TAL
Querying results: FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]? on page 159
Selecting reference antenna: CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection on page 177

3.3 Transmit On / Off Power Measurement

The Transmit On/Off Power measurement captures and analyzes new I/Q data when you select it.

The Transmit On / Off Power measurement consists of several result displays that you can select from the evaluation bar. You can arrange them as you like with the SmartGrid functionality.

On / Off Power

The On / Off Power measurement shows the characteristics of an LTE TDD signal over time.

The transition from transmission to reception is an issue in TDD systems. Therefore, the measurement is available for TDD signals.

The measurement is designed to verify if the signal intervals during which no downlink signal is transmitted (reception or "off" periods) complies with the limits defined by 3GPP. Because the transition from transmission ("on" periods) to reception has to be very fast in order to efficiently use the resources, 3GPP has also defined limits for the transient periods. The limits for these are also verified by the measurement.

Note that the measurement works only if you are using the RF input. When you start the measurement, the R&S FPS records new I/Q data instead of using the data other I/Q measurements are based on.

For more information on setting up the measurement see chapter 4.6, "Performing Transmit On/Off Power Measurements", on page 53.

The result display for the On / Off Power measurement consists of numerical results and the graphic display of the signal characteristics.

Numerical results

In the default display layout, the lower part of the result display shows the results in numerical form.

Each line in the table shows the measurement results for one "off" period.

6 Transmit ON/OFF Power List

Start OFF Period Limit	Stop OFF Period Limit	Time at Δ to Limit	OFF Power Abs [dBm]	OFF Power Δ to Limit	Falling Trans Period	Rising Trans Period
1.267 ms	4.948 ms	4.786523 ms	-92.41 dBm	17.41 dB	2.73 µs	2.80 µs
6.267 ms	9.948 ms	8.799381 ms	-92.32 dBm	17.32 dB	2.73 µs	2.77 µs

- Start OFF Period Limit

Shows the beginning of the "off" period relative to the frame start (0 seconds).

- Stop OFF Period Limit
  Shows the end of the "off" period relative to the frame start (0 seconds).
  The time from the start to the stop of the "off" period is the period over which the limits are checked. It corresponds to the yellow trace in the graphic result display.
- Time at Δ to Limit
  Shows the trace point at which the lowest distance between trace and limit line has been detected. The result is a time relative to the frame start.
- OFF Power
  Shows the absolute power of the signal at the trace point with the lowest distance to the limit line.
- OFF Power Δ to Limit
  Shows the distance between the trace and the limit line of the trace point with the lowest distance to the limit line in dB.
- Falling Transition Period
  Shows the length of the falling transient.
- Rising Transition Period
  Shows the length of the rising transient.
  Note that the beginning and end of a transition period is determined based on the "Off Power Density Limit". This limit is defined by 3GPP in TS 36.141 as the maximum allowed mean power spectral density. The length of the transient from "on" to "off" period is, for example, the distance from the detected end of the subframe to the last time that the signal power is above the measured mean power spectral density.

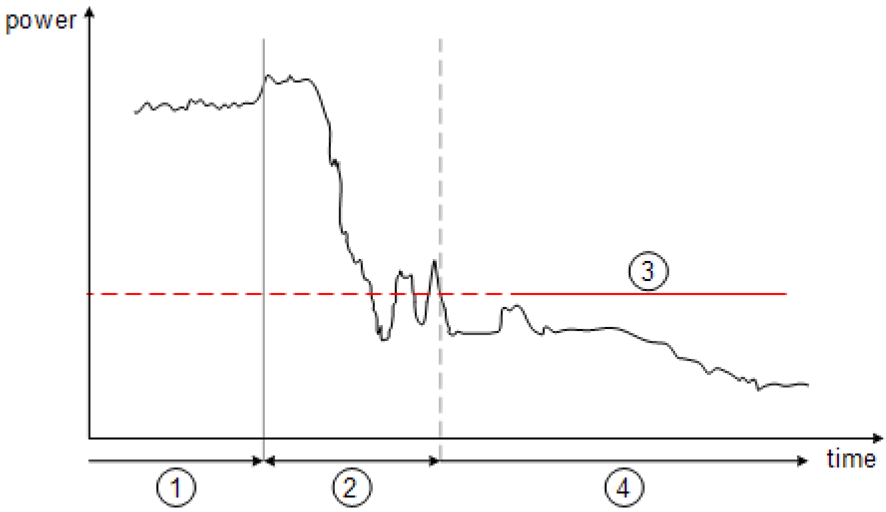


Fig. 3-1: Power profile of an TD-LTE On-to-Off transition. The transition lasts from the end of the OFF period until the signal is completely below the Off Power Density limit.

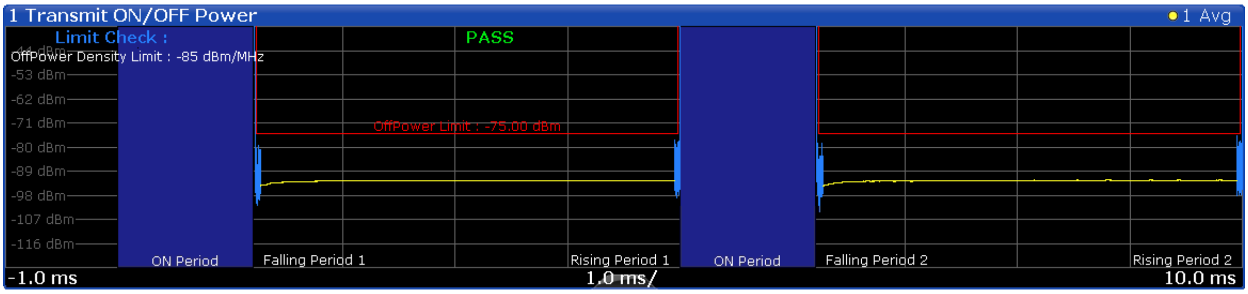
1 = subframe ("on" power period)
2 = transient (transition length)
3 = "off" power density limit
4 = "off" power period

The diagram contains an overall limit check result (Pass / Fail message). Only if all "off" periods (including the transients) comply to the limits, the overall limit check will pass.

Results that comply to the limits are displayed in green. Any results that violate the limits defined by 3GPP are displayed in red.

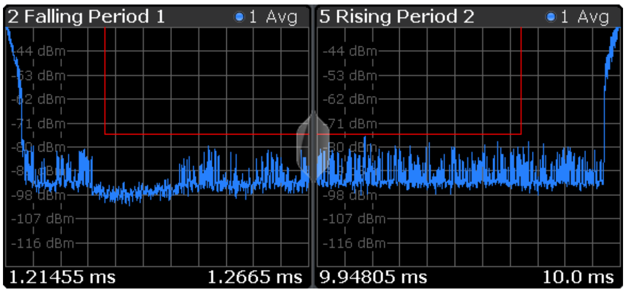
Graphic results

The upper part of the result display shows a graphical representation of the analyzed TDD frame(s).



The diagram contains several elements.

- Yellow trace
  The yellow trace represents the signal power during the "off" periods. Filtering as defined in 3GPP TS 36.141 is taken into account for the calculation of the trace.
- Blue trace
  The blue trace represents the transition periods (falling and rising).
  Note that the blue trace might not be visible in the Transmit On/Off Power overview because of its steep flank and small horizontal dimensions. By default, the application thus shows the rising and falling transitions in detail in a separate diagram.



- Blue rectangles
  The blue rectangles represent the "on" periods. Because of the overload during the "on" periods, the actual signal power is only hinted at, not shown.
- Red lines
  Limits as defined by 3GPP.

In addition to these elements, the diagram also shows the overall limit check (see above), the average count and the limit for the mean power spectral density ("Off Power Density Limit").

Adjust Timing

If you are using an external trigger for the On / Off power measurement, you have to determine the offset of the trigger time to the time the LTE frame starts. You can do this with the "Adjust Timing" function. When the application has determined the offset, it corrects the results of the On / Off Power measurement accordingly.

Remote command:
Selecting the result display: `CONFigure[:LTE]:MEASurement` on page 169
Querying results: TRACe:DATA?
Querying limit check results:
`CALCulate<n>:LIMit<k>:OOPower:OFFPower?` on page 162
`CALCulate<n>:LIMit<k>:OOPower:TRANsient?` on page 163
`[SENSe][:LTE]:OOPower:ATIMing` on page 133,

3.4 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

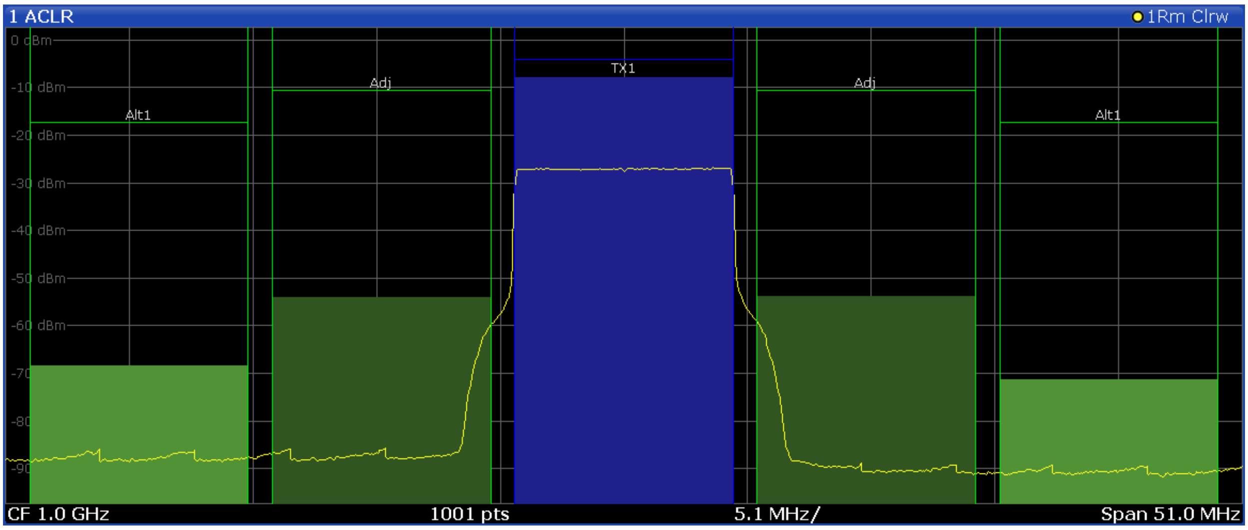
Frequency sweep measurements are available if RF input is selected.

ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of the transmission (TX) channel and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channel. Thus, the ACLR measurement provides information about the power in the adjacent channels as well as the leakage into these adjacent channels.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent channel bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and, if required, customize the channel setup to your needs. For more information see the documentation of the R&S FPS.



The power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

2 Result Summary — EUTRA/LTE Square

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	9.015 MHz		**-7.82 dBm**	
Tx Total			**-7.82 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	9.015 MHz	10.000 MHz	**-46.34 dB**	**-46.04 dB**
Alt1	9.015 MHz	20.000 MHz	**-60.57 dB**	**-63.57 dB**

Remote command:
Selecting the result display:
CONF:MEAS ACLR
Querying results:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?`
TRACe:DATA?

Cumulative ACLR
Starts the Cumulative Adjacent Channel Leakage Ratio (Cumulative ACLR) measurement.

The Cumulative ACLR measurement is designed to measure the Cumulative ACLR test requirement for non-contiguous spectrum in 3GPP 36.141. It calculates the Cumulative ACLR of the gaps as defined in 3GPP 36.141. Note that this measurement is only useful for two non-contiguous carriers.

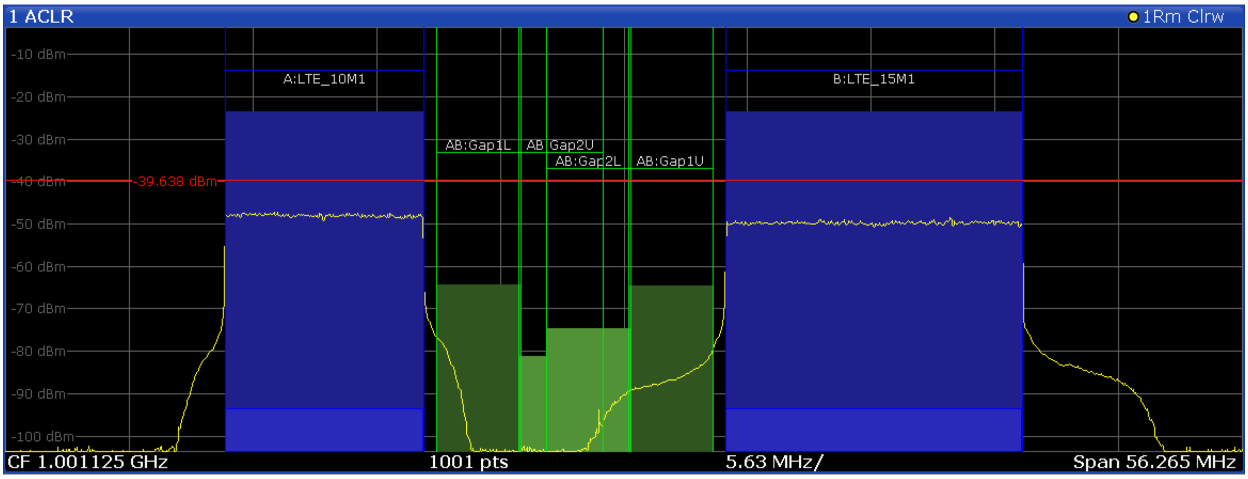
The gap channels are labeled "Gap<x>U" or "Gap<x>L", with "<x>" representing the number of the gap channels and "U" and "L" standing for "Upper" and "Lower". The number of analyzed gap channels depeneds on the channel spacing between the carriers as defined in the test specification.

The x-axis represents the frequency. Note that the application automatically determines the center frequency and span of the measurement according to the frequencies of the carriers.

On the y-axis, the power is plotted in dBm. The power for the TX channels is an absolute value in dBm. The power of the gap channels are absolute values relative to the cumulative power of the TX channels. The power of the channels is automatically tested against the limits defined by 3GPP.

The result display contains several additional elements.

- Blue and green lines:
  Represent the bandwidths of the carriers (blue lines) and those of the gap channels (green lines). Note that the channels may overlap each other.
- Blue and green bars:
  Represent the integrated power of the transmission channels (blue bars) and gap channels (green bars).



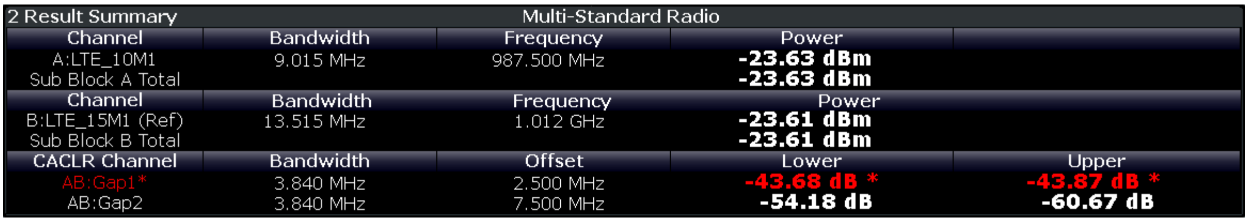
Cumulative ACLR table

A table in the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the type of channel.

Channel "A" and "B" represent the component carriers. For each of the channels, the application also shows the "Total", which should be the same as that for the channel.
The other rows ("AB:Gap") represent the gap channels.

- **Bandwidth**
  Shows the bandwidth of the channel.
  The bandwidth of the carrier is the sum of the two component carriers.
- **Frequency**
  Shows the frequency of the carrier.
  Available for the aggregated carriers.
- **Offset**
  Frequency offset relative to the center frequency of the aggregated carrier.
  Available for the gap channels.
- **Power / Lower / Upper**
  Shows the power of the carrier and the power of the lower and upper gap channels relative to the power of the aggregated carrier.



2 Result Summary	Multi-Standard Radio			
Channel	Bandwidth	Frequency	Power	
A:LTE_10M1	9.015 MHz	987.500 MHz	-23.63 dBm	
Sub Block A Total			-23.63 dBm	
Channel	Bandwidth	Frequency	Power	
B:LTE_15M1 (Ref)	13.515 MHz	1.012 GHz	-23.61 dBm	
Sub Block B Total			-23.61 dBm	
CACLR Channel	Bandwidth	Offset	Lower	Upper
AB:Gap1*	3.840 MHz	2.500 MHz	-43.68 dB *	-43.87 dB *
AB:Gap2	3.840 MHz	7.500 MHz	-54.18 dB	-60.67 dB

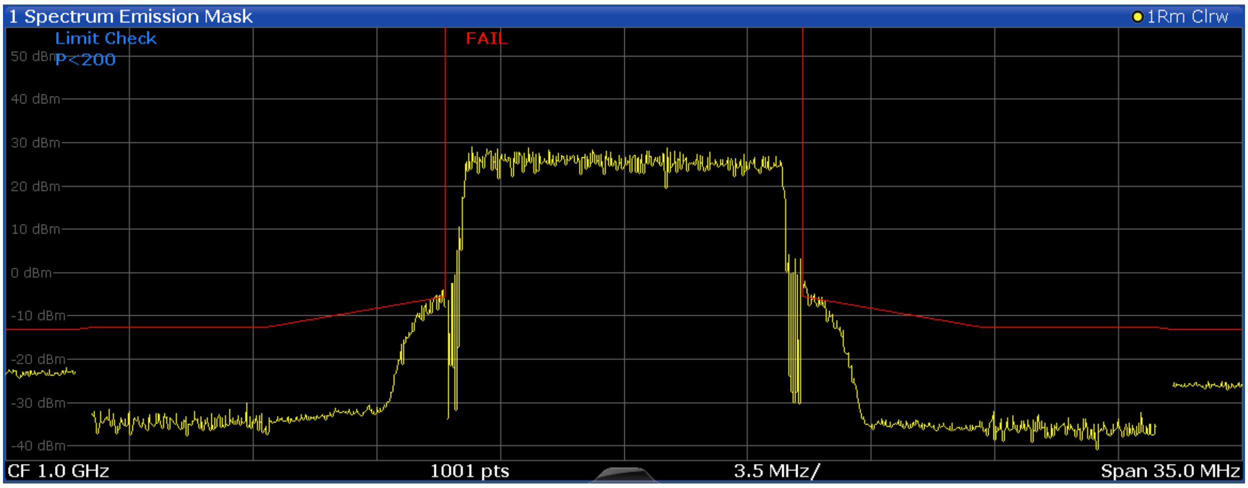
Remote command:
Selecting the result display:
CONF:MEAS CCAC
Querying results:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?`
TRACe:DATA?
Querying limit check results:
`CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?` on page 162
`CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?` on page 162

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The application labels the limit line to indicate whether the limit check has passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

2 Result Summary — LTE Category A (Freq. > 1GHz) DL

Tx Power 45.24 dBm — Tx Bandwidth 10.000 MHz — RBW 100.000 kHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-17.500 MHz	-15.500 MHz	1.000 MHz	982.51724 MHz	-21.93 dBm	-67.17 dB	-8.93 dB
-15.050 MHz	-10.050 MHz	100.000 kHz	988.81054 MHz	-31.93 dBm	-77.17 dB	-19.43 dB
-10.050 MHz	-5.050 MHz	100.000 kHz	994.89898 MHz*	-4.10 dBm*	-49.33 dB*	1.47 dB*
5.050 MHz	10.050 MHz	100.000 kHz	1.00510 GHz*	-2.10 dBm*	-47.33 dB*	3.47 dB*
10.050 MHz	15.050 MHz	100.000 kHz	1.01044 GHz	-32.06 dBm	-77.29 dB	-19.56 dB
15.500 MHz	17.500 MHz	1.000 MHz	1.01690 GHz	-25.05 dBm	-70.29 dB	-12.05 dB

Remote command:
Selecting the result display: CONF:MEAS ESP
Querying results: TRACe:DATA?

3.5 3GPP Test Scenarios

3GPP defines several test scenarios for measuring base stations. These test scenarios are described in detail in 3GPP TS 36.141.

The following table provides an overview which measurements available in the LTE application are suited to use for the test scenarios in the 3GPP documents.

Table 3-1: Test scenarios for E-TMs as defined by 3GPP (3GPP TS 36.141)

Test Model	Test scenario	Test described in	Measurement
E-TM1.1	Base station output power	chapter 6.2	Power (→ Result Summary)
	Transmit On/Off power	chapter 6.4	On/Off Power
	DL RS power	chapter 6.5.4	RSTP (→ Result Summary)
	Time alignment	chapter 6.5.3	Time Alignment Error
	Transmitter intermodulation	chapter 6.7	ACLR
	Occupied bandwidth	chapter 6.6.1	Occupied Bandwidth[1]
	ACLR	chapter 6.6.2	ACLR
	Operating band unwanted emissions	chapter 6.6.3	Spectrum Emission Mask
	Transmitter spurious emis-sions	chapter 6.6.4	Spurious Emissions[1]
E-TM1.2	ACLR	chapter 6.6.2	ACLR
	Operating band unwanted emissions	chapter 6.6.2	Spectrum Emission Mask
E-TM2	RE power control dynamic range	chapter 6.3.1	Power results
	Frequency error	chapter 6.5.1	Frequency Error (→ Result Summary)
	Total power dynamic range	chapter 6.3.2	OSTP (→ Result Summary)
	Error Vector Magnitude	chapter 6.5.2	EVM results
E-TM3.1	RE power control dynamic range	chapter 6.3.1	Power results
	Total power dynamic range	chapter 6.3.2	OSTP (→ Result Summary)
	Frequency error	chapter 6.5.1	Frequency Error (→ Result Summary)
	Error Vector Magnitude	chapter 6.5.2	EVM results
E-TM3.2	RE power control dynamic range	chapter 6.3.1	Power results
	Frequency error	chapter 6.5.1	Frequency Error (→ Result Summary)
	Error Vector Magnitude	chapter 6.5.2	EVM results

Test Model	Test scenario	Test described in	Measurement
E-TM3.3	RE power control dynamic range	chapter 6.3.1	Power results
	Frequency error	chapter 6.5.1	Frequency Error (→ Result Summary)
	Error Vector Magnitude	chapter 6.5.2	EVM results

[1]these measurements are available in the Spectrum application of the Rohde & Schwarz signal and spectrum analyzers (for example the R&S FSW)

4 Measurement Basics

4.1 Symbols and Variables

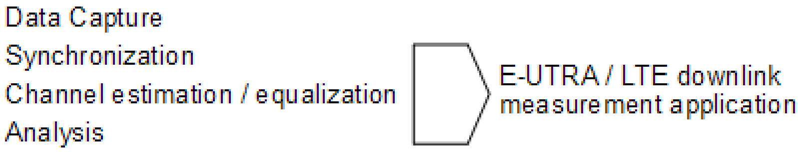
The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{RE}	number of resource elements
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
r(i)	received sample in the time domain
$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time

T_g	guard time
T_s	symbol time

4.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.



The contents of this chapter are structered like the DSP.

4.3 The LTE Downlink Analysis Measurement Application

The block diagram in figure 4-1 shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

4.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbols in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{\imath}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation according to 3GPP TS 36.211 (v8.9.0), the block "window" produces three signals taken at the timing offsets $\Delta\tilde{\tau}$, $\Delta\tilde{\tau}_l$ and $\Delta\tilde{\tau}_h$. For the reference path, only the signal taken at the timing offset $\Delta\tilde{\tau}$ is used.

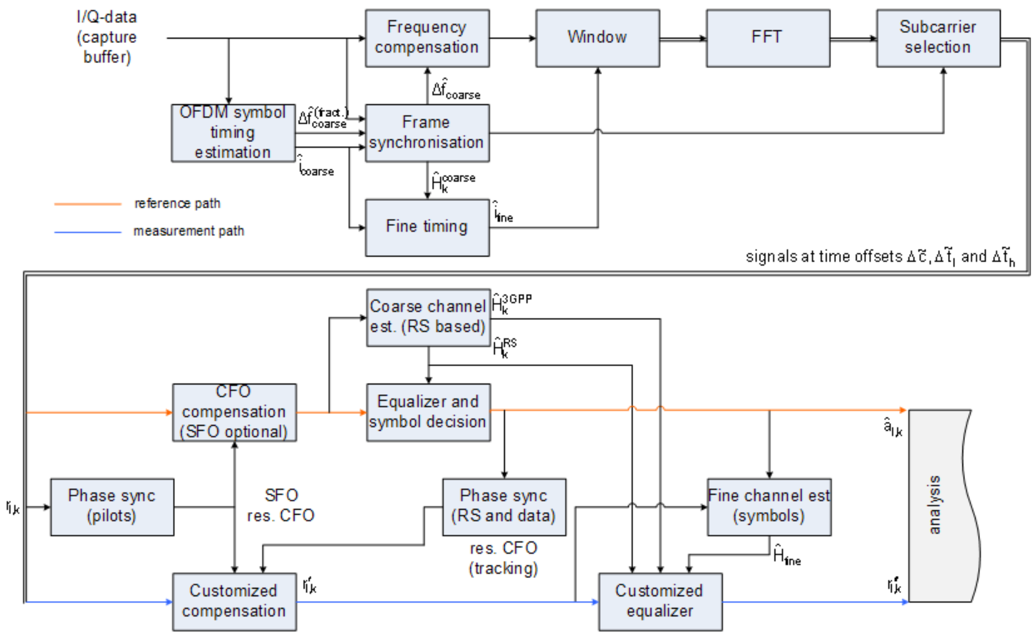


Fig. 4-1: Block diagram for the LTE DL measurement application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l (CPE)

According to 3GPP TS 25.913 and 3GPP TR 25.892, the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k} \tag{4 - 1}$$

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T=T_s-T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

4.3.2 Channel Estimation and Equalizitaion

As shown in figure 4-1, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses the reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation ($\hat{H}_k^{3GPP}$) as defined in 3GPP TS 36.211 is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

4.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results 'EVM PDSCH QPSK/16-QAM/64-QAM' are calculated according to the specification in 3GPP TS 36.211.

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}\sqrt{E\left\{\left|\frac{a_{l,k}}{b_{l,k}}\right|^2\right\}}} \qquad (4 - 2)$$

on subcarrier k at OFDM symbol l, where $b_{l,k}$ is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, the equation can be rewritten as

$$EVM_{n,l} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}} \qquad (4 - 3)$$

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_{l} \sum_{k_{data}} EVM^2_{l,k_{data}}}$$

(4 - 4)

The number of resource elements taken into account is denoted by $N_{RE\ data}$.

I/Q imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(4 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(4 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(4 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$.

Other measurement variables

Without going into detail, the EUTRA/LTE downlink measurement application additionally provides the following results.

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

4.4 MIMO Measurement Guide

Performing MIMO measurements requires additional equipment that allows you to capture multiple data streams.

- Several signal analyzers, the number depending on the number of data streams you have to capture.
- At least one analyzer equipped with option R&S FS(x)-K102(PC) that unlocks MIMO functionality.

True MIMO measurements are useful to verifiy MIMO precoding implementations for setups where it is not possible to decode the transmit data using only one antenna (e.g. applying spatial multiplexing MIMO precoding with more than 1 layer) and to measure the hardware performance of the MIMO transmitter hardware in a true MIMO measurement setup.

4.4.1 MIMO Measurements with Signal Analyzers

MIMO measurements require multiple signal analyzers. The number depends on the number of data streams you have to capture.

For valid measurement results, the frequencies of the analyzers in the test setup have to be synchronized. It is also necessary to configure the trigger system properly to capture the data simultaneously.

Synchronizing the frequency

The frequency of the analyzers in the test setup have to be synchronized. Thus, one of the analyzers (master) controls the other analyzers (slaves) in the test setup. The master analyzer has to be equipped with the LTE MIMO application and provides the reference oscillator source for the slave analyzers.

► Connect the REF OUT of the master to the REF IN connector of the slaves. Make sure to configure the slaves to use an external reference (→ General Setup menu).

If you are using a measurement setup with several R&S signal generators (for example R&S SMW), the situation is similar. One of the generators controls the other via the external reference.

► Connect the REF OUT of the master to the REF IN of the slaves. Make sure to configure the slaves to use an external reference (→ Reference Oscillator settings).

Triggering MIMO measurements

For valid MIMO measurements, it is crucial to capture all data streams simultaneously. To do so, you need a trigger signal provided by the DUT or the signal generator. The trigger signal has to be connected to all analyzers. If you have several signal generators in the setup, the master generator has to trigger the slave as well.

The 4-2 shows a MIMO setup with two (or optional four) analyzers and one (or optional two) signal generators with two channels.

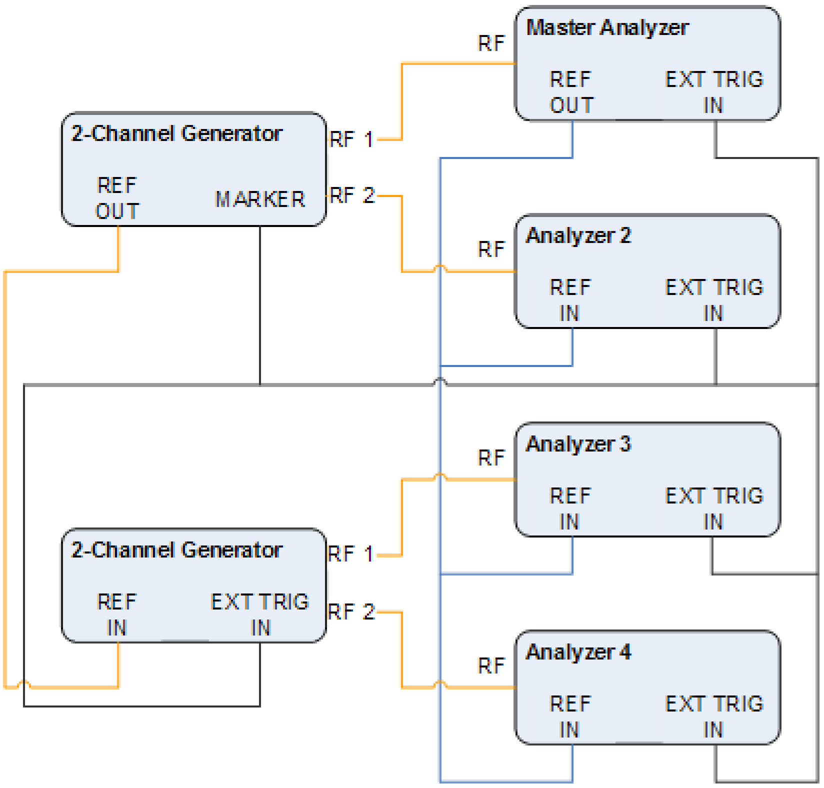


Fig. 4-2: MIMO Hardware Setup

You can use several trigger configurations, with or without additional hardware.

Measurements with a delayed trigger signal

Simultaneous capture of the I/Q data requires the trigger inputs of all instruments in the setup to be armed.

Arming a trigger does not happen immediately when you start a measurement, but is delayed slightly for a number of reasons, for example:

- Connecting several instruments with a LAN or GPIB connection usually causes a certain network delay.
- Tasks like the auto leveling function require some time to finish.

Because of these factors, you have to make sure that the trigger event does not occur during this time frame. You can do so, for example, by configuring an appropriate delay time on the DUT.

The exact delay depends on the GPIB or network condition and the input settings.

A typical delay to arm the trigger is 2 seconds per instrument.

The minimum delay of the trigger signal must now be greater than the measured time multiplied with the number of measured antennas (the number of analyzers), because the spectrum analyzers are initialized sequentially.

The usage of an LTE frame trigger is not possible for this measurement setup.

Measurements with a frame trigger signal

You can use a frame trigger if all transmitted LTE frames use the same frame configuration and contain the same data. In this case, the analyzers in the test setup capture data from different LTE frames but with the same content.

This method to analyze data, however, raises one issue. The phase variations of the reference oscillators of the different signals that are transmitted are not the same, because the data is not captured simultaneously.

The result is a phase error which degrades the EVM (see the figures below).

An application for this measurement method is, for example, the test of the MIMO precoding implementation. Because of the bad EVM values, it is not recommended to use this test setup to measure hardware performance.

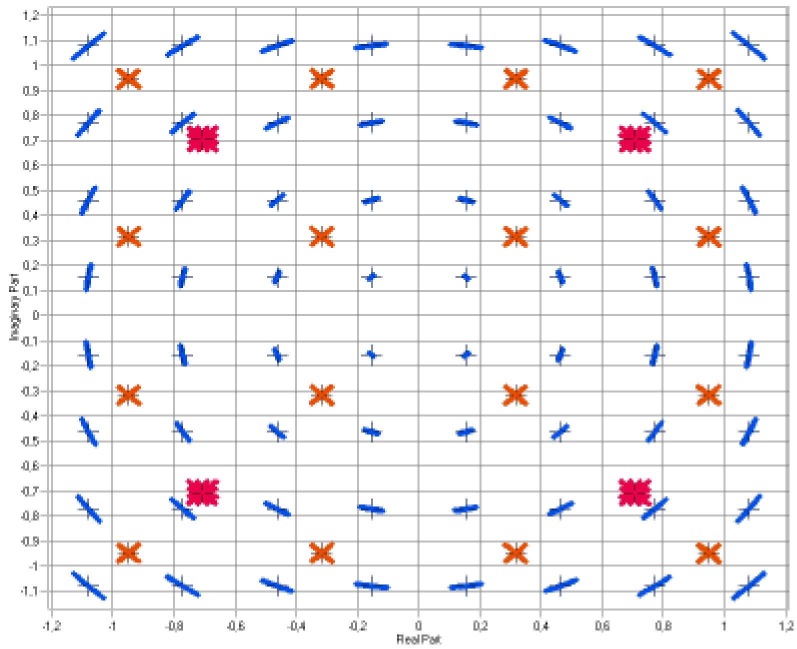


Fig. 4-3: Constellation diagram

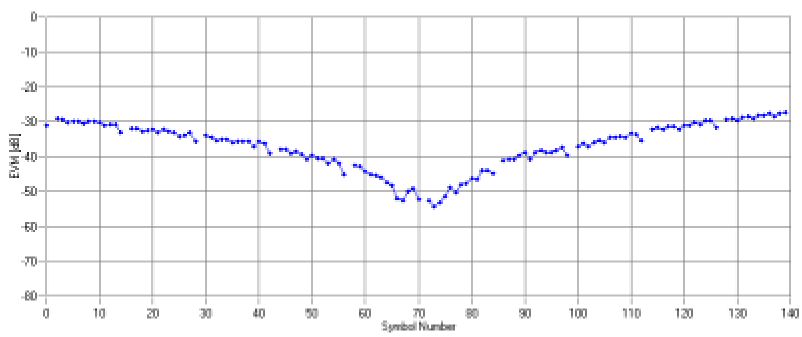


Fig. 4-4: EVM vs OFDM symbol number

Measurements with the R&S FS-Z11 trigger unit

The trigger unit R&S FS-Z11 is a device that makes sure that the measurement starts on all analyzers (master and slaves) at the same time.

Connecting the trigger unit

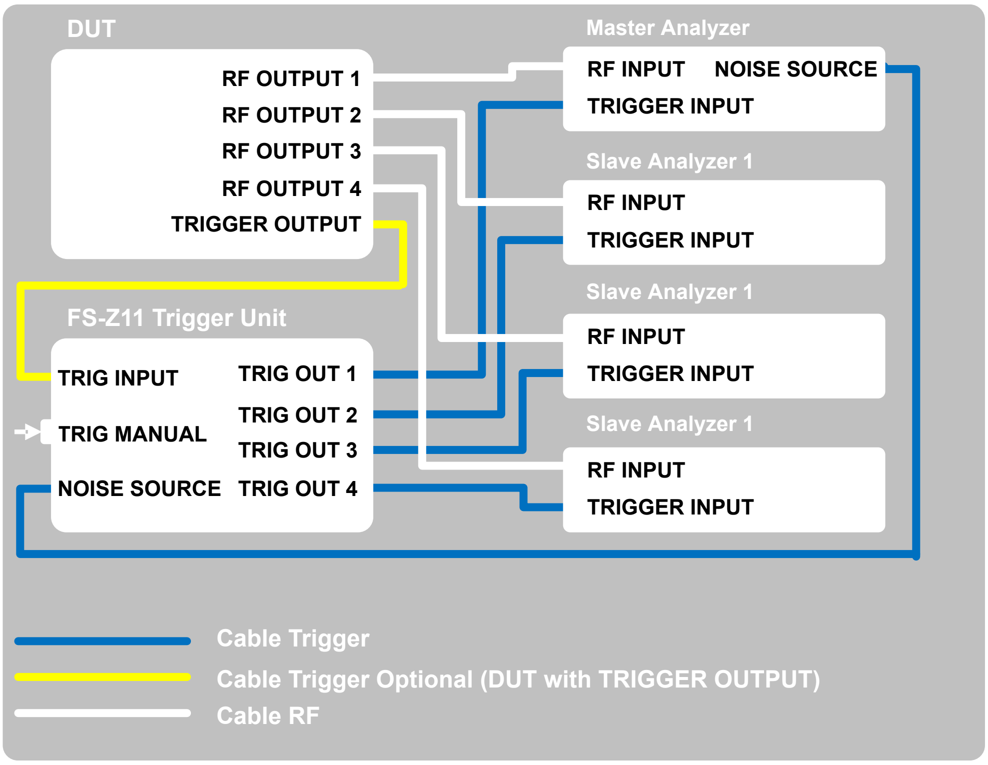
► Connect the NOISE SOURCE output of the master analyzer to the NOISE SOURCE CONTROL input of the trigger unit.

► Connect the EXT TRIG inputs of all analyzers (master **and** slaves) to the TRIG OUT 1 to 4 (or 1 and 2 in case of measurements on two antennas) of the trigger unit. The order is irrelevant, that means it would be no problem if you connect the master analyzer to the TRIG OUT 2 of the trigger unit.

With this setup, all analyzers (including the master analyzer) are triggered by the trigger unit.

The trigger unit also has a TRIG INPUT connector that you can connect an external trigger to. If you are using an external trigger, the external trigger supplies the trigger event. If not, the analyzer noise source control supplies the trigger event. Note that if you do not use an external trigger, the TRIG INPUT must remain open.

To use the R&S FS-Z11 as the trigger source, you have to turn it on in the "Trigger" dialog box of the LTE measurement application. For more information see chapter 5.2.21, "Triggering Measurements", on page 95.



4.5 Performing Time Alignment Measurements

The measurement application allows you to perform Time Alignment measurements between different antennas.

You can perform this measurement in 2 or 4 Tx antenna MIMO setups.

The result of the measurement is the Time Alignment Error. The Time Alignment Error is the time offset between a reference antenna (for example antenna 1) and another antenna.

The Time Alignment Error results are summarized in the corresponding result display.

A schematic description of the results is provided in figure 4-5.

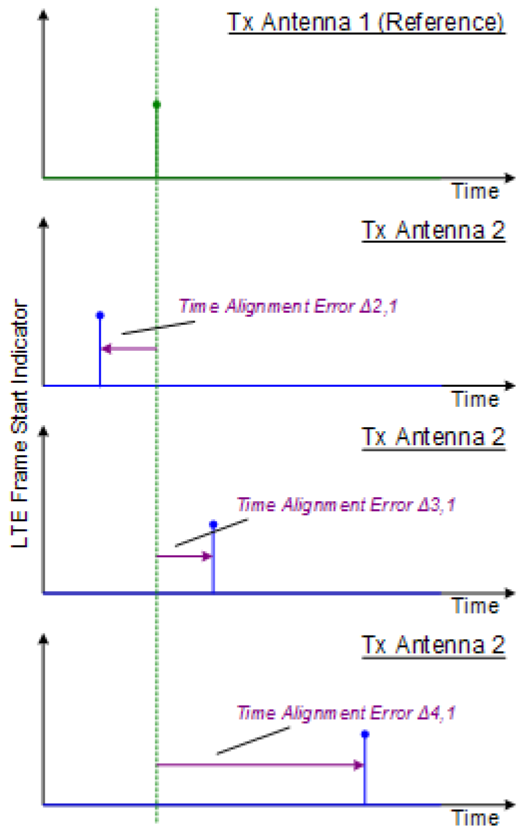


Fig. 4-5: Time Alignment Error (4 Tx antennas)

Test setup

Successful Time Alignment measurements require a correct test setup.

A typical hardware test setup is shown in figure 4-6. Note that the dashed connection are only required for MIMO measurements on 4 Tx antennas.

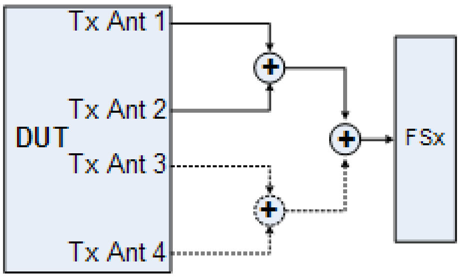


Fig. 4-6: Hardware setup

For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

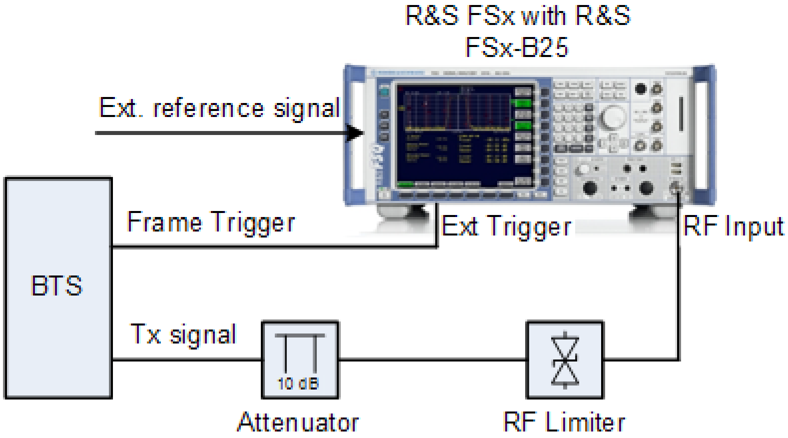
In the application, make sure to correctly apply the following settings.

- select a reference antenna in the MIMO Configuration dialog box (**not** "All")
- set the Subframe Selection to "All"
- turn on Compensate Crosstalk in the "Demodulation Settings"
- Note that the Time Alignment meaurement only evaluates the reference signal and therefore ignores any PDSCH settings - for example, it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing.

4.6 Performing Transmit On/Off Power Measurements

The technical specification in 3GPP TS 36.141 prescribes the measurement of the transmitter OFF power and the transmitter transient period of an EUTRA/LTE TDD base transceiver station (BTS) operating at its specified maximum output power. A special hardware setup is required for this measurement since the actual measurement is done at very low power during the transmitter OFF periods requiring low attenuation at the analyzer input. The signal power during the transmitter ON periods in this test scenario is usually higher than the specified maximum input power of the R&S FSx signal analyzer and will cause severe damage to the analyzer if the measurement is not set up appropriately.

Test setup



To protect the analyzer input from damage, an RF limiter has to be applied at the analyzer input connector, as can be seen in figure 2-16. Table 1.1 shows the specifications the used limiter has to fulfill.

Min. acceptable CW input power	BTS output power minus 10 dB
Min. acceptable peak input power	BTS peak output power minus 10 dB
Max. output leakage	20 dBm
Max. response time	1 µs
Max. recovery time	1 µs

An additional 10 dB attenuation should be placed in front of the RF limiter to absorb eventual reflected waves because of the high VSWR of the limiter. The allowed maximum CW input power of the attenuator must be lower than the maximum output power of the BTS.

Performing the measurement

For the transmit ON/OFF power measurements according to 36.141, 6.4, the test model E-TM1.1 has to be used. For more information on loading the test model settings see "Using Test Models" on page 60.

If an external trigger is used, before the actual measurement can be started, the timing must be adjusted by pressing the 'Adjust Timing' hotkey. The status display in the header of the graph changes from 'Timing not adjusted' to 'Timing adjusted' and the run hotkeys are released. Relevant setting changes again lead to a 'Timing not adjusted' status display.

If the adjustment fails, an error message is shown and the adjustment state is still "not adjusted". To find out what causes the synchronization failure, you should perform a regular EVM measurement (i.e. leave the ON/OFF Power measurement). Then you can use all the measurement results like EVM vs. Carrier to get more detailed information about the failure. The timing adjustment will succeed if the Sync State in the header is OK.

Using a R&S FSQ or R&S FSG it is recommended to use the external trigger mode since for high power signals a successful synchronization is not guaranteed under certain circumstances.

Pressing the 'Run Single' hotkey starts the averaging of the traces of the number of frames given in the 'General Settings' dialog. After performing all sweeps, the table in the upper half of the screen shows if the measurements pass or fail.

5 Configuration

LTE measurements require a special application on the R&S FPS, which you activate using the MODE key on the front panel.

When you start the LTE application, the R&S FPS starts to measure the input signal with the default configuration or the configuration of the last measurement (when you haven't performed a preset since then).

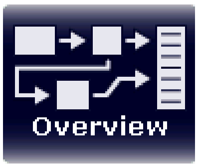
Automatic refresh of preview and visualization in dialog boxes after configuration changes

The R&S FPS supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before accepting the changes.

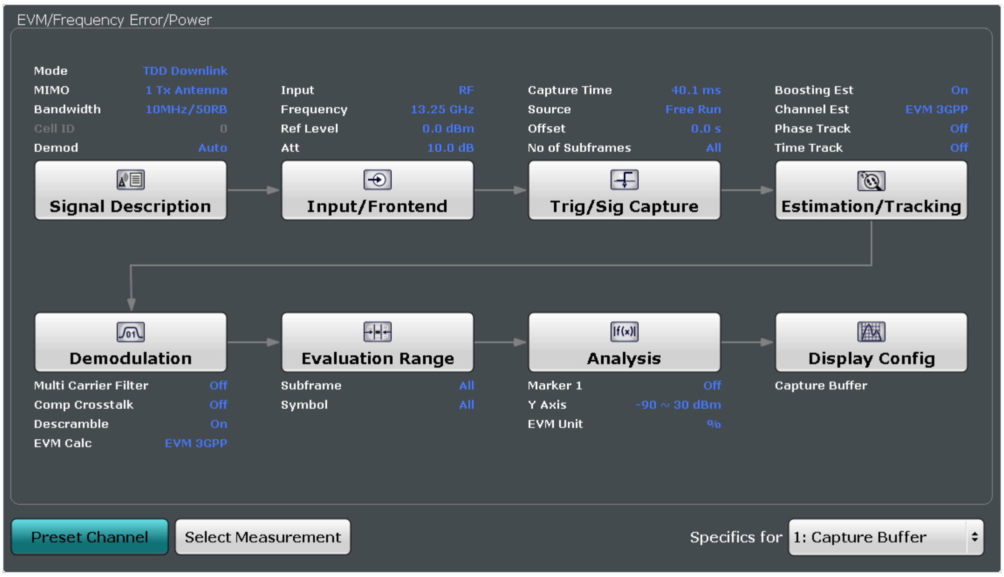
Unavailable hardkeys

Note that the SPAN, BW, TRACE, LINES and MKR FUNC keys have no contents and no function in the LTE application.

5.1 Configuration Overview



Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See chapter 5.2.1, "Defining Signal Characteristics", on page 59.
2. Input / Frontend
   See chapter 5.2.17, "Selecting the Input Source", on page 89.
3. Trigger / Signal Capture
   See chapter 5.2.21, "Triggering Measurements", on page 95.
   See chapter 5.2.20, "Configuring the Data Capture", on page 93
4. Estimation / Tracking
   See chapter 5.2.23, "Compensating Measurement Errors", on page 98.
5. Demodulation
   See chapter 5.2.24, "Configuring Demodulation Parameters", on page 99.
6. Evaluation Range
   See chapter 6.2.1, "Evaluation Range", on page 108.
7. Analysis
   See chapter 6, "Analysis", on page 108.
8. Display Configuration
   See chapter 3, "Measurements and Result Displays", on page 13.

In addition, the dialog box provides the "Select Measurement" button that serves as a shortcut to select the measurement type.

Note that the "Overview" dialog box for frequency sweep measurement is similar to that of the Spectrum mode.

For more information refer to the documentation of the R&S FPS.

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FPS (except for the default Spectrum application channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 170

Specifics for
The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

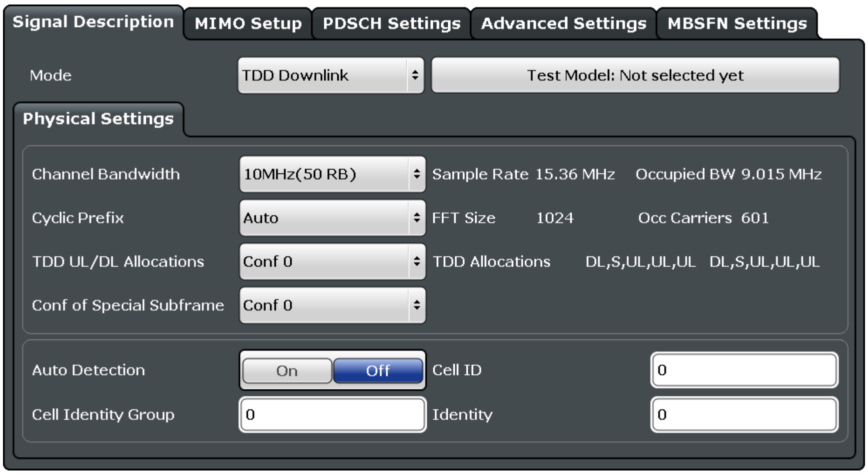
Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

5.2 Configuring I/Q Measurements

5.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal. They are part of the "Signal Description" tab of the "Signal Description" dialog box.



Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the set of options you have installed.

- Option xxx-K100 enables testing of 3GPP LTE FDD signals on the downlink
- Option xxx-K101 enables testing of 3GPP LTE FDD signals on the uplink
- Option xxx-K102 enables testing of 3GPP LTE MIMO signals on the downlink
- Option xxx-K103 enables testing of 3GPP MIMO signals on the uplink
- Option xxx-K104 enables testing of 3GPP LTE TDD signals on the downlink
- Option xxx-K105 enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:
Link direction: CONFigure[:LTE]:LDIRection on page 174
Duplexing mode: CONFigure[:LTE]:DUPLexing on page 171

Using Test Models

Test models are descriptions of LTE signals that you can use for particular test scenarios.

The "Test Models" dialog box contains functionality to select, manage and create test models.

- "Specification"
  The "Specification" tab contains predefined test models as defined by 3GPP.
  Predefined test models are supported in downlink mode.
- "User Defined"
  The "User Defined" tab contains functionality to manage custom test models.
  Custom test models are supported in downlink and uplink mode.
  To create a custom test model, describe a signal as required and then save it via the "Test Models" dialog box.
  Here, you can also restore custom test models and delete ones you do not need anymore.

Predefined test models (E-TM)

In case of downlink signals, the 3GPP standard (TS 36.141) already defines several EUTRA test models (E-TM) for specific test scenarios. These test models are split into three main groups (E-TM1, E-TM2 and E-TM3) and are defined by the following characteristics.

- single antenna port, single code word, single layer and no precoding
- duration of one frame
- normal cyclic prefix
- localized virtual resource blocks, no intra-subframe hopping for PDSCH
- UE-specific reference signal not used

The data content of the physical channels and signals are defined in the 3GPP standard. Each E-TM is defined for for all bandwidths defined in the standard (1.4 MHz / 3 MHz / 5 MHz / 10 MHz / 15 MHz / 20 MHz).

More information.

Remote command:
`MMEMory:LOAD:TMOD:DL` on page 175

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The application also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

For more information about configuring aggregated carriers (for example for Cumulative ACLR measurements) see "Carrier Aggregation" on page 103.

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:
`CONFigure[:LTE]:DL[:CC<cci>]:BW` on page 171

Cyclic Prefix

The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

Remote command:
`CONFigure[:LTE]:DL[:CC<cci>]:CYCPrefix` on page 171

Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 10 different configurations for the special subframe. However, configurations 8 and 9 only work for a normal cyclic prefix.

If you select configurations 8 or 9 using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

Remote command:
Subframe: `CONFigure[:LTE]:DL[:CC<cci>]:TDD:UDConf` on page 173
Special subframe: `CONFigure[:LTE]:DL[:CC<cci>]:TDD:SPSC` on page 173

Configuring the Physical Layer Cell Identity

The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the application automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is part of the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is part of the S-SYNC.

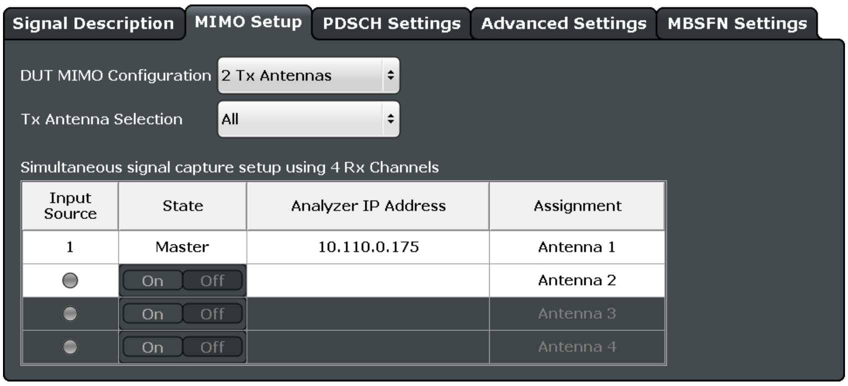
In addition to the synchronization information, the cell ID also determines

- the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
- the frequency shifts of the reference signal.

Remote command:
Cell ID: `CONFigure[:LTE]:DL[:CC<cci>]:PLC:CID` on page 172
Cell Identity Group (setting): `CONFigure[:LTE]:DL[:CC<cci>]:PLC:CIDGroup` on page 172
Cell Identity Group (query): `FETCh[:CC<cci>]:PLC:CIDGroup?` on page 174
Identity (setting): `CONFigure[:LTE]:DL[:CC<cci>]:PLC:PLID` on page 173
Identity (query): `FETCh[:CC<cci>]:PLC:PLID?` on page 174

5.2.2 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups. They are part of the "MIMO Setup" tab of the "Signal Characteristics" dialog box.



MIMO Configuration

Selects the antenna configuration and test conditions for a MIMO system.

The MIMO **configuration** selects the number of transmit antennas in the system. 1-, 2-, and 4-antenna configurations are possible.

In setups with multiple antennas, **antenna selection** defines the antenna(s) you'd like to test. You can select the antenna(s) to test manually ("Antenna 1...4" and "All" menu items) or let the application decide which antenna to test ("Auto" menu item). Note that the selected antenna is also the reference antenna for Time Alignment measurements.

In case of automatic detection the application analyzes the reference signal to select the antenna. It also determines the order in which the antennas are tested in.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.
Antenna 3	Tests antenna 3 only.
Antenna 4	Tests antenna 4 only.
All	Tests all antennas in the test setup in consecutive order (1-2-3-4). A corresponding number of analyzers is required.
Auto (1 antenna)	Automatically selects the antenna to test.
Auto (2 antennas)	Automatically selects the antennas to test in a test setup with two or four antennas. Requires 2 analyzers.
Auto (4 antennas)	Automatically selects the order in which the antennas are tested in. Available for 4-antenna configurations. Requires 4 analyzers.

More information.

Remote command:
MIMO configuration: `CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig` on page 177
Antenna selection: `CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection` on page 177

Connecting multiple analyzers

MIMO measurements require several R&S FSWs (**input sources**), depending on the number of antennas you have to measure. One of these analyzers (master) controls the other analyzers. The master analyzer has to be equipped with the LTE measurement application.

Before you can start the measurement, you have to configure the test setup. The functionality to do so is provided in the table in the "MIMO Setup" dialog box. The table is made up out of four rows, one for each possible analyzer. Note that configuration of input sources 2 to 4 is only possible if you have actually selected a corresponding number of antennas from the "MIMO Configuration" and "Tx Antenna Selection" dropdown menus.

- **Input Source**
  Shows the state of the analyzer or input source connection. When the LED turns green, the connection to the corresponding analyzer has been successful. Otherwise the LED turns red to indicate an unsuccessful connection.
- **State**
  Includes or excludes the corresponding analyzer from the test setup. Note that the master analyzer (input source 1) is always active.
- **Analyzer IP Address**
  Defines the IP address of the corresponding analyzer.
- **Assignment**
  Selects the antenna that the corresponding analyzer measures. You cabn assign any antenna to any analyzer in the test setup, a consecutive order is not necessary.

Remote command:
State: `CONFigure:LTE:ANTMatrix:STATe<instrument>` on page 176
IP address: `CONFigure:LTE:ANTMatrix:ADDRess<instrument>` on page 176
Instrument state: `CONFigure:LTE:ANTMatrix:LEDState<instrument>?` on page 176

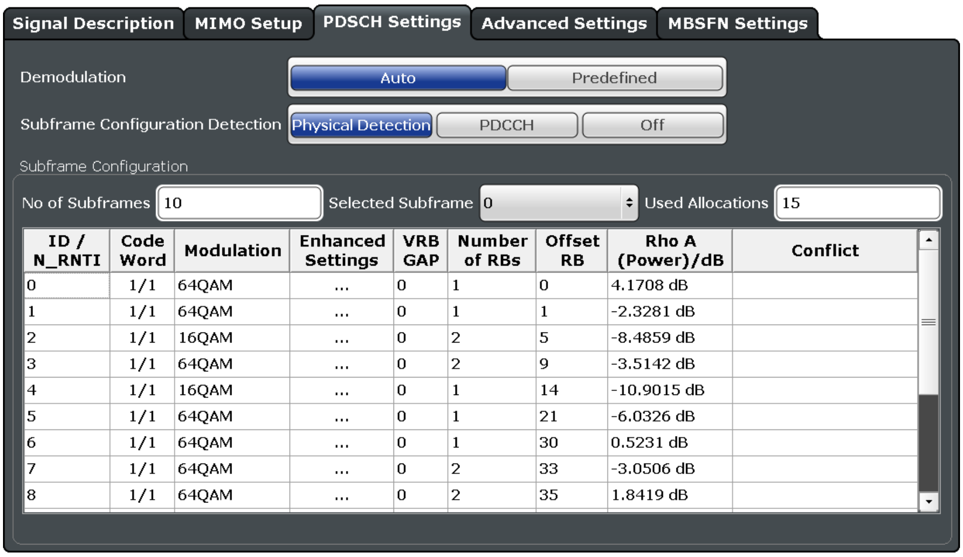
5.2.3 Demodulating the PDSCH

The Physical Layer Shared Channel (PDSCH) carries user data, broadcast system information and paging messages. It is always present in a downlink transmission.

The application allows you to automatically demodulate the PDSCH and detect the subframe configuration of the signal you are testing.

For more information on manual PDSCH configuration see chapter 5.2.4, "Configuring PDSCH Subframes", on page 67.

The PDSCH demodulation settings are part of the "PDSCH Settings" tab of the "Signal Description" dialog box.



PDSCH Subframe Configuration Detection

Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
  When you use this method, the application measures the boosting for each PDCCH it has detected. The result is displayed in the Channel Decoder Results.
- Physical detection
  The physical detection is based on power and modulation detection.
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.
  More information.

Remote command:
`[SENSe][:LTE]:DL:FORMat:PSCD` on page 178

Auto PDSCH Demodulation

Turns automatic demodulation of the PDSCH on and off.

When you turn this feature on, the application automatically detects the PDSCH resource allocation. This is possible by analyzing the protocol information in the PDCCH or by analyzing the physical signal. The application then writes the results into the PDSCH Configuration Table.

You can set the way the application identifies the PDSCH resource allocation with PDSCH Subframe Configuration Detection.

When you turn off automatic demodulation of the PDSCH, you have to configure the PDSCH manually. In that case, the application compares the demodulated LTE frame to the customized configuration. If the "PDSCH Subframe Configuration Detection" is not turned off, the application analyzes the frame only if both configurations are the same.

Remote command:
[SENSe][:LTE]:DL:DEMod:AUTO on page 178

5.2.4 Configuring PDSCH Subframes

The application allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

When you turn "Auto Demodulation" on, the application automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on (→ More information).

Every LTE frame (FDD and TDD) contains 10 subframes. (In TDD systems, some subframes are used by the uplink, however.) Each downlink subframe consists of one or more (resource) allocations. The application shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	Enhanced Settings	VRB GAP	Number of RBs	Offset RB	Rho A (Power)/dB	Conflict
0	1/1	64QAM	...	0	1	0	4.1708 dB	
1	1/1	64QAM	...	0	1	1	-2.3281 dB	
2	1/1	16QAM	...	0	2	5	-8.4859 dB	
3	1/1	64QAM	...	0	2	9	-3.5142 dB	
4	1/1	16QAM	...	0	1	14	-10.9015 dB	
5	1/1	64QAM	...	0	1	21	-6.0326 dB	
6	1/1	64QAM	...	0	1	30	0.5231 dB	
7	1/1	64QAM	...	0	2	33	-3.0506 dB	
8	1/1	64QAM	...	0	2	35	1.8419 dB	

If there are any errors or conflicts between allocations in one or more subframes, the application shows the corrupt subframe in the "Error in Subframes" field, which appears below the table and is highlighted red if an error occurs. In addition, it shows the conflicting rows of the configuration table. It does not show the kind of error.

ID / N_RNTI	Code Word	Modulation	Enhanced Settings	VRB GAP	Number of RBs	Offset RB	Rho A (Power)/dB	Conflict
0	1/1	64QAM	...	0	1	0	4.1708 dB	Collision : 1
1	1/1	64QAM	...	0	1	0	4.1708 dB	Collision : 0
2	1/1	64QAM	...	0	1	1	4.1708 dB	
3	1/1	QPSK	...	0	1	2	4.1708 dB	
4	1/1	QPSK	...	0	5	4	4.1708 dB	Exceeds BW

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 40 subframes.

Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The application updates the contents of the configuration table to the selected subframe.

Remote command:

Number of subframes: CONFigure[:LTE]:DL:CSUBframes on page 179

Number of allocations: CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount on page 179

5.2.4.1 PDSCH Allocations

In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The application expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 110 allocations in every subframe.

The configuration table contains the settings to configure the allocations.

ID/N_RNTI

Selects the allocation's ID. The ID corresponds to the N_RNTI.

By default, the application assigns consecutive numbers starting with 0.

The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.

Remote command:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID on page 183

Code Word

Shows the code word of the allocation.

The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation contains. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.

Usually one allocation corresponds to one code word. In case of measurements on a MIMO system (2 or 4 antennas) in combination with the "Spatial Multiplexing" precoding value, however, you can change the number of layers. Selecting 2 or more layers assigns two code words to the allocation. This results in an expansion of the configuration table. The allocation with the spatial multiplexing then comprises two rows instead of only one. Except for the modulation of the code word, which can be different, the contents of the second code word (row) are the same as the contents of the first code word.

Modulation

Selects the modulation scheme for the corresponding allocation.

The modulation scheme for the PDSCH is either QPSK, 16QAM, 64QAM or 256QAM.

Remote command:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation` on page 183

Enhanced Settings

Opens a dialog box to configure MIMO functionality.

For more information see chapter 5.2.4.2, "Enhanced Settings", on page 71.

VRB Gap

Turns the use of virtual resource blocks (VRB) on and off.

The standard defines two types of VRBs. Localized VRBs and distributed VRBs. While localized VRBs have a direct mapping to the PRBs, distributed VRBs result in a better frequency diversity.

Three values of VRB gap are allowed.

- **0** = Localized VRBs are used.
- **1** = Distributed VRBs are used and the first gap is applied.
- **2** = Distributed VRBs are used and the second gap is applied (for channel bandwidths > 50 resource blocks).
  The second gap has a smaller size compared to the first gap.
  If on, the VRB Gap determines the distribution and mapping of the VRB pairs to the physical resource blocks (PRB) pairs.
  The distribution of the VRBs is performed in a way that consecutive VRBs are spread over the frequencies and are not mapped to PRBs whose frequencies are next to each other. Each VRB pair is split into two parts which results in a frequency gap between the two VRB parts. This method corresponds to frequency hopping on a slot basis.
  The information whether localized or distributed VRBs are applied is carried in the PDCCH. The DCI formats 1A, 1B and 1D provide a special 1-bit flag for this purpose ("Localized / Distributed VRB Assignment"). Another bit in the DCI formats controls whether the first or second bit is applied.

Remote command:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:GAP`
on page 179

Number of RB
Defines the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.

If you allocate too many resource blocks compared to the bandwidth you have set, the application will show an error message in the "Conflicts" column and the "Error in Subframes" field.

Remote command:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount` on page 182

Offset RB
Sets the resource block at which the allocation begins.

A wrong offset for any allocation would lead to an overlap of allocations. In that case the application will show an error message.

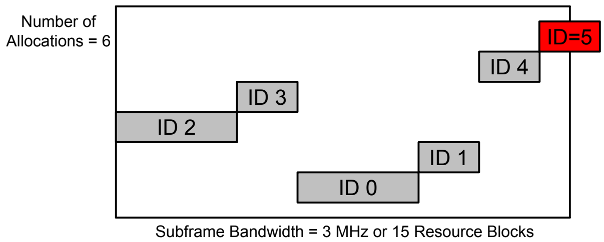
Remote command:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset` on page 182

Power
Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.

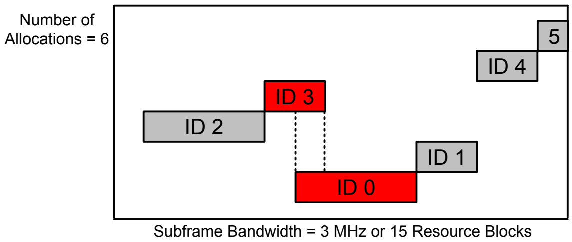
Remote command:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer` on page 179

Conflict
In case of a conflict, the application shows the type of conflict and the ID of the allocations that are affected. Possible conflicts are:

- bandwidth error (">BW")
  A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



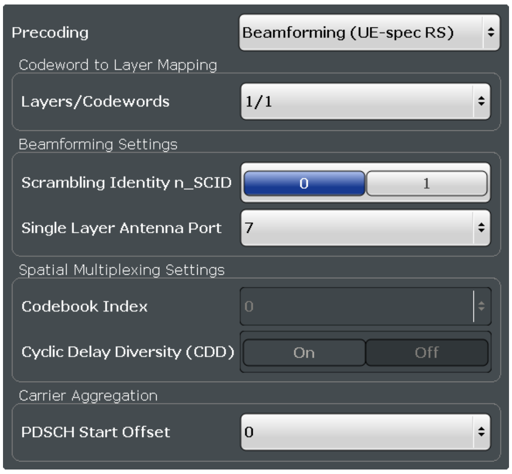
- RB overlap errors
  An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



5.2.4.2 Enhanced Settings

The "Enhanced Settings" contain mostly functionality to configure the precoding scheme of a physical channel. The application supports several precoding schemes that you can select from a dropdown menu.

In addition, you can configure PDSCH allocations that use carrier aggregation.



None

Turns off precoding.

Remote command:

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme]` on page 181

Transmit Diversity

Turns on precoding for transmit diversity according to 3GPP TS 36.211.

Remote command:

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme]` on page 181

Spatial Multiplexing

Turns on precoding for spatial multiplexing according to 3GPP TS 36.211.

If you are using spatial multiplexing, you can also define the number of layers for any allocation and the codebook index.

The number of layers of an allocation in combination with the number of code words determines the layer mapping. The available number of layers depends on the number of transmission antennas. Thus, the maximum number of layers you can select is eight.

The codebook index determines the precoding matrix. The available number of indices depends on the number of transmission antennas in use. The range is from 0 to 15. The application automatically selects the codebook index if you turn the "Cyclic Delay Diversity" (CDD) on.

Remote command:

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme]` on page 181

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CLMapping` on page 181

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CBINdex` on page 180

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CDD` on page 180

Beamforming (UE Spec RS)

Turns on the precoding for beamforming.

If you are using beamforming, you can also define the number of layers and codewords (see Spatial Multiplexing), the scrambling identity and the single layer antenna port.

The mapping of antenna port to the physical antenna is fixed:

- Port 5 and 7: Antenna 1
- Port 8: Antenna 2
- Port 9: Antenna 3
- Port 10: Antenna 4

The scrambling identity (n_{SCID}) is available for antenna ports 7 and 8. It is used to initialize the sequence that generates UE specific reference signals according to 36.211 (section 6.10.3.1).

The single layer antenna port selects the preconfigured antenna port in single layer beamforming scenarios. Available if the codeword to layer mapping is "1/1".

Remote command:

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme]` on page 181

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CLMapping` on page 181

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:SCID` on page 181

`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP` on page 180

Carrier Aggregation
Defines the PDSCH start offset for the selected PDSCH allocation in a system that uses carrier aggregation.

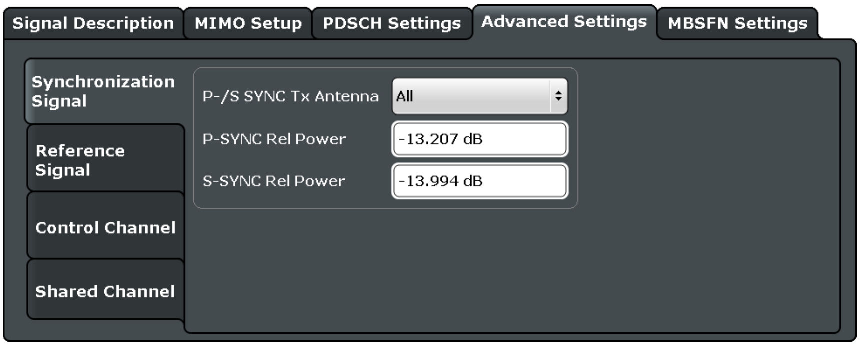
For cross-scheduled UEs, the PDSCH start offset for the secondary carrier is usually not defined for each subframe individually but is constant over several subframes. In case the control channel region of the secondary component carrier is longer than the PDSCH start offset you have defined for the primary carrier, PDSCH resource elements might be overwritten by the resource elements of the control channel. Note that the bit stream result displays labels these resource element with a "#" sign.

Remote command:
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PSOFfset on page 182

5.2.5 Configuring the Synchronization Signal

The synchronization signal settings contain settings to describe the physical attributes and structure of the synchronization signal.

The synchronization signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



P-/S-SYNC Tx Antenna
Selects the antenna that transmits the synchronization signal (P-SYNC or S-SYNC).

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the application uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

Remote command:
CONFigure[:LTE]:DL[:CC<cci>]:SYNC:ANTenna on page 183

P-SYNC Relative Power

Defines the power of the primary synchronization signal (P-SYNC) relative to the reference signal.

Remote command:

CONFigure[:LTE]:DL:SYNC:PPOWer on page 184

S-SYNC Relative Power

Defines the power of the secondary synchronization signal (S-SYNC) relative to the reference signal.

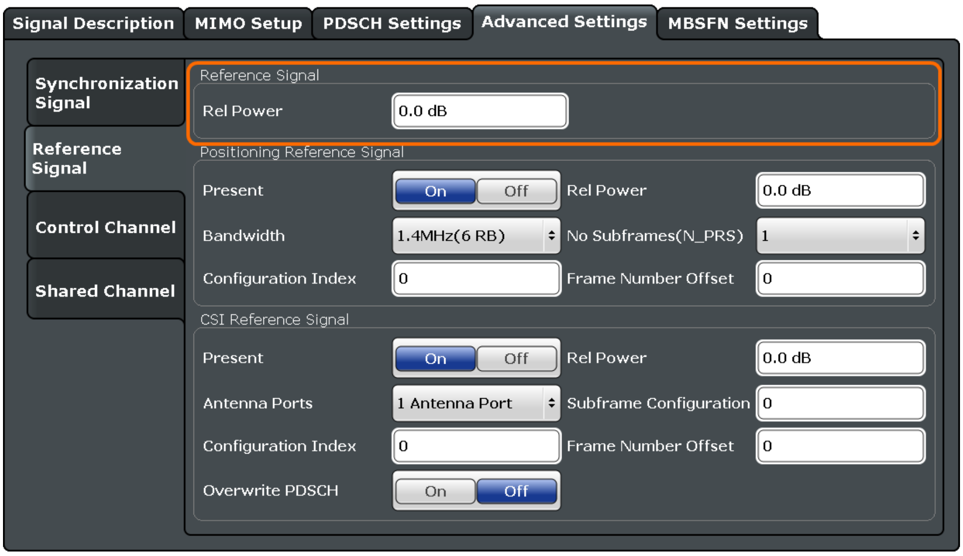
Remote command:

CONFigure[:LTE]:DL:SYNC:SPOWer on page 184

5.2.6 Configuring the Reference Signal

The reference signal settings contain settings to describe the physical attributes and structure of the reference signal.

The reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Rel Power (Reference Signal)

Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

Note that this setting gives you an offset to all other relative power settings.

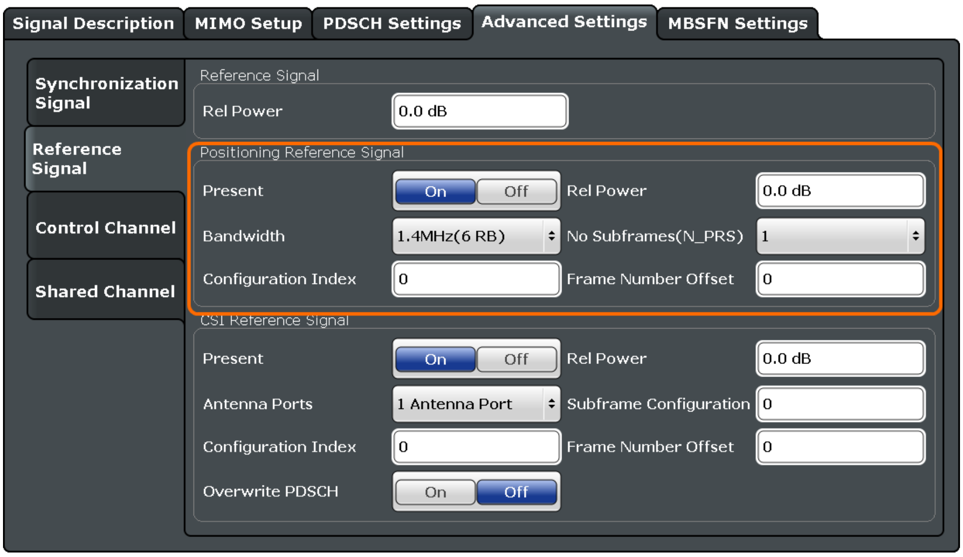
Remote command:

CONFigure[:LTE]:DL:REFSig:POWer on page 184

5.2.7 Configuring the Positioning Reference Signal

The positioning reference signal settings contain settings to describe the physical attributes and structure of the positioning reference signal.

The positioning reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Present

Turns the positioning reference signal on and off.

Remote command:

`CONFigure[:LTE]:DL:PRSS:STATe` on page 186

Bandwidth

Defines the bandwidth and thus the number of resource blocks the positioning reference signal occupies.

Note that the PRS bandwidth has to be smaller than the channel bandwidth.

Remote command:

`CONFigure[:LTE]:DL:PRSS:BW` on page 185

Configuration Index

Defines the PRS Configuration Index I_{PRS} as defined in 3GPP TS 36.211, table 6.10.4.3-1.

Remote command:

`CONFigure[:LTE]:DL:PRSS:CI` on page 185

Num. Subframes (N_PRS)
Defines the number of consecutive DL subframes in that PRS are transmitted.

Remote command:
`CONFigure[:LTE]:DL:PRSS:NPRS` on page 185

Relative Power (Positioning Reference Signal)
Defines the power of a PRS resource element in relation to the power of a common reference signal resource element.

Remote command:
`CONFigure[:LTE]:DL:PRSS:POWer` on page 185

Frame Number Offset
Defines the system frame number of the current frame that you want to analyze.

Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations is it necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

Remote command:
`CONFigure[:LTE]:DL:SFNO` on page 186

5.2.8 Configuring the Channel State Information Reference Signal

The channel state information reference signal (CSI-RS) settings contain settings to describe the physical attributes and structure of the Channel State Information Reference Signal (CSI-RS).

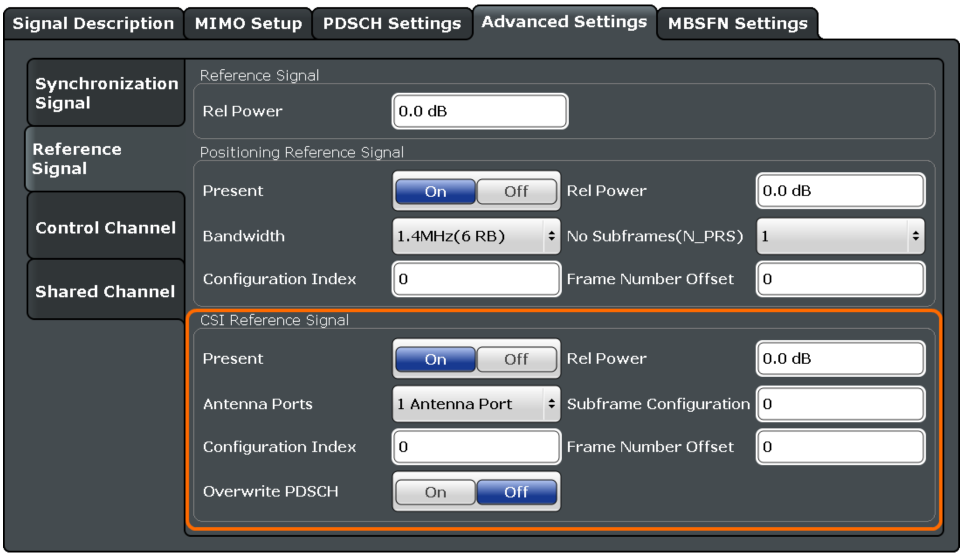
CSI-RS are used to estimate the channel properties of the signal propagation channel from the base station to the user equipement. This information is quantized and fed back to the base station. The base station makes use of this information for example to adjust the beamforming parameters.

The mapping of antenna port to the physical antenna is fix:

- Port 15: antenna 1
- Port 16: antenna 2
- Port 17: antenna 3
- Port 18: antenna 4

Resource elements used by CSI-RS are shown in yellow color in the Allocation ID versus Symbol X Carrier measurement.

The CSI-RS settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Present

Turns the CSI reference signal on and off.

Remote command:

`CONFigure[:LTE]:DL:CSIRs:STATe` on page 188

Antenna Ports

Defines the number of antenna ports that transmit the CSI reference signal.

The CSI reference signals are transmitted on one, two, four or eight antenna ports using

- p = 15
- p = 15 to 16
- p = 15 to 18
- p = 15 to 22

Remote command:

`CONFigure[:LTE]:DL:CSIRs:NAP` on page 187

Configuration Index

Defines the CSI reference signal configuration as defined in 3GPP TS 36.211, table 6.10.5.2-1/2

Remote command:

`CONFigure[:LTE]:DL:CSIRs:CI` on page 186

Overwrite PDSCH

Turns overwriting of PDSCH resource elements for UEs that do not consider the CSI reference signal on and off.

If on, the application assumes that the UE is not configured to consider CSI reference signals. Thus, resource elements of the CSI reference signal overwrite the PDSCH resource elements. Note that the bit stream result displays labels these resource element with a "#" sign.

Remote command:
`CONFigure[:LTE]:DL:CSIRs:OPDSch` on page 187

Relative Power (CSI Reference Signal)

Defines the power of a CSI reference signal resource element in relation to the power of a common reference signal resource element.

Remote command:
`CONFigure[:LTE]:DL:CSIRs:POWer` on page 187

Subframe Configuration

Defines the CSI reference signal subframe configuration index (I_CSI-RS) as defined in 3GPP TS 36.211, table 6.10.5.3-1.

Remote command:
`CONFigure[:LTE]:DL:CSIRs:SCI` on page 187

Frame Number Offset

Defines the system frame number of the current frame that you want to analyze.

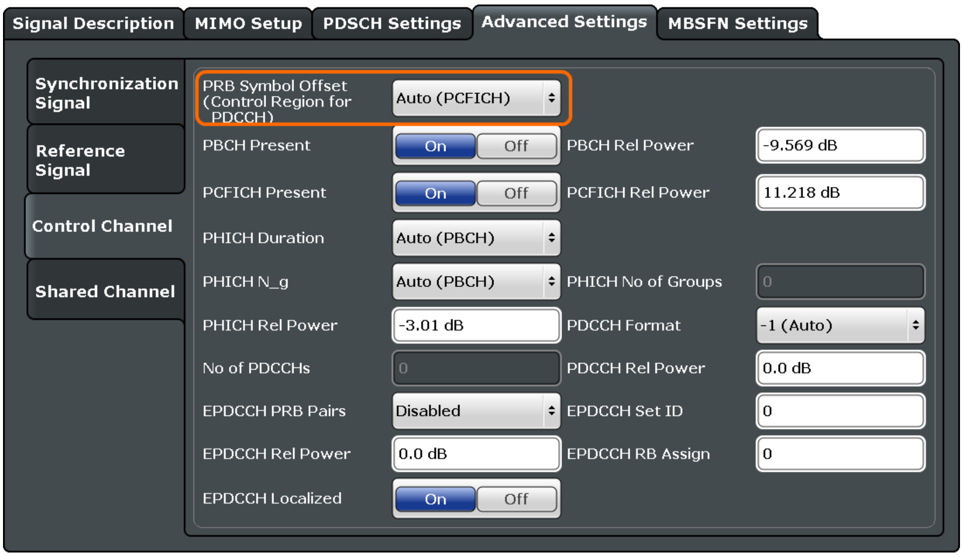
Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations is it necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

Remote command:
`CONFigure[:LTE]:DL:SFNO` on page 186

5.2.9 Defining the PDSCH Resource Block Symbol Offset

The PDSCH resource block symbol offset is part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PRB Symbol Offset

PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data overwrites some resource elements of the PDSCH.

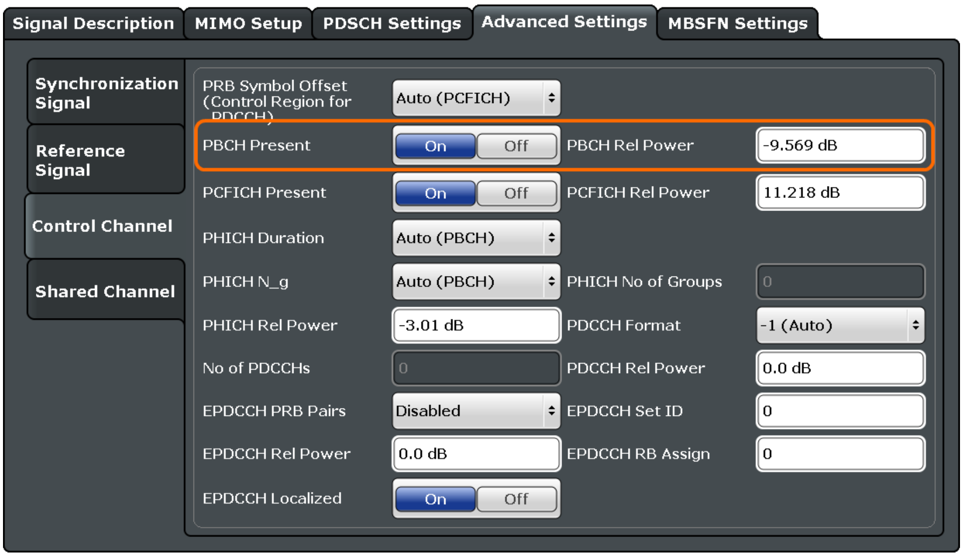
If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct Demodulation of a 3GPP conform PCFICH signal, the Scrambling of Coded Bits has to be enabled.

Remote command:
`CONFigure[:LTE]:DL:PSOFfset` on page 193

5.2.10 Configuring the PBCH

The physical broadcast channel (PBCH) carries system information for the user equipment. You can include or exclude the PBCH in the test setup and define the relative power of this channel.

The PBCH is part of the control channel. The control channel settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PBCH Present

Includes or excludes the PBCH from the test setup.

Remote command:

`CONFigure[:LTE]:DL:PBCH:STAT` on page 190

PBCH Relative Power

Defines the power of the PBCH relative to the reference signal.

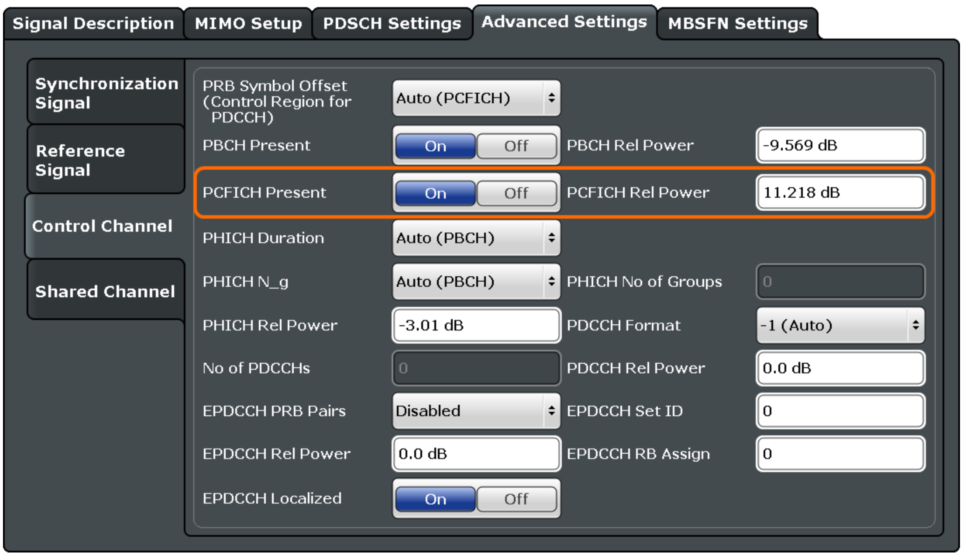
Remote command:

`CONFigure[:LTE]:DL:PBCH:POWer` on page 189

5.2.11 Configuring the PCFICH

The physical control format indicator channel (PCFICH) carries information about the format of the PDCCH. You can include or exclude the PCFICH in the test setup and define the relative power of this channel.

The PCFICH is part of the control channel. The control channel settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PCFICH Present

Includes or excludes the PCFICH from the test setup.

Remote command:

`CONFigure[:LTE]:DL:PCFich:STAT` on page 190

PCFICH Relative Power

Defines the power of the PCFICH relative to the reference signal.

Remote command:

`CONFigure[:LTE]:DL:PCFich:POWer` on page 190

5.2.12 Configuring the PHICH

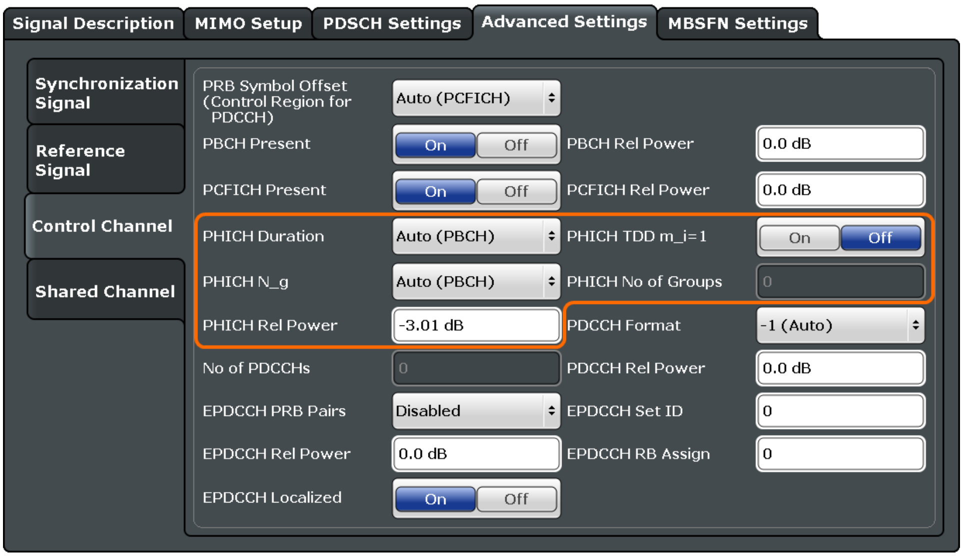
The physical hybrid ARQ indicator channel (PHICH) contains the hybrid ARQ indicator. The hybrid ARQ indicator contains the acknowledgement / negative acknowledgments for uplink blocks.

You can set several specific parameters for the PHICH.

The PHICH is part of the control channel. The control channel settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.

Turning off the PHICH

If you set the value of the PHICH N_g to Custom and at the same time define "0" PHICH groups, the PHICH is excluded from the signal.



PHICH Duration

Selects the duration of the PHICH. Normal and extended duration are supported.

With a normal duration, all resource element groups of the PHICH are allocated on the first OFDM symbol.

With an extended duration, the resource element groups of the PHICH are distributed over three OFDM symbols for a normal subframe or over two symbols within a special subframe.

If you select Auto, the duration of PHICH is automatically determined and based on the PBCH decoding results.

Note that you have to turn on the PBCH for an automatic detetemination of the PHICH duration.

Remote command:
`CONFigure[:LTE]:DL:PHICh:DURation` on page 191

PHICH TDD m_i=1 (E-TM)

Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

Remote command:
`CONFigure[:LTE]:DL:PHICh:MITM` on page 192

PHICH N_g

Sets the variable N_g.

N_g in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N_g that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with PHICH Number of Groups.

Remote command:
`CONFigure[:LTE]:DL:PHICh:NGParameter` on page 192

PHICH Number of Groups

Sets the number of PHICH groups contained in a subframe.

To select a number of groups, you have to set the PHICH N_g to "Custom".

Remote command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 192

PHICH Rel Power

Defines the power of all PHICHs in a PHICH group relative to the reference signal.

The application measures a separate relative power for each PHICH if Boosting Estimation is on. In that case, the "Rel. Power / dB" result in the Allocation Summary stays empty, because it refers to the common relative power for all PHICHs. The relative powers for each PHICH in the group are displayed in the Channel Decoder Results.

Note that the PHICH power results are quantized to 1 dB steps based on the PHICH relative power, because only a few PHICH symbols are available for boosting estimation.

Example:

The "PHICH Rel Power" is -3.01 dB.

In that case, possible PHICH boostings are -4.01 dB, -3.01 dB, -2.01 dB, etc.

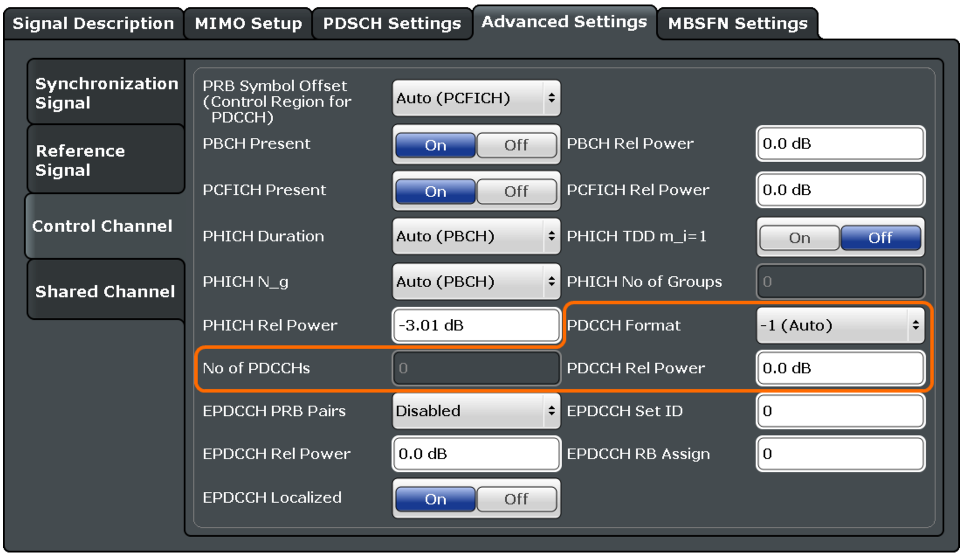
Remote command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 193

5.2.13 Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information (for example the information about the PDSCH resource allocation).

You can define several specific parameters for the PDCCH.

The PDCCH is part of the control channel. The control channel settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PDCCH Format

Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 191

Number of PDCCHs

Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 191

PDCCH Rel Power

Defines the power of the PDCCH relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:POWer` on page 191

5.2.14 Configuring the EPDCCH

The enhanced physical downlink control channel (EPDCCH) carries the downlink control information. Compared to the PDCCH, the EPDCCH uses resource blocks normally reserved for the PDSCH.

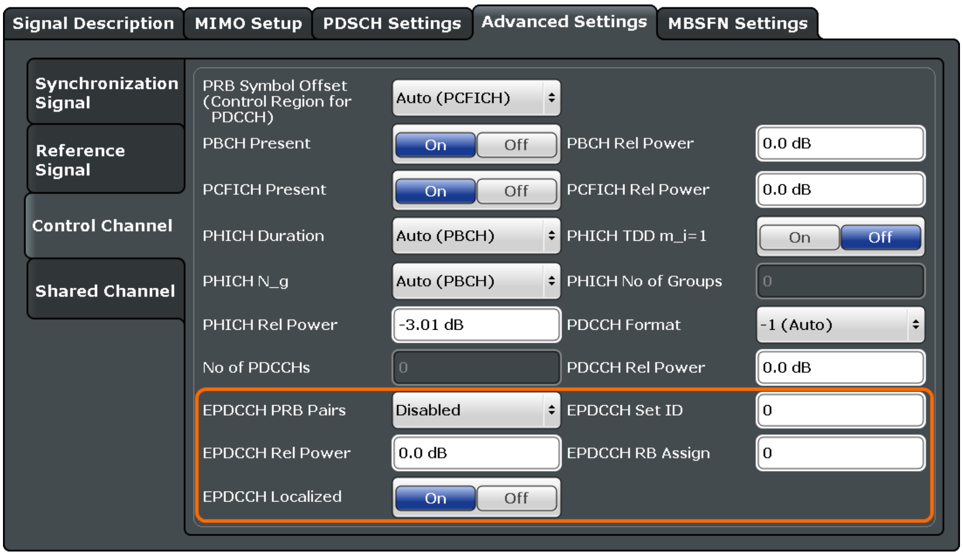
Shared resource blocks of PDSCH and EPDCCH

PDSCH allocations overwrite the EPDCCH if they occupy the same resource blocks.

The EPDCCH is always transmitted in an EPDCCH-PRB set. For each cell and user, you can define one or two EPDCCH-PRB sets. A EPDCCH-PRB set is made up out of two or more resource blocks that are combined logically.

Note that you have to measure one EPDCCH-PRB set at a time. If you have to measure a signal with more than one EPDCCH-PRB set, you have to configure each set separately and refresh the I/Q data for each set.

You can define several parameters for the EPDCCH.



EPDCCH PRB Pairs

Selects the number of resource blocks used in an EPDCCH-PRB set.

If you select the "Disabled" item, the EPDCCH is turned off.

For more information see 3GPP TS 36.213 (`numberPRBPairs-r11`).

Remote command:

`CONFigure[:LTE]:DL:EPDCch:NPRB` on page 189

EPDCCH Set ID

Defines the EPDCCH set ID.

The set ID controls the generation of reference symbols for the EPDCCH. For more information see TS36.211, 6.10.3A.1.

Remote command:

`CONFigure[:LTE]:DL:EPDCch:SID` on page 189

EPDCCH Rel Power
Defines the power of the EPDCCH relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL:EPDCch:POWer on page 189

EPDCCH RB Assignment
Defines the location of the resource blocks that the EPDCCH is transmitted in.

For more information see 3GPP TS 36.213 (resourceBlockAssignment-r11).

Remote command:
CONFigure[:LTE]:DL:EPDCch:RBASsign on page 189

EPDCCH Localized
Turns localized transmission of the EPDCCH on and off.

Localized transmission is useful for known channel conditions. In that case, the scheduling and MIMO precoding can be optimized.

If the channel conditions are unknown, distributed transmission is used. Distributed transmission utilizes the frequency diversity in that the information is distributed over the selected frequency range.

Remote command:
CONFigure[:LTE]:DL:EPDCch:LOCalized on page 188

5.2.15 Configuring Shared Channels

The shared channel characteristics are part of the "Advanced Settings" tab of the "Signal Description" dialog box.

PDSCH Power Ratio
Selects the PDSCH P_B parameter that defines the cell-specific ratio of rho_B to rho_A according to 3GPP TS 36.213, table 5.2-1.

The table below shows the resulting values as a function of the number of antennas.

PDSCH P_B	1 Tx antenna	2 and 4 Tx antennas
0	0.000 dB	0.969 dB
1	-0.969 dB	0.000 dB
2	-2.218 dB	-1.249 dB
3	-3.979 dB	-3.010 dB

If you select "p_B/p_A=1", the ratio is always 1, regardless of the number of antennas.

Remote command:
CONFigure[:LTE]:DL:PDSCh:PB on page 193

5.2.16 Defining MBSFN Characteristics

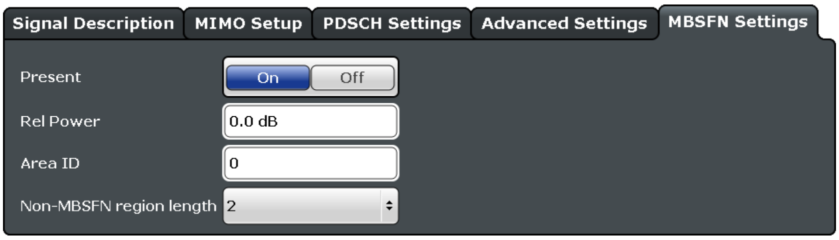
The MBSFN settings contain settings to configure Multimedia Broadcast Single Frequency Networks (MBSFNs).

The positioning reference signal settings are part of the "MBSFN Settings" tab of the "Signal Description" dialog box.

5.2.16.1 Configuring MBSFNs

The general MBSFN settings contain settings that apply to all subframes that contain MBSFN information.

The MBSFN settings are part of the "MBSFN Settings" tab of the "Demodulation Settings" dialog box.



Present

Includes or excludes an MBSFN from the test setup.

Remote command:

`CONFigure[:LTE]:DL:MBSFn:STATe` on page 195

MBSFN Relative Power

Defines the power of the MBSFN transmission relative to the reference signal.

Remote command:

`CONFigure[:LTE]:DL:MBSFn:POWer` on page 195

Area ID

Defines the ID for an MBFSN area.

Radio cells that shall transmit the same content to multiple users will form a so called MBSFN area. Multiple cells can belong to such an area, and every cell can be part of up to eight MBSFN areas. There could be up to 256 different MBSFN areas defined, each one with an own identity.

The area ID (N_{ID}^{MBFSN}) is defined in 3GPP 36.211.

Remote command:
CONFigure[:LTE]:DL:MBSFn:AI:ID on page 194

Non-MBSFN Region Length
Selects the length of the MBSFN control data region at the start of the MBSFN subframe.

If you select a region length of '1', the first symbol in an MBFSN subframe carries data of the control channel. All other symbols of an MBSFN region may be used by the PMCH.

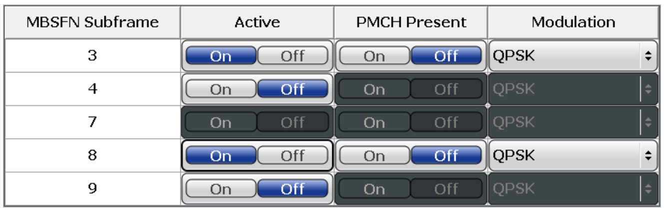
If you select a region length of '2', the first two symbols in an MBFSN subframe carry data of the control channel.

Remote command:
CONFigure[:LTE]:DL:MBSFn:AI:NMRL on page 194

5.2.16.2 Configuring MBSFN Subframes

If you are testing systems that support MBSFN, 3GPP allows you to reserve one or more subframes for multimedia broadcasting.

The MBSFN subframe configuration is part of the "MBSFN Settings" tab of the "Demodulation Settings" dialog box.



MBSFN Subframe
Shows the subframe number that may contain MBSFN data.

Note that 3GPP only allows to turn selected subframes into MBSFN subframes. Depending on the configuration (for example the TDD configuration), different subframe numbers are available for MBSFN transmissions.

Active
Turns a subframe into a MBSFN subframe.

If active, the corresponding subframe may contains MBSFN data.

Remote command:
CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:STATe on page 196

PMCH Present
Turns the Physical Multicast Channel (PMCH) on and off.

If you turn on the PMCH, the resource elements of the MBSFN subframe are used by the PMCH.

If you turn off the PMCH, the resource elements of the MBSFN subframe may be used by the PDSCH.

Remote command:
`CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:PMCH:STATe` on page 195

Modulation
Selects the modulation scheme for the MBSFN subframe.

Remote command:
`CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:PMCH:MODulation` on page 195

5.2.17 Selecting the Input Source

5.2.17.1 RF Input

Functions to configure the RF input described elsewhere:
- "Input Coupling" on page 92
- "Impedance" on page 92

YIG-Preselector
Activates or deactivates the YIG-preselector, if available on the R&S FPS.

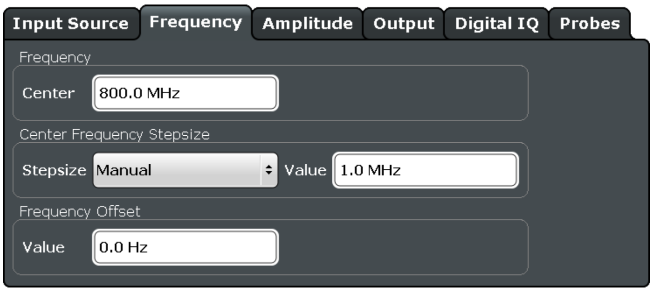
An internal YIG-preselector at the input of the R&S FPS ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FPS, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 197

5.2.18 Defining the Frequency

Frequency settings define the frequency characteristics of the signal at the RF input. They are part of the "Frequency" tab of the "Signal Characteristics" dialog box.



Defining the Signal Frequency
For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

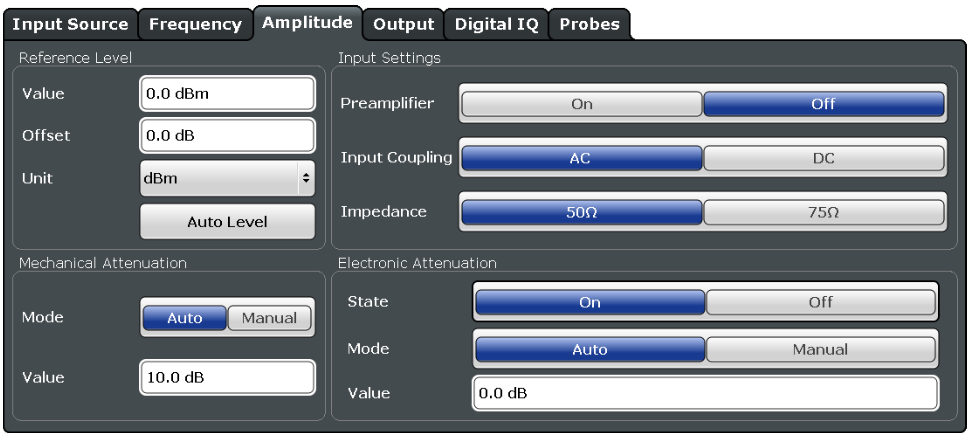
In addition to the frequency itself, you can also define a frequency stepsize. The frequency stepsize defines the extent of a frequency change if you change it for example with the rotary knob. Define the stepsize in two ways.

- = Center
  One frequency step corresponds to the current center frequency.
- Manual
  Define a any stepsize you need.

Remote command:
Center frequency: `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 197
Frequency stepsize: `[SENSe:]FREQuency:CENTer:STEP` on page 199
Frequency offset: `[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet` on page 198

5.2.19 Defining Level Characteristics

Amplitude settings define the expected level characteristics of the signal at the RF input.



Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can specify the reference level in several **units** and define an arithmetic **level offset**. A level offset is useful if the signal is attenuated or amplified before it is fed into the analyzer. All displayed power level results will be shifted by this value. Note however, that the reference value ignores the level offset. Thus, it is still mandatory to define the actual power level that the analyzer has to handle as the reference level.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value.

Automatic level detection also optimizes RF attenuation.

The application shows the current reference level (including RF and external attenuation) in the channel bar.

Remote command:
Manual: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 200
Automatic: `[SENSe:]ADJust:LEVel` on page 203
Offset: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 200
Unit: `CALCulate<n>:UNIT:POWer` on page 200

Attenuating the Signal

Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE measurement application provides several attenuation modes.

- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.

- It is also possible to equip the R&S FPS with the optional **electronic** attenuator. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.
  For both methods, the application provides **automatic** detection of the ideal attenuation level. Alternatively, you can define the attenuation level **manually**. The range is from 0 dB to 79 dB (RF attenuation) or 30 dB (electronic attenuation) in 1 dB steps.

For more information on attenuating the signal see the manual of the R&S FPS.

The application shows the attenuation level (mechanical and electronic) in the channel bar.

Remote command:
RF attenuation: `INPut:ATTenuation` on page 201
RF attenuation: `INPut:ATTenuation:AUTO` on page 201
Electronic attenuation: `INPut<n>:EATT:STATe` on page 203
Electronic attenuation: `INPut<n>:EATT:AUTO` on page 203
Electronic attenuation: `INPut<n>:EATT` on page 202

Preamplifier (option B22/B24)
Switches the preamplifier on and off. If activated, the input signal is amplified by 20 dB.

If option R&S FPS-B22 is installed, the preamplifier is only active below 7 GHz.

If option R&S FPS-B24 is installed, the preamplifier is active for all frequencies.

Remote command:
`INPut:GAIN:STATe` on page 202

Input Coupling
The RF input of the R&S FPS can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 201

Impedance
The reference impedance for the measured levels of the R&S FPS can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

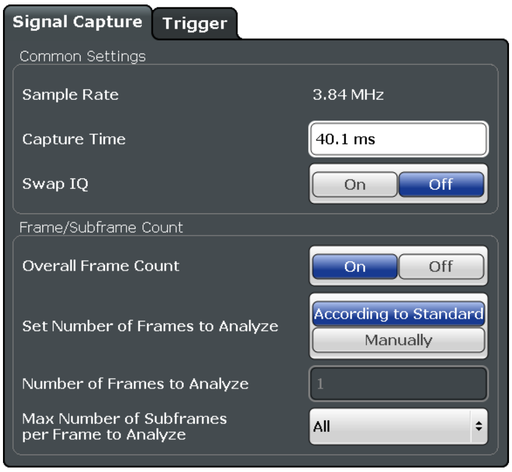
This value also affects the unit conversion.

Remote command:
`INPut:IMPedance` on page 202

5.2.20 Configuring the Data Capture

The data capture settings contain settings that control the data capture.

The data capture settings are part of the "Signal Capture" tab of the "Trigger/Signal Capture" dialog box.



Capture Time

Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

The application shows the current capture time in the channel bar.

Note that if you are using the multi-standard radio analyzer, only the MSRA master channel actually captures the data. The capture time only defines the LTE analysis interval.

More information.

Remote command:
`[SENSe]:SWEep:TIME` on page 205

Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
`[SENSe]:SWAPiq` on page 205

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FPS analyzes all complete LTE frames currently in the capture buffer.

The application shows the current frame count in the channel bar.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 204

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FPS evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 204

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FPS continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 204

Maximum Number of Subframes per Frame to Analyze
Selects the maximum number of subframes that the application analyzes and therefore improves measurement speed.

Reducing the number of analyzed subframes may become necessary if you define a capture time of less than 20.1 ms. For successful synchronization, all subframes that you want to analyze must be in the capture buffer. You can make sure that this is the case by using, for example, an external frame trigger signal.

For maximum measurement speed, the application turns off Auto According to Standard and sets the Number of Frames to Analyze to 1. These settings prevent the application from capturing more than once for a single run measurement.

Remote command:
`[SENSe][:LTE]:FRAMe:SCOunt` on page 205

5.2.21 Triggering Measurements

The trigger functionality of the LTE measurement application is similar as that of the R&S FPS. The available features depend on the number of data streams that are captured in the measurement.

For a comprehensive description of the available trigger settings not described here, please refer to the documentation of the R&S FPS.

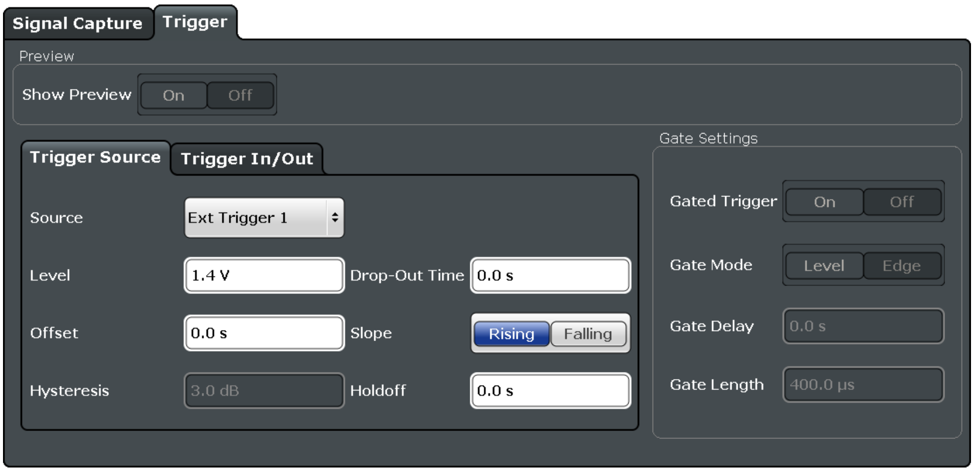
5.2.21.1 Triggering Single Data Streams and Frequency Sweep Measurements

The trigger functionality to capture single data streams is the same as that of the R&S FPS. For a comprehensive description of the available trigger settings see the documentation of the R&S FPS.

Note that some trigger sources available in Spectrum mode are not available in the LTE application. Note also that the Preview and Gate functionality are only available for frequency sweep measurements (for example ACLR and SEM).

Gated frequency sweep measurements
The application automatically selects the correct gate settings (delay and length) according to the TDD configuration.

The trigger settings are part of the "Trigger" tab of the "Trigger/Signal Capture" dialog box.

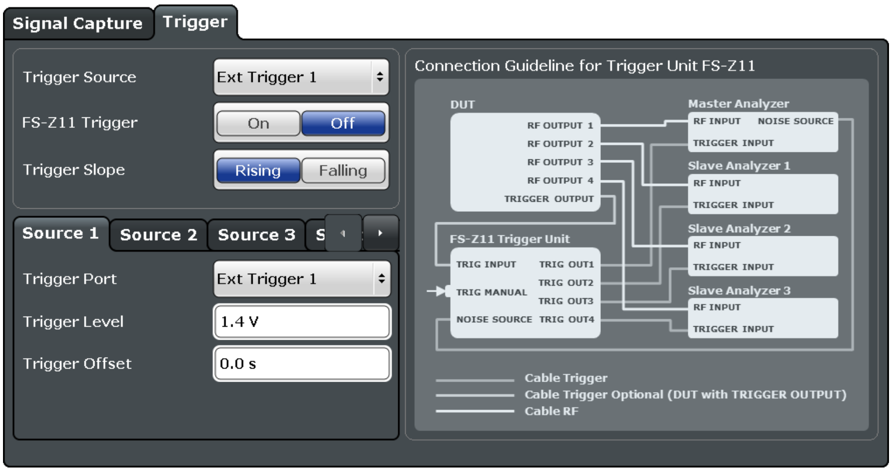


For more information on trigger functionality please also refer to the documentation of the R&S FPS.

5.2.21.2 Triggering Multiple Data Streams (MIMO Measurements)

The trigger functionlity for MIMO measurements allows you to configure trigger characteristics for each R&S FPS in the setup. Using a trigger for MIMO measurements is important, because, for valid measurements, it is mandatory to capture all signals simultaneously.

For more information about configuring and performing MIMO measurements, including trigger configuration, see chapter 4.4, "MIMO Measurement Guide", on page 47.



Configuring the Trigger

The trigger settings for MIMO measurements contain some extra functionality not supported for single stream data capture.

While the application runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

General trigger settings

The application supports several **trigger sources**.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/ Gate" input.
  The R&S FPS has three trigger ports ("External 1 to 3"). The trigger source you select for the controlling analyzer (master) corresponds to the trigger port you are using ("External 1", for example is always on trigger port 1).

If you are using a trigger, you can select the **trigger slope**. The trigger slope defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

Trigger unit

The trigger unit **R&S FS-Z11** is a device that controls the analyzers in the MIMO test setup. It makes sure that all data streams are captured simultaneously. When you turn it on, the application takes the trigger unit into account during measurements.

The diagram next to the trigger settings visualizes the connections and cabling necessary to use the trigger unit. It is displayed in color when you turn the trigger unit on. For more information see "Measurements with the R&S FS-Z11 trigger unit" on page 51.

Trigger settings for individual analyzers

The LTE measurement application allows you to assign several trigger settings for each analyzer individually.

In the "Trigger" tab, this is represented by the "Source 1" to "Source 4" tabs. In the default state, all analyzers use the same settings as the first analyzer ("Same as Master Setting" is on).

If the analyzer you use has more than one **trigger port**, you can use different one than on the master analyzer.

In addition the power level, you can also define a custom trigger offset for all analyzers in the setup.

The measurement starts as soon as the trigger event happens. In case of external triggers, this is the voltage that the signal must exceed.

For simultaneous data capture, it may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset**. The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

Remote command:
Trigger source: `TRIGger[:SEQuence]:SOURce` on page 207
Trigger slope: `TRIGger[:SEQuence]:SLOPe` on page 207
Trigger port: `TRIGger[:SEQuence]:PORT<instrument>` on page 207
Trigger level: `TRIGger[:SEQuence]:LEVel<instrument>[:EXTernal]` on page 206
Trigger offset: `TRIGger[:SEQuence]:HOLDoff<instrument>` on page 206

5.2.22 Estimating Parameters

The parameter estimation settings contain settings that estimate various parameters during the measurement. They increase the quality of measurement results.

The parameter estimation settings are part of the "Parameter Estimation / Tracking" dialog box.

Boosting Estimation
Turns boosting estimation on and off.

When you turn this eature on, the application automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

Remote command:
`[SENSe][:LTE]:DL:DEMod:BESTimation` on page 210

Channel Estimation
Selects the method of channel estimation.

- **EVM 3GPP Definition**
  Channel estimation according to 3GPP TS 36.141. This method is based on averaging in frequency direction and linear interpolation. Examines the reference signal only.
- **Optimal, Pilot only**
  Optimal channel estimation method. Examines the reference signal only.
- **Optimal, Pilot and Payload**
  Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

Remote command:
`[SENSe][:LTE]:DL:DEMod:CESTimation` on page 210

5.2.23 Compensating Measurement Errors

The tracking settings contain settings that compensate for various common measurement errors that may occur.

The tracking settings are part of the "Parameter Estimation / Tracking" dialog box.

Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off"	Phase tracking is not applied.
"Pilot Only"	Only the reference signal is used for the estimation of the phase error.

"Pilot and Payload" Both reference signal and payload resource elements are used for the estimation of the phase error.

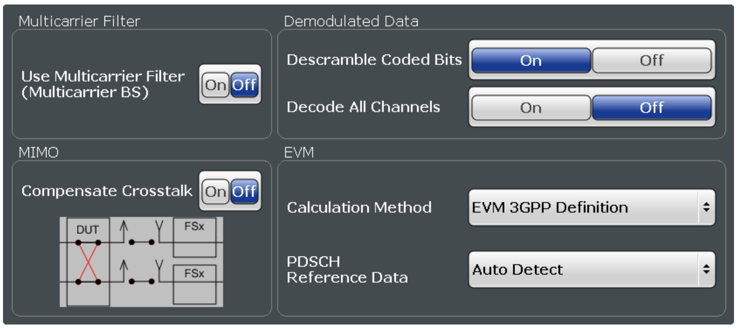
Remote command:
`[SENSe][:LTE]:DL:TRACking:PHASe` on page 211

Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:
`[SENSe][:LTE]:DL:TRACking:TIME` on page 211

5.2.24 Configuring Demodulation Parameters

Demodulation settings contain settings that describe signal processing and the way the signal is measured.



Multicarrier Filter
Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc).

Remote command:
`[SENSe][:LTE]:DL:DEMod:MCFilter` on page 208

Compensate Crosstalk
Turns compensation of crosstalk produced by one of the components in the test setup on and off.

Turn this feature on, if you expect crosstalk from the DUT or another component in the test setup. This may be necessary, for example, for over-the-air measurements.

If you connect the DUT to the analyzer by cable, turn off crosstalk compensation. In that case, the only crosstalk results from the DUT itself and contributes as distortion to the measurement results.

Crosstalk compensation must be activated for Time Alignment Error measurements. For more information see chapter 4.5, "Performing Time Alignment Measurements", on page 52.

Remote command:
CONFigure[:LTE]:DL:MIMO:CROSstalk on page 209

Scrambling of Coded Bits
Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.

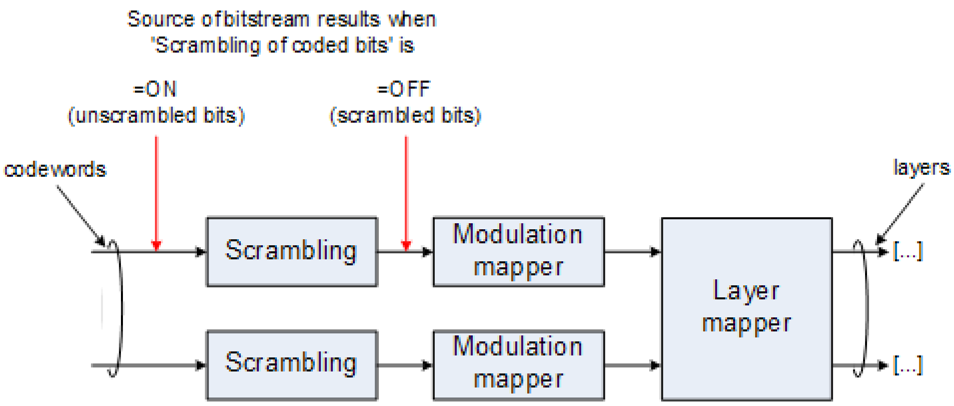


Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
[SENSe][:LTE]:DL:DEMod:CBSCrambling on page 208

Decode All Channels
Turns the decoding of all physical channels on and off.

When you turn this feature on, the application shows the decoding results in the "Channel Decoder Results" result display.

In addition, the application only measures the EPDCCH resource block that are actually used.

When you turn the feature off,
- the PBCH is decoded only if the PHICH Duration or the PHICH N_g are automatically determined
- the PDCCH is decoded only if the PDSCH Subframe Configuration Detection is set to PDCCH protocol.

If decoding of all control channels is off, measurement speed will increase.

Remote command:
[SENSe][:LTE]:DL:DEMod:DACHannels on page 209

EVM Calculation Method
Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**
  Calculates the EVM using the optimal timing position.

Remote command:
`[SENSe][:LTE]:DL:DEMod:EVMCalc` on page 209

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

- Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector.
  This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

Remote command:
`[SENSe][:LTE]:DL:DEMod:PRData` on page 210

5.3 Configuring Time Alignment Error Measurements

Several settings supported by Time Alignment Error measurements are the same as those for I/Q measurements. For a comprehensive description of those, refer to the following chapters.

- chapter 5.2.1, "Defining Signal Characteristics", on page 59
- chapter 5.2.5, "Configuring the Synchronization Signal", on page 73
  (note that the Time Alignment Error measurement does not support all synchronization signal settings)
- chapter 5.2.17, "Selecting the Input Source", on page 89
- chapter 5.2.18, "Defining the Frequency", on page 89
- chapter 5.2.19, "Defining Level Characteristics", on page 90
- chapter 5.2.20, "Configuring the Data Capture", on page 93
- chapter 5.2.21, "Triggering Measurements", on page 95
- chapter 5.2.24, "Configuring Demodulation Parameters", on page 99

The application also provides several settings that are exclusive to Time Alignment Error measurements.

Carrier Aggregation
The application supports Time Alignment Error measurements with carrier aggregation.

Select the number of carriers from the **"Number of Component Carriers"** dropdown menu.

Note that the application shows measurement results for the second component carrier even if only one antenna of the second component carrier is attached (i.e. no combiner is used).

Remote command:
`[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 197

5.4 Configuring Power On/Off Measurements

Several settings supported by Power On / Off measurements are the same as those for I/Q measurements. For a comprehensive description of those, refer to the following chapters.

- chapter 5.2.1, "Defining Signal Characteristics", on page 59
- chapter 5.2.5, "Configuring the Synchronization Signal", on page 73
(Note that the Power On/Off measurement does not support all synchronization signal settings.)
- chapter 5.2.17, "Selecting the Input Source", on page 89
- chapter 5.2.18, "Defining the Frequency", on page 89
- chapter 5.2.19, "Defining Level Characteristics", on page 90
- chapter 5.2.20, "Configuring the Data Capture", on page 93
- chapter 5.2.21, "Triggering Measurements", on page 95

The application also provides several settings that are exclusive to Power On / Off measurements.

Number of Frames
Defines the number of frames that are averaged to calculate a reliable power trace for On/Off Power measurements.

Remote command:
`CONFigure[:LTE]:OOPower:NFRames` on page 213

Noise Correction
Turns noise correction for On/Off Power measurements on and off.

For more information see the manual of the R&S FPS.

Remote command:
`[SENSe][:LTE]:OOPower:NCORrection` on page 213

Carrier Aggregation
Carrier aggregation has been introduced in the LTE standard to increase the bandwidth. In those systems, several carriers can be used to transmit a signal. Each carrier usually has one of the channel bandwidths defined by 3GPP.

The R&S FPS features several measurements that support contiguous and non-contiguous intra-band carrier aggeregation (the carriers are in the same frequency band).

- Time Alignment Error (downlink)
- Time Alignment Error (uplink)
- Transmit On/Off Power (downlink)
- Cumulative ACLR (downlink, non-contiguous intra-band carrier aggregation)
- Multi Carrier ACLR (downlink, non-contiguous intra-band carrier aggregation)
- Multi Carrier ACLR (uplink, contiguous intra-band carrier aggregation)
- SEM (downlink, non-contiguous intra-band carrier aggregation)
- SEM (uplink, contiguous intra-band carrier aggregation)

The way to configure these measurements is similar (but not identical, the differences are indicated below).

- "Basic component carrier configuration" on page 103
- "Features of the Time Alignment Error measurement" on page 104
- "Features of the Transmit Power On/Off measurement" on page 104
- "Features of the Cumulative and MC ACLR measurement" on page 104
- "Remote commands to configure carrier aggregation" on page 104

Basic component carrier configuration ← Carrier Aggregation
The number of component carriers (CCs) you can select depends on the measurement.

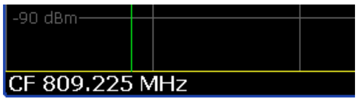
- Time Alignment Error: up to 2 CCs
- Transmit On/Off Power: up to 5 CCs
- Multi-carrier ACLR: up to 5 CCs
- C-ACLR: up to 5 CCs
- Multi-carrier SEM: up to 3 CCs

You can define the characteristics of the CCs in the table in the "Carrier Configuration" panel (in the "Signal Characteristics" dialog box). Depending on the **number of component carriers**, the application adjusts the size of the table. Each line corresponds to a component carrier.

The **center frequency** defines the carrier frequency of the carriers, each with a certain **bandwidth** that you can select from the corresponding dropdown menu. For all component carriers, the application also shows the **frequency offset** relative to the center frequency of the first carrier.

If you define a different frequency offset, the application adjusts the center frequency accordingly.

Note that the actual measurement frequency differs from the two carrier frequencies: the application calculates that frequency based on the carrier frequencies. It is somewhere in between the carrier frequencies. The measurement frequency is displayed at the bottom of the diagram area.



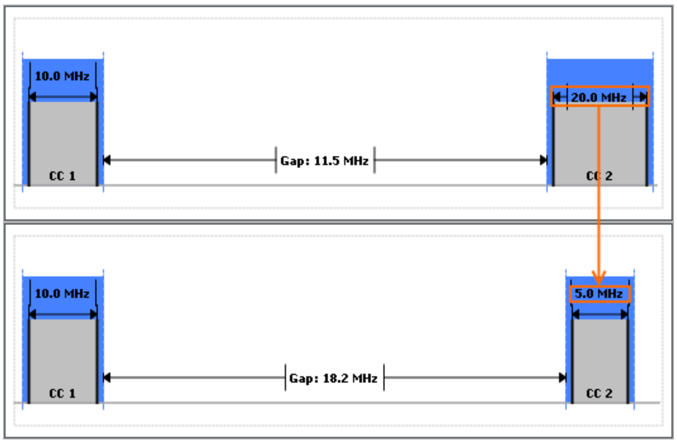
For each component carrier, you can select one of the **channel bandwidths** defined by 3GPP from the "Bandwidth" dropdown menus. The combination of bandwidths is arbitrary.

When the defined carrier configuration is not supported by the application, a corresponding error message is displayed. This may be the case, for example, if the carriers occupy a bandwidth that is too large.

Features of the Time Alignment Error measurement ← Carrier Aggregation
For more information see "Carrier Aggregation" on page 101.

Features of the Transmit Power On/Off measurement ← Carrier Aggregation
The **"Frequency Lower Edge"** and **"Frequency Higher Edge"** field displayed below the component carrier table represent the bandwidth required by the aggregated carriers.

Features of the Cumulative and MC ACLR measurement ← Carrier Aggregation
The diagram at the bottom of the dialog box represents the current configuration. When you change the bandwidth of a carrier (represented by blue bars), the application adjusts the bandwidth of the carriers in the diagram accordingly.



Remote commands to configure carrier aggregation ← Carrier Aggregation

Remote command:
Number of carriers: `CONFigure:NOCC` on page 212
Carrier frequency: `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 197
Measurement frequency: `SENSe:FREQuency:CENTer?`
Offset: `[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet` on page 198
Channel bandwidth: `CONFigure[:LTE]:DL[:CC<cci>]:BW` on page 171

5.5 Configuring Frequency Sweep Measurements

After starting one of the frequency sweep measurements, the application automatically loads the configuration required by measurements according to the 3GPP standard: the spectral mask as defined in the 3GPP standard for SEM measurements and the channel configuration defined in the standard for the ACLR measurement.

If you need a different measurement configuration, you can change all parameters as required. Except for the dialog box described below, the measurement configuration menus for the frequency sweep measurements are the same as in the Spectrum application.

Please refer to the User Manual of the R&S FPS for a detailed description on how to configure ACLR and SEM measurements.

5.5.1 ACLR Signal Description

The signal description for ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

  The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model and Channel Bandwidth see Selecting the LTE Mode, Using Test Models and Channel Bandwidth / Number of Resource Blocks.

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:
`[SENSe]:POWer:ACHannel:AACHannel` on page 213

5.5.2 SEM Signal Description

The signal description for SEM measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see Selecting the LTE Mode, Using Test Models, "Channel Bandwidth / Number of Resource Blocks" on page 61 and Cyclic Prefix.

Category
Selects the type, category and option of the limit defintions for SEM measurements.

The software supports limit defintions for the following types of base stations:
- Wide areas base stations (Category A and B)
- Local Area base stations
- Home base stations
- Medium Range base stations

Category A and B are defined in ITU-R recommendation SM.329. For Category B operating band unwanted emissions, there are two options for the limits that may be applied regionally (Opt1 and Opt2).

The type and category you should use for the measurement depends on the category and option that the base station you are testing supports.

For Home Area base stations, you can define an additional Aggregated Maximum Power Of All TX Ports (P) for all antenna ports of a home area base station. The aggregated maximum power is the aggregated power of all antenna ports and has an effect on the shape of the SEM.

For Medium Range base station, you can automatically measure or manually enter the power of the carrier TX Power.

Remote command:
`[SENSe]:POWer:SEM:CATegory` on page 214
Home BS power: `[SENSe]:POWer:SEM:CHBS:AMPower` on page 215
Medium BS power mode: `[SENSe]:POWer:SEM:CHBS:AMPower:AUTO` on page 215
Medium BS power value: `[SENSe]:POWer:SEM:CHBS:AMPower` on page 215

Aggregated Maximum Power Of All TX Ports (P)
Defines the aggregated maximum power of all TX ports of home base stations. The aggregate maximum power is required to calculate limit line values for SEM measurements on home base stations.

The parameter is available only if you have selected SEM Category "Home".

Remote command:
`[SENSe]:POWer:SEM:CHBS:AMPower` on page 215

TX Power
Turns automatic detection of the TX channel power for Medium Range base stations on and off.

When you turn this feature off, you can manually define the power of the transmission channel.

When you turn automatic detection of the power on, the application measures the power of the transmission channel.

The parameter is available only if you have selected SEM Category "Medium Range".

Remote command:
State: `[SENSe]:POWer:SEM:CHBS:AMPower:AUTO` on page 215
Power: `[SENSe]:POWer:SEM:CHBS:AMPower` on page 215

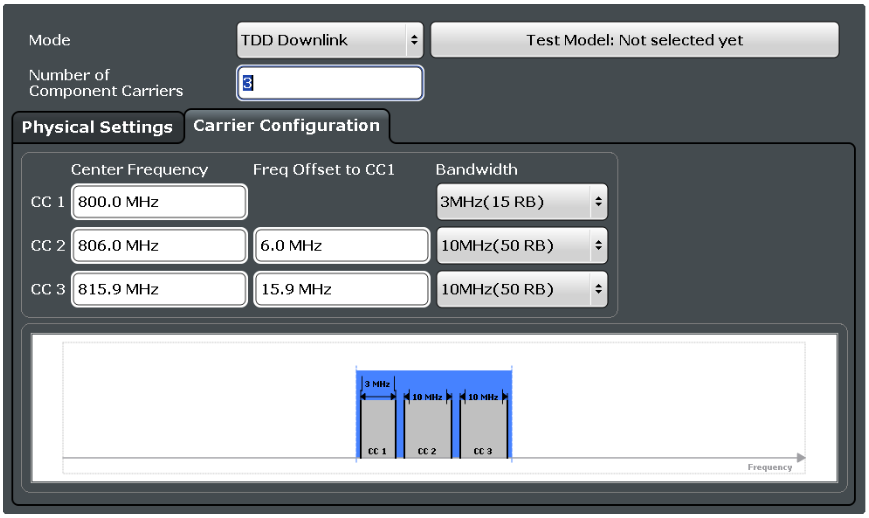
5.5.3 Cumulative ACLR

The signal description for ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.
You can configure the characteristics of the carriers in the "Carrier Configuration" tab.
Note: the "Carrier Configuration" button in the "Physical Settings" tab also opens the "Carrier Configuration" tab.



For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see "Selecting the LTE Mode" on page 59, "Using Test Models" on page 60, "Channel Bandwidth / Number of Resource Blocks" on page 61 and "Cyclic Prefix" on page 61.

For more information about configuring component carriers in the Multi-Carrier SEM see Carrier Aggregation.

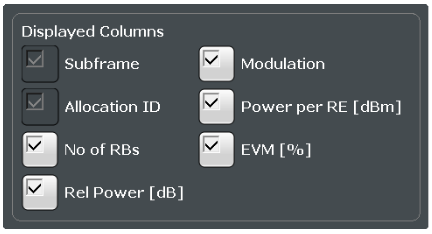
6 Analysis

6.1 Configuring Tables / Numerical Results

The application allows you to customize the number of columns for some numeric result displays, for example the Allocation Summary.

► Select a point somewhere in the header row of the table.

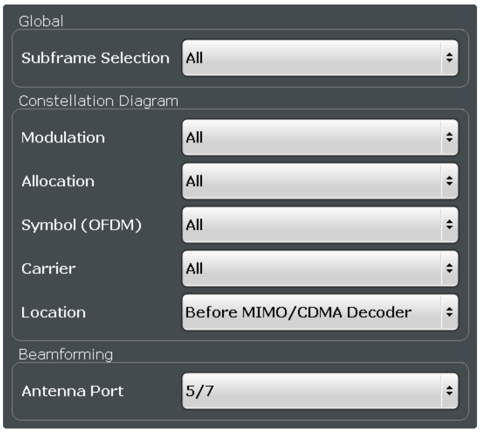
The application opens a dialog box to add or remove columns.



6.2 Analyzing I/Q Measurements

6.2.1 Evaluation Range

The evaluation range defines the signal parts that are considered during signal analysis.



Subframe Selection

Selects a particular subframe whose results the application displays.

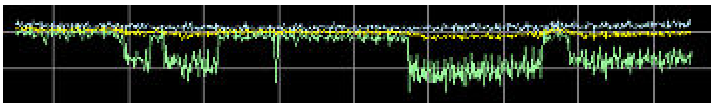
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, EVM vs. Symbol x Carrier, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Power vs Symbol x Carrier, Constellation Diagram, Allocation Summary, Bit Stream and Time Alignment. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

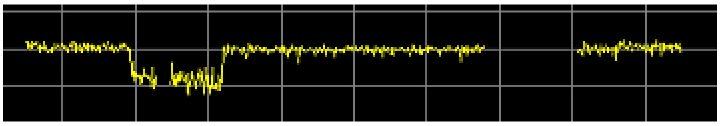
Example: Subframe selection

If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



Remote command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 218

Evaluation Range for the Constellation Diagram

The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the application displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.

- Modulation
  Filters the results to include only the selected type of modulation.
- Allocation
  Filters the results to include only a particular type of allocation.
- Symbol
  Filters the results to include only a particular OFDM symbol.
  Filtering by OFDM symbols is available for constellations created before MIMO decoding.
- Carrier
  Filters the results to include only a particular subcarrier.
  Filtering by carrier is available for constellations created before MIMO decoding.
- Symbol
  Filters the results to include only a particular codeword symbol.
  Filtering by codeword symbols is available for constellations created after MIMO decoding.
- Codeword
  Filters the results to include only a particular codeword.
  Filtering by codeword is available for constellations created after MIMO decoding.
- Location

Selects the point in the signal processing at which the constellation diagram is created, before or after the MIMO encoding.
In case of spatial multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. When you filter these symbols to show a modulation "MIXTURE", you get the mixed symbols only if you have selected the "Before MIMO/CDMA Decoder" option.
Note that the PHICH is CDMA encoded. Thus, the constellation points for the PHICH are either created before or after CDMA encoding.
If you have selected "After MIMO/CDMA Decoder", filtering by "Symbol" and "Carrier" is not available. Instead, you can filter by "Symbol" and "Codeword".

The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Modulation: `[SENSe][:LTE]:MODulation:SELect` on page 217
Allocation: `[SENSe][:LTE]:ALLocation:SELect` on page 216
Symbol: `[SENSe][:LTE]:SYMBol:SELect` on page 218
Carrier: `[SENSe][:LTE]:CARRier:SELect` on page 216
Location: `[SENSe][:LTE]:LOCation:SELect` on page 217

Beamforming Selection
Filters the displayed results to include only certain antenna port(s).

The availability of antenna ports depends on the number of transmission antennas and the number of beamforming layers you are testing.

Remote command:
`CONFigure[:LTE]:DL:BF:AP` on page 216

6.2.2 Scale

Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you are using the **automatic scale** function.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis by defining the **minimum** and **maximum** values displayed on the vertical axis. Possible values and units depend on the result display you want to adjust the scale of.

You can restore the default scale at any time with "Restore Scale".

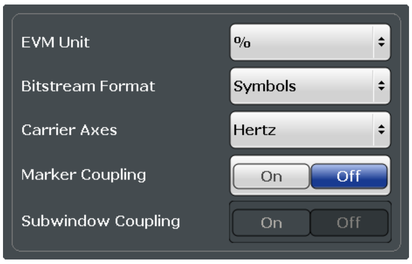
Tip:

Alternatively, you can scale the windows in the "Auto Set" menu. In addition to scaling the window currently in focus ("Auto Scale Window"), there you can scale **all windows** at the same time ("Auto Scale All").

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 218
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 219
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 219

6.2.3 Result Settings

Result settings define the way certain measurement results are displayed.



EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 220

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

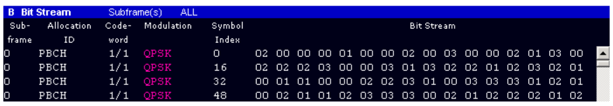
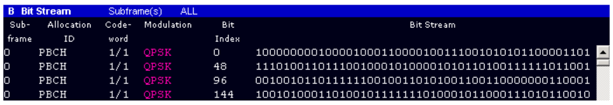


Fig. 6-1: Bit stream display in downlink application if the bit stream format is set to "symbols"



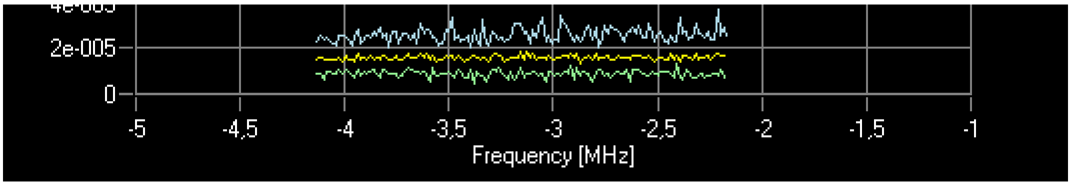
B Bit Stream	Subframe(s) ALL				
Sub-frame	Allocation ID	Code-word	Modulation	Bit Index	Bit Stream
0	PBCH	1/1	QPSK	0	100000000100001000110000100111001010101100001101
0	PBCH	1/1	QPSK	48	111010011011100100010100001010110100111111011001
0	PBCH	1/1	QPSK	96	001001011011111100100110101001100110000000110001
0	PBCH	1/1	QPSK	144	100101000110100101111111010001011000111010110010

Fig. 6-2: Bit stream display in downlink application if the bit stream format is set to "bits"

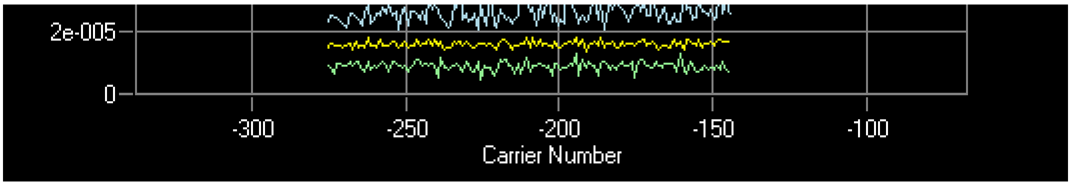
Remote command:
`UNIT:BSTR` on page 220

Carrier Axes
Selects the scale of the x-axis for result displays that show results of OFDM subcarriers.

- X-axis shows the frequency of the subcarrier



- X-axis shows the number of the subcarrier



Remote command:
`UNIT:CAXes` on page 220

Subwindow Coupling
Couples or decouples result display tabs (subwindows).

If the coupling is on and you select another tab in a result display, the application automatically selects the same tab for all result displays

Subwindow coupling is available for measurements with multiple data streams (MIMO).

Marker Coupling
Couples or decouples markers that are active in multiple result displays.

When you turn this feature on, the application moves the marker to its new position in all active result displays.

When you turn it off, you can move the markers in different result displays independent from each other.

Remote command:
`CALCulate:MARKer:COUPling` on page 219

6.2.4 Markers

Markers are available for most of the I/Q measurement result displays and for the frequency sweep measurements. The functionality (setting and positioning) is the same as in Spectrum mode.

Markers in result displays with a third aspect

In result displays that have a third dimension (EVM vs Symbol x Carrier etc.), you can position a marker on a particular symbol in a particular carrier.

When you activate a marker, you can select the symbol and carrier you want to position the marker on. Alternatively, you can define the marker position in the "Marker Configuration" dialog box, which is expanded accordingly.

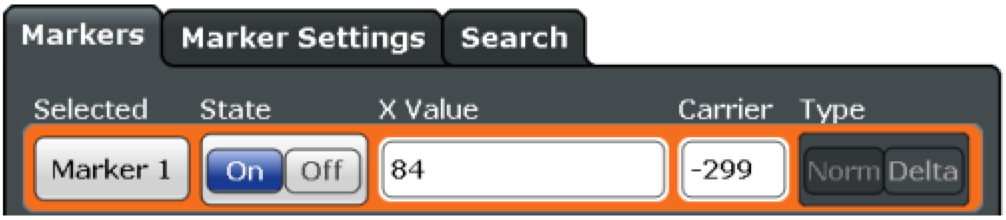


Fig. 6-3: Marker Configuration dialog, the "Carrier" firld is only available for result displays with a third dimension.

For a comprehensive description of the marker functionality see the corresponding chapters in the documentation of the R&S FPS.

6.3 Analyzing Frequency Sweep Measurements

The LTE application supports the same functionality to analyze the results of frequency sweep measurements (Spectrum Emission mask and Adjacent Channel Leakage Ratio) as the R&S FPS base unit does for those measurements.

Please refer to the User Manual of the R&S FPS for a detailed description on how to analyze ACLR and SEM measurements.

7 Remote Control

The following remote control commands are required to configure and perform noise figure measurements in a remote environment. The R&S FPS must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FPS User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data.
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation.
- Using the common status registers (specific status registers for Pulse measurements are not used).

7.1 Overview of Remote Command Suffixes

The remote commands for the LTE Measurement application support the following suffixes.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.

Suffix	Description
<m>	Selects a marker.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

7.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FPS.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

7.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.

Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FPS follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

7.2.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

7.2.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

7.2.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

7.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

7.2.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

7.2.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

7.2.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

7.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 7.2.2, "Long and Short Form", on page 117.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

7.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

7.2.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies 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.

7.3 Remote Commands to Select the LTE Application

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "Spectrum" -> "Spectrum 2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA Master channel is selected.

Example:
`INST:SEL 'Spectrum'`
`INST:CRE:DUPL`
Duplicates the channel named 'Spectrum' and creates a new measurement channel named 'Spectrum 2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 122.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 122).

Example:
`INST:CRE SAN, 'Spectrum 2'`
Adds an additional spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 122.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 122).

Example: `INST:CRE:REPL 'Spectrum2',IQ,'IQAnalyzer'`
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'Spectrum4'`
Deletes the channel with the name 'Spectrum4'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 7-1: Available measurement channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Analog Demodulation (R&S FPS-K7)	ADEM	Analog Demod
GSM (R&S FPS-K10)	GSM	GSM
Noise (R&S FPS-K30)	NOISE	Noise
Phase Noise (R&S FPS-K40)	PNOISE	Phase Noise
VSA (R&S FPS-K70)	DDEM	VSA
3GPP FDD BTS (R&S FPS-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FPS-K73)	MWCD	3G FDD UE
TD-SCDMA BTS (R&S FPS-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FPS-K77)	MTDS	TD-SCDMA UE
cdma2000 BTS (R&S FPS-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FPS-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FPS-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FPS-K85)	MDO	1xEV-DO MS
WLAN (R&S FPS-K91)	WLAN	WLAN
LTE (R&S FPS-K10x)	LTE	LTE
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'Spectrum2','Spectrum3'`
Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

This command selects a new measurement channel with the defined channel type.

Parameters:

<ChannelType> **LTE**
LTE measurement channel (R&S FPS-K10x)

Example: `INST LTE`
Selects the LTE application.

7.4 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format> **SPLit**
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 128).

Parameters:

<Size> **LARGe**
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:LARG`

7.5 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Capture Buffer" on page 16
See "EVM vs Carrier" on page 17
See "EVM vs Symbol" on page 18
See "EVM vs RB" on page 19
See "EVM vs Subframe" on page 19
See "Frequency Error vs Symbol" on page 20
See "Power Spectrum" on page 20
See "Power vs Resource Block PDSCH" on page 21
See "Power vs Resource Block RS" on page 21
See "Channel Flatness" on page 22
See "Channel Group Delay" on page 22
See "Channel Flatness Difference" on page 23
See "Constellation Diagram" on page 23
See "CCDF" on page 24
See "Allocation Summary" on page 24
See "Bit Stream" on page 25
See "Channel Decoder Results" on page 26
See "EVM vs Sym x Carr" on page 27
See "Power vs Symbol x Carrier" on page 28
See "Allocation ID vs Symbol x Carrier" on page 28
See "UE RS Weights (Magnitude)" on page 29
See "Result Summary" on page 29
See "Marker Table" on page 31
See "Time Alignment Error" on page 32

Table 7-2: <WindowType> parameter values for LTE Downlink Measurement application

Parameter value	Window type
AISC	Allocation ID vs Symbol X Carrier
ASUM	Allocation Summary
BSTR	Bitstream
CBUF	Capture Buffer
CCDF	CCDF
CDEC	Channel Decoder Results
FLAT	Channel Flatness
CONS	Constellation Diagram
EVCA	EVM vs Carrier
EVRP	EVM vs RB
EVSC	EVM vs Symbol X Carrier
EVSU	EVM vs Subframe
EVSY	EVM vs Symbol
FEVS	Frequency Error vs Symbol
GDEL	Group Delay

Parameter value	Window type
MTAB	Marker Table
PSPE	Power Spectrum
PVRP	Power vs RB PDSCH
PVRR	Power vs RB RS
PVSC	Power vs Symbol X Carrier
RSUM	Result Summary
TAL	Time Alignment Error
URWM	UE Specific RS Weights Magnitude

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 125 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 124 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

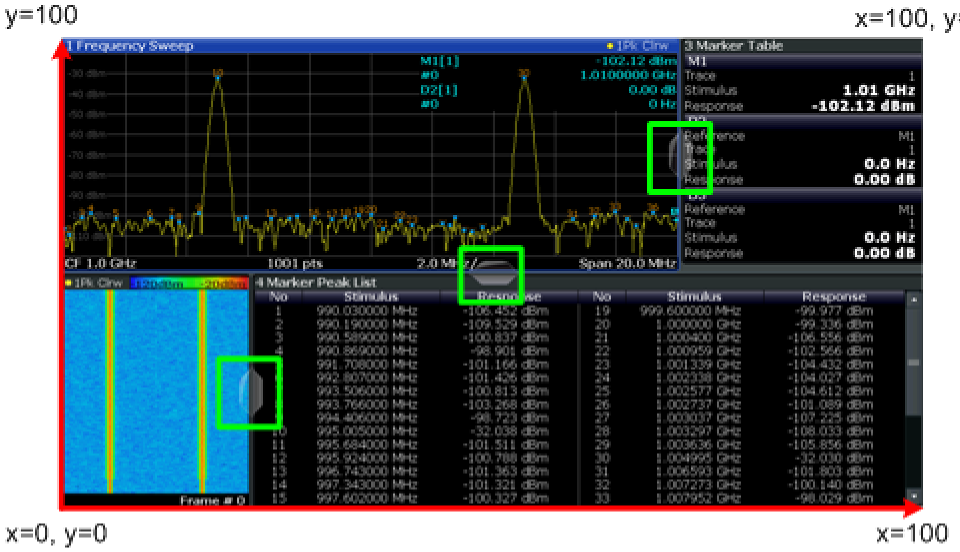


Fig. 7-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 7-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
Range: 0 to 100

Example:
```
LAY:SPL 1,3,50
```
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example:
```
LAY:SPL 1,4,70
```
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to LAYout:ADD[:WINDow]?, for which the existing window is defined by a parameter.

To replace an existing window, use the LAYout:WINDow<n>:REPLace command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See LAYout:ADD[:WINDow]? on page 125 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the LAYout:IDENtify[:WINDow]? command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the LAYout:REMove[:WINDow] command.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 125 for a list of available window types.

7.6 Performing Measurements

7.6.1 Measurements

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FPS User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FPS is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FPS on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONTinuous <State>

This command controls the sweep mode for an individual measurement channel.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FPS User Manual.

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate<n>:SEQuencer:IMMediate` on page 134) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous sweep

OFF | 0
Single sweep

*RST: 0

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep .
`INIT:CONT ON`
Switches the sweep mode to continuous sweep .

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FPS User Manual.

Suffix:

<n>	irrelevant
Usage:	Event

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example:	`OOP:ATIM` Adjusts the On/Off Power timing.
Usage:	Event
Manual operation:	See "On / Off Power" on page 33

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State>	The string contains the following information. • <OFDMSymbolTiming> is the coarse symbol timing • <P-SYNCSynchronization> is the P-SYNC synchronization state • <S-SYNCSynchronization> is the S-SYNC synchronization state A zero represents a failure and a one represents a successful synchronization.
Example:	`SYNC:STAT?` Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.
Usage:	Query only

7.6.2 Measurement Sequences

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 134.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 135.

Suffix:

<n>	irrelevant
Usage:	Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 135).

Suffix:

<n>	irrelevant

Example:	`SYST:SEQ ON`
	Activates the Sequencer.
	`INIT:SEQ:MODE SING`
	Sets single sequence mode so each active measurement will be performed once.
	`INIT:SEQ:IMM`
	Starts the sequential measurements.

Usage:	Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FPS application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 135).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FPS User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FPS User Manual.

Suffix:

<n>	irrelevant

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FPS User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

7.7 Remote Commands to Read Trace Data

7.7.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC2:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe<n>[:DATA]?`).

Selecting a measurement window

Compared to the LTE application on the R&S FSQ or R&S FSV, you have to select the measurement window directly with the suffix <n> at `TRACe`. The range of <n> depends on the number of active measurement windows.

On an R&S FSQ or R&S FSV, the suffix <n> was not supported. On these instruments, you had to select the measurement window with `DISPlay:WINDow<n>:SELect` first.

7.7.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.

7.7.1.2 Allocation ID vs Symbol x Carrier

For the Allocation ID vs Symbol x Carrier, the command returns one value for each resource element.

```
<ID[Symbol(0),Carrier(1)]>, ..., <ID[Symbol(0),Carrier(n)]>,
<ID[Symbol(1),Carrier(1)]>, ..., <ID[Symbol(1),Carrier(n)]>,
```

...

`<ID[Symbol(n),Carrier(1)]>, ..., <ID[Symbol(n),Carrier(n)]>,`

The `<allocation ID>` is encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.

The following parameters are supported.

- TRACE1

7.7.1.3 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

`<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...`

The unit for `<absolute power>` is always dBm. The unit for `<relative power>` is always dB. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.

Note that the data format of the return values is always ASCII.

Example:


Allocation Summary Selection Antenna: 1

Sub-frame	Alloc. ID	Number of RB	Rel. Power/dB	Modulation	Power per RE/dBm	EVM/%
0	RS Ant1		0,000	QPSK	-45,546	0,733
	P-SYNC		-0,007	CAZAC	-42,558	0,254
	S-SYNC		0,005	RBPSK	-42,546	0,251

`TRAC:DATA? TRACE1` would return:

```
0, -5, 0, 0.0000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

7.7.1.4 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

`<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The `<allocation ID>`, `<codeword>` and `<modulation>` are encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.

For symbols or bits that are not transmitted, the command returns

- "FFF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FFE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:

Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	01 01 00 02 03 00 01 02 01 02 01 00 03 00 02 02
0	PBCH	1/1	QPSK	16	02 03 02 03 03 03 00 02 00 03 00 02 02 03 01 01
0	PBCH	1/1	QPSK	32	03 02 03 03 03 03 01 03 00 03 00 03 03 00 03 02

`TRAC:DATA? TRACE1` would return:

```
0, -12, 0, 2, 0, 01, 01, 00, 02, 03, 00, 01, 02, 01, 02, 01, ...
<continues like this until the next data block starts or the end of data is reached>
0, -12, 0, 2, 32, 03, 02, 03, 03, 03, 03, 01, 03, 00, 03, ...
```

7.7.1.5 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

7.7.1.6 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

7.7.1.7 Channel Decoder Results

For the Channel Decoder Results, the number and type of return values depend on the parameter.

- PBCH
  Returns the results for the PBCH if PBCH decoding (or CRC check) was successful. The results are made up out of six values.
  `<subframe>, <# of antennas>, <system bandwidth>, <frame>, <PHICH duration>, <PHICH resource>`
  The unit for `<system bandwidth>` is Hz. All other values have no unit.
  The `<PHICH duration>` and `<PHICH resource>` are encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.
  If PBCH decoding was not successful, the command returns NAN.
- PCFICH
  Returns the results for the PCFICH. The results are made up out of two parameters.
  `<subframe>, <number of symbols for PDCCH>`
  The values have no unit.
- PHICH
  Returns the results for the PHICH. The results are made up out of three values for each line of the table.
  `<subframe>, <ACK/NACK>, <relative power>`
  The unit for `<relative power>` is dB. All other values have no unit.
  The `<ACK/NACK>` is encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.
- PDCCH
  Returns the results for the PDCCH. The results are made up out of seven values for each line of the table.
  `<subframe>, <RNTI>, <DCI format>, <PDCCH format>, <CCE offset>, <# of transmitted bits>, [stream of binary numbers]`
  The values have no unit.
  The `[stream of binary numbers]` is a list of binary numbers separated by comma.
  The `<DCI format>` and `<PDCCH format>` are encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.
- PDSCH
  Returns the results for the PDSCH. The results are made up out of five values for each line of the table.
  `<subframe>, <allocationID>, <codeword>, <# of transmitted bits>, [stream of binary numbers]`
  The values have no unit.
  The `[stream of binary numbers]` is a list of binary numbers separated by comma.
  If the PDSCH could not be decoded, the NAN is returned instead of the `<# of transmitted bits>`. The `[stream of binary numbers]` is not shown.
  The `<allocationID>` and `<codeword>` are encoded. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.

7.7.1.8 Channel and Spectrum Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

`<relative power>, ...`

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.9 Channel and Spectrum Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

`<relative power>, ...`

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.10 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

`<group delay>, ...`

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

7.7.1.11 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Sym0][Carrier1]>, <Q[SF0][Sym0][Carrier1]>, ..., <I[SF0][Sym0][Carrier(n)]>, <Q[SF0][Sym0][Carrier(n)]>,

<I[SF0][Sym1][Carrier1]>, <Q[SF0][Sym1][Carrier1]>, ..., <I[SF0][Sym1][Carrier(n)]>, <Q[SF0][Sym1][Carrier(n)]>,

<I[SF0][Sym(n)][Carrier1]>, <Q[SF0][Sym(n)][Carrier1]>, ..., <I[SF0][Sym(n)][Carrier(n)]>, <Q[SF0][Sym(n)][Carrier(n)]>,

<I[SF1][Sym0][Carrier1]>, <Q[SF1][Sym0][Carrier1]>, ..., <I[SF1][Sym0][Carrier(n)]>, <Q[SF1][Sym0][Carrier(n)]>,

<I[SF1][Sym1][Carrier1]>, <Q[SF1][Sym1][Carrier1]>, ..., <I[SF1][Sym1][Carrier(n)]>, <Q[SF1][Sym1][Carrier(n)]>,

<I[SF(n)][Sym(n)][Carrier1]>, <Q[SF(n)][Sym(n)][Carrier1]>, ..., <I[SF(n)][Sym(n)][Carrier(n)]>, <Q[SF(n)][Sym(n)][Carrier(n)]>

With SF = subframe and Sym = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

7.7.1.12 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.13 EVM vs RB

For the EVM vs RB result display, the command returns one value for each resource block that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average power for each resource block over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.14 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

7.7.1.15 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<EVM>, ...`

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

7.7.1.16 EVM vs Symbol x Carrier

For the EVM vs Symbol x Carrier, the command returns one value for each resource element.

`<EVM[Symbol(0),Carrier(1)]>, ..., <EVM[Symbol(0),Carrier(n)]>,`

`<EVM[Symbol(1),Carrier(1)]>, ..., <EVM[Symbol(1),Carrier(n)]>,`

`...`

`<EVM[Symbol(n),Carrier(1)]>, ..., <EVM[Symbol(n),Carrier(n)]>,`

The unit depends on `UNIT:EVM`.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

7.7.1.17 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<frequency error>,...`

The unit is always Hz.

The following parameters are supported.

- TRACE1

7.7.1.18 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
  Returns the power for the Off power regions.
  `<absolute power>,...`
  The unit is always dBm.
- TRACE2
  Returns the power for the transient regions.
  `<absolute power>,...`
  The unit is always dBm.
- LIST
  Returns the contents of the On/Off Power table. For each line, it returns seven values.
  `<off period start limit>, <off period stop limit>, <time at delta to limit>, <absolute off power>, <distance to limit>, <falling transient period>, <rising transient period>,...`
  The unit for the `<absolute off power>` is dBm. The unit for the `<distance to limit>` is dB. All other values have the unit s.

7.7.1.19 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

7.7.1.20 Power vs RB RS

For the Power vs RB RS result display, the command returns one value for each resource block of the reference signal that has been analyzed.

`<absolute power>,...`

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.21 Power vs RB PDSCH

For the Power vs RB PDSCH result display, the command returns one value for each resource block of the PDSCH that has been analyzed.

`<absolute power>,...`

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.22 Power vs Symbol x Carrier

For the Power vs Symbol x Carrier, the command returns one value for each resource element.

`<P[Symbol(0),Carrier(1)]>, ..., <P[Symbol(0),Carrier(n)]>,`

`<P[Symbol(1),Carrier(1)]>, ..., <P[Symbol(1),Carrier(n)]>,`

`...`

`<P[Symbol(n),Carrier(1)]>, ..., <P[Symbol(n),Carrier(n)]>,`

with P = Power of a resource element.

The unit is always dBm.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

7.7.1.23 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns 11 values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, <reserved>, <reserved>...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

7.7.1.24 UE RS Weights Magnitude (Difference)

For the UE RS Weights Magnitude result display, the command returns one value for each subcarrier that has been analyzed.

`<Magnitude>, ...`

The unit dB.

The following parameters are supported.

- TRACE1
  Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.25 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- **1** = ACK
- **0** = NACK
- **-1** = DTX

<allocation ID>

Represents the allocation ID. The range is as follows.

- **0 - 65535** = PDSCH
- **-1** = Invalid / not used
- **-2** = All
- **-3** = P-SYNC
- **-4** = S-SYNC
- **-5** = Reference Signal (Antenna 1)
- **-6** = Reference Signal (Antenna 2)
- **-7** = Reference Signal (Antenna 3)
- **-8** = Reference Signal (Antenna 4)
- **-9** = PCFICH
- **-10** = PHICH
- **-11** = PDCCH
- **-12** = PBCH
- **-14** = Positioning Reference Signal
- **-15** = CSI Reference Signal (Port 15 and 16)
- **-16** = CSI Reference Signal (Port 17 and 18)
- **-17** = CSI Reference Signal (Port 19 and 20)
- **-18** = CSI Reference Signal (Port 21 and 22)
- **-19** = EPDCCH
- **-20** = EPDCCH DMRS1
- **-21** = EPDCCH DMRS2
- **-22** = PMCH Reference Signal
- **-1xxxxx** = UE Reference Signal (Port 5)
- **-2xxxxx** = UE Reference Signal 1 (Port 7, 8, 11, 12)
- **-3xxxxx** = UE Reference Signal 2 (Port 9, 10, 13, 14, signals with more than 2 layers)
  Note. **xxxxx** is a placeholder for the ID of the PDSCH.
  If the PDSCH has, for example, the ID 22, the return value would be -100022, -200022 or -300022 (depending on the configuration)

<channel type>

- **0** = TX channel
- **1** = adjacent channel

- **2** = alternate channel

<codeword>

Represents the codeword of an allocation. The range is {0...6}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2
- **3** = 1/4
- **4** = 2/4
- **5** = 3/4
- **6** = 4/4

<DCI format>

Represents the DCI format. The value is a number in the range {0...103}.

- **0** = DCI format 0
- **10** = DCI format 1
- **11** = DCI format 1A
- **12** = DCI format 1B
- **13** = DCI format 1C
- **14** = DCI format 1D
- **20** = DCI format 2
- **21** = DCI format 2A
- **22** = DCI format 2B
- **23** = DCI format 2C
- **24** = DCI format 2D
- **30** = DCI format 3
- **31** = DCI format A
- **103** = DCI format 0/3/3A

<modulation>

Represents the modulation scheme. The range is {0...14}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

- **14** = 256QAM

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- **1** = normal
- **2** = extended

<PHICH resource>

Represents the parameter N_g. The range is {1...4}.

- **1** = N_g 1/6
- **2** = N_g 1/2
- **3** = N_g 1
- **4** = N_g 2

TRACe<n>[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 7.7.1, "Using the TRACe[:DATA] Command", on page 136.

Query parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Example: `TRAC2? TRACE1`
Queries results of the second measurement window. The type of data that is returned by the parameter (`TRACE1`) depends on the result display shown in measurement window 2.

Usage: Query only

7.7.2 Remote Commands to Read Measurement Results

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]? <ResultType>

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m> 1

Query parameters:

<ResultType>

CPOW
This parameter queries the channel power of the reference range.

MCAC
Queries the channel powers of the ACLR, MC ACLR and Cumulative ACLR measurements as shown in the ACLR table.
Where available, this parameter also queries the power of the adjacent channels (for example in the ACLR measurement).

GACLr
Queries the ACLR values for each gap channel in the MC ACLR measurement.

Return values:

<Result>

Results for the Spectrum Emission Mask measurement:
Power level in dBm.

Results for the ACLR measurements:
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
- <TXChannelPower> is the power of the transmission channel in dBm
- <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
- <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
- <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
- <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB

(...)
- <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
- <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example:

```
CALC1:MARK:FUNC:POW:RES? MCAC
```

Returns the current ACLR measurement results.

Usage: Query only

Manual operation: See "ACLR" on page 36
See "Cumulative ACLR" on page 38

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: `FORM REAL`

The software will send binary data in Real32 data format.

7.8 Remote Commands to Read Numeric Results

7.8.1 Frame Results

FETCh[:CC<cci>]:SUMMary:EVM:DSQP:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSQP:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Suffix:

<cci> 1..2

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSQP?`
Returns the PDSCH QSPK EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:EVM:DSST:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSST:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Suffix:
<cci> 1..2

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSST?`
Returns the PDSCH 16QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:EVM:DSSF:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSSF:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Suffix:
<cci> 1..2

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSSF?`
Returns the PDSCH 64QAM EVM.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 29

7.8.2 Result for Selection

FETCh[:CC<cci>]:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Suffix:

<cci> 1..2

Return values:

<CrestFactor> <numeric value>

Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:EVM[:ALL]:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM[:ALL]:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Suffix:
<cci> 1..2

Return values:
<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:EVM:PCHannel:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:PCHannel:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Suffix:
<cci> 1..2

Return values:
<EVM>

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Suffix:
<cci> 1..2

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:FERRor:MAXimum?
FETCh[:CC<cci>]:SUMMary:FERRor:MINimum?
FETCh[:CC<cci>]:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Suffix:

<cci> 1..2

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:GIMBalance:MAXimum?
FETCh[:CC<cci>]:SUMMary:GIMBalance:MINimum?
FETCh[:CC<cci>]:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Suffix:

<cci> 1..2

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:IQOFfset:MAXimum?
FETCh[:CC<cci>]:SUMMary:IQOFfset:MINimum?
FETCh[:CC<cci>]:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Suffix:
<cci> 1..2

Return values:
<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:OSTP:MAXimum?
FETCh[:CC<cci>]:SUMMary:OSTP:MINimum?
FETCh[:CC<cci>]:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Suffix:
<cci> 1..2

Return values:
<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:OSTP?`
Returns the current average OSTP value.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:POWer:MAXimum?
FETCh[:CC<cci>]:SUMMary:POWer:MINimum?
FETCh[:CC<cci>]:SUMMary:POWer[:AVERage]?

This command queries the total power.

Suffix:
<cci> 1..2

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`

Returns the total power in dBm

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:QUADerror:MAXimum?
FETCh[:CC<cci>]:SUMMary:QUADerror:MINimum?
FETCh[:CC<cci>]:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Suffix:

<cci> 1..2

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`

Returns the current mean quadrature error in degrees.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:RSSI:MAXimum?
FETCh[:CC<cci>]:SUMMary:RSSI:MINimum?
FETCh[:CC<cci>]:SUMMary:RSSI[:AVERage]?

This command queries the RSSI as shown in the result summary.

Suffix:

<cci> 1..2

Return values:

<RSSI> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:RSSI?`

Queries the average RSSI.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:RSTP:MAXimum?
FETCh[:CC<cci>]:SUMMary:RSTP:MINimum?
FETCh[:CC<cci>]:SUMMary:RSTP[:AVERage]?

This command queries the RSTP as shown in the result summary.

Suffix:
<cci> 1..2

Return values:
<RSTP> RSTP in dBm.

Example: `FETC:SUMM:RSTP?`
Queries the RSTP.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh[:CC<cci>]:SUMMary:SERRor:MAXimum?
FETCh[:CC<cci>]:SUMMary:SERRor:MINimum?
FETCh[:CC<cci>]:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Suffix:
<cci> 1..2

Return values:
<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`
Returns the current mean sampling error in ppm.

Usage: Query only

Manual operation: See "Result Summary" on page 29

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Return values:
<Offset> Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the (sub)frame start offset.

Usage: Query only

Manual operation: See "Capture Buffer" on page 16

7.8.3 Time Alignment Error

FETCh:FERRor[:CC<cci>][:AVERage]?

This command queries the Carrier Frequency Error.

Return values:

<FrequencyError> Average, minimum or maxmum frequency error, depending on the command syntax.
Default unit: Hz

Example: `FETC:FERR?`
Queries the average frequency error.

Usage: Query only

FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MAXimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MINimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]?

This command queries the time alignment error.

Return values:

<Time Alignment Error> Minimum, maximum or average time alignment error, depending on the last command syntax element.
Default unit: s

Example: `FETC:TAER:ANT2?`
Returns the average time alignment error between the reference antenna and antenna 2 in s.

Usage: Query only

Manual operation: See "Time Alignment Error" on page 32

7.8.4 Marker Table

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 132.

The unit depends on the application of the command.

Return values:
<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 31

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 132.

Return values:

<Result> Result at the marker position.

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 31

7.9 Remote Commands to Read Limit Check Results

7.9.1 Checking Limits for Graphical Result Displays

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower adjacent channel.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:ACP:ACH:RES? ALL`
Queries the results of the adjacent channel limit check.

Usage: Query only

Manual operation: See "Cumulative ACLR" on page 38

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower alternate channel.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:ACP:ALT:RES? ALL`
Queries the results of the alternate channel limit check.

Usage: Query only

Manual operation: See "Cumulative ACLR" on page 38

CALCulate<n>:LIMit<k>:OOPower:OFFPower?

This command queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Return values:

<OOPResults> Returns one value for every "Off" period.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:OOP:OFFP?`
Queries the results for the limit check during the signal Off periods.

Usage: Query only

Manual operation: See "On / Off Power" on page 33

CALCulate<n>:LIMit<k>:OOPower:TRANsient? <Result>

This command queries the results of the limit check during the transient periods of the On/Off power measurement.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

FALLing
Queries the limit check results of falling transients.

RISing
Queries the limit check results of rising transients.

Return values:

<OOPResults> Returns one value for every "Off" period.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:OOP:TRAN? RIS`
Queries the limit check of rising transients.

Usage: Query only

Manual operation: See "On / Off Power" on page 33

7.9.2 Checking Limits for Numerical Result Display

CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL][:AVERage]:RESult?

This command queries the results of the EVM limit check of all resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements with a QPSK modulation.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:DSQP:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements with a 64QAM modulation.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:DSSF:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements with a 16QAM modulation.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:DSST:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical channel resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:PCH:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical signal resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:PSIG:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERage]:RESult?

This command queries the result of the frequency error limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERage]:RESult?

This command queries the result of the gain imbalance limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:GIMB:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:IQOFfset:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:IQOFfset[:AVERage]:RESult?

This command queries the result of the I/Q offset limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:IQOF:MAX:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERage]:RESult?

This command queries the result of the quadrature error limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:QUAD:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERage]:RESult?

This command queries the results of the sampling error limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
Queries the limit check.

Usage: Query only

7.10 Remote Commands to Configure the Application

7.10.1 General Configuration

The following remote control command control general configration of the application.

The remote control commands to select the result displays for I/Q measurements are described in chapter 7.5, "Working with Windows in the Display", on page 125.

CONFigure[:LTE]:MEASurement <Measurement>

This command selects the measurement.

Parameters:

<Measurement>

ACLR
Selects the Adjacent Channel Leakage Ratio measurement.

CACLr
Selects the Cumulative ACLR measurement.

ESPectrum
Selects the Spectrum Emission Mask measurement.

EVM
Selects I/Q measurements with the "EVM" display configuration.

MCACIr
Selects Multi-Carrier ACLR measurement.

MCESpectrum
Selects Multi-Carrier SEM measurement.

TAERor
Selects the Time Alignment Error measurement.

TPOO
Selects the Transmit On/Off Power measurement.

Example:

```
CONF:MEAS ACLR
```

Selects the ACLR measurement.

Manual operation:
See "On / Off Power" on page 33
See "ACLR" on page 36
See "Cumulative ACLR" on page 38
See "Spectrum Mask" on page 39

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Setting parameters:

<Path> String containing the path and name of the source file.

Example:

```
MMEM:LOAD:IQ:STAT 'C:
\R_S\Instr\user\data.iq.tar'
```

Loads I/Q data from the specified file.

Usage: Setting only

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 58

7.10.2 Configuring I/Q Measurements

7.10.2.1 Signal Description

Signal Characteristics

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example:
`CONF:DUPL TDD`
Activates time division duplex.

Manual operation: See "Selecting the LTE Mode" on page 59

CONFigure[:LTE]:DL[:CC<cci>]:BW <Bandwidth>

This command selects the channel bandwidth.

Parameters:

<Bandwidth>
BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW10_00

Example:
Single carrier measurement:
`CONF:DL:BW BW1_40`
Defines a channel bandwidth of 1.4 MHz.

Example:
Aggregated carrier measurement:
`CONF:NOCC 2`
`CONF:DL:CC1:BW BW10_00`
`CONF:DL:CC2:BW BW5_00`
Selects two carriers, one with a bandwidth of 5 MHz, the other with 10 MHz.

Manual operation: See "Channel Bandwidth / Number of Resource Blocks" on page 61
See "Remote commands to configure carrier aggregation" on page 104

CONFigure[:LTE]:DL[:CC<cci>]:CYCPrefix <PrefixLength>

This command selects the cyclic prefix.

Parameters:

<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: Single carrier measurements:
`CONF:DL:CYCP EXT`
Selects an extended cyclic prefix.

Example: Aggregated carrier measurements:
`CONF:DL:CC1:CYCP EXT`
Selects an extended cyclic prefix for the first carrier.

Manual operation: See "Cyclic Prefix" on page 61

CONFigure[:LTE]:DL[:CC<cci>]:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>

AUTO
Automatically defines the cell ID.

<numeric value>
Number of the cell ID.

Range: 0 to 503

Example:
```
CONF:NOCC 2
CONF:DL:CC1:PLC:CID 12
CONF:DL:CC2:PLC:CID 15
```
Selects 2 carriers and defines a cell ID for each one.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 62

CONFigure[:LTE]:DL[:CC<cci>]:PLC:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber>

AUTO
Automatic selection

0...167
Manual selection

*RST: AUTO

Example: `CONF:DL:PLC:CIDG 134`
Cell identity group number 134 is selected
`CONF:DL:PLC:CIDG AUTO`
Automatic cell identity group detection is selected

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 62

CONFigure[:LTE]:DL[:CC<cci>]:PLC:PLID <Identity>

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity> **AUTO**
Automatic selection

0...2
Manual selection

*RST: AUTO

Example: `CONF:DL:PLC:PLID 1`
Selects physical layer cell ID 2.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 62

CONFigure[:LTE]:DL[:CC<cci>]:TDD:SPSC <Configuration>

This command selects the special TDD subframe configuration.

Parameters:

<Configuration> <numeric value>

Numeric value that defines the subframe configuration.
Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8
*RST: 0

Example: Single carrier measurements:
`CONF:DL:CYCP NORM`
`CONF:DL:TDD:SPSC 7`
Selects subframe configuration 7, available only with a normal cyclic prefix.

Example: Carrier aggregation measurements:
`CONF:DL:CC1:TDD:SPSC 2`
Selects special subframe configuration 2 for the first carrier.

Manual operation: See "Configuring TDD Frames" on page 62

CONFigure[:LTE]:DL[:CC<cci>]:TDD:UDConf <Configuration>

This command selects the subframe configuration for TDD signals.

Parameters:

<Configuration> Range: 0 to 6
*RST: 0

Example: Single carrier measurements:
`CONF:DL:TDD:UDC 4`
Selects allocation configuration number 4.

Example: Carrier aggregation measurements:
`CONF:DL:CC1:TDD:UDC 4`
Selects allocation configuration number 4 for the first carrier.

Manual operation: See "Configuring TDD Frames" on page 62

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

Manual operation: See "Selecting the LTE Mode" on page 59

FETCh[:CC<cci>]:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.
Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 62

FETCh[:CC<cci>]:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity> The command returns -1 if no valid result has been detected yet.
Range: 0 to 2

Example: `FETC:PLC:PLID?`
Returns the current cell identity.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 62

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:

<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>

'E-TM1_1__20MHz'
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__20MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__20MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__20MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__20MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__20MHz'
EUTRA Test Model 3.3 (E-TM3.3)
To select a test model for a different bandwidth, replace "20MHz" with either "1_4MHz", "3MHz", "5MHz", "10MHz" or "15MHz".

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

Manual operation: See "Using Test Models" on page 60

MIMO Setup

CONFigure:LTE:ANTMatrix:ADDRess<instrument> <Address>

This command defines the network address of an analyzer in the test setup.

Parameters:

<Address> String containing the address of the analyzer.
Connections are possible via TCP/IP.

Example: `CONF:LTE:ANTM:ADDR2 '192.0.2.0'`
Assign the IP address to the second analyzer in the setup.

Manual operation: See "Connecting multiple analyzers" on page 65

CONFigure:LTE:ANTMatrix:STATe<instrument> <State>

This command includes or excludes an analyzer from a MIMO setup.

Parameters:

<State> ON | OFF

Example: `CONF:LTE:ANTM:STAT2 ON`
Includes the second analyzer in the test setup.

Manual operation: See "Connecting multiple analyzers" on page 65

CONFigure:LTE:ANTMatrix:LEDState<instrument>?

This command queries the state of one of the instruments in a MIMO setup.

Return values:

<Color>

GREEN
Connection to the instrument has been successfully established.

GREY
Instrument connection has been turned off with `CONFigure:LTE:ANTMatrix:STATe<instrument>`.

RED
Connection to the instrument could not be established.

Example: `CONF:LTE:ANTM:LEDS2?`
Queries the state of the second analyzer in the test setup.

Usage: Query only

Manual operation: See "Connecting multiple analyzers" on page 65

CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

In case of Time Alignment measurements, the command selects the reference antenna.

Parameters:

<Antenna>

ANT1 | ANT2 | ANT3 | ANT4
Select a single antenna to be analyzed

ALL
Select all antennas to be analyzed

AUT1 | AUT2 | AUT4
Automatically selects the antenna(s) to be analyzed.
AUT1 tests a single antenna, AUT2 tests two antennas, AUT4 tests four antennas.
Available if the number of input channels is taken "From Antenna Selection".

AUTO
Automatically selects the antenna(s) to be analyzed.

*RST: ANT1

Manual operation: See "Time Alignment Error" on page 32
See "MIMO Configuration" on page 64

CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas>

TX1
Use one Tx-antenna

TX2
Use two Tx-antennas

TX4
Use four Tx-antennas

*RST: TX1

Example:

```
CONF:DL:MIMO:CONF TX2
```

TX configuration with two antennas is selected.

Manual operation: See "MIMO Configuration" on page 64

PDSCH Settings

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

<Format>

OFF
Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH
Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET
Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example:
`DL:FORM:PSCD OFF`
Applies the user configuration and does not check the received signal

Manual operation: See "PDSCH Subframe Configuration Detection" on page 66

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example:
`DL:DEM:AUTO ON`
Activates the auto-demodulation for DL.

Manual operation: See "Auto PDSCH Demodulation" on page 66

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes> Range: 0 to 39
*RST: 1

Example: `CONF:DL:CSUB 5`
Sets the number of configurable subframes to 5.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>
*RST: 1

Example: `CONF:DL:SUBF2:ALC 5`
Defines 5 allocations for subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:GAP <VRBGap>

This command turns the VRB Gap on and off.

Parameters:

<VRBGap> **0**
Selects localized VRBs

1
Selects distributed VRBs and applies the first gap

2
Selects distributed VRBs and applies the second gap (for channel bandwidths > 50 resource blocks)

*RST: 0

Example:
`CONF:DL:SUBF2:ALL5:GAP 0`
Selects localized VRBs for allocation 5 in subframe 2.

Manual operation: See "VRB Gap" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SUBF2:ALL5:POW -1.3`
Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

Manual operation: See "Power" on page 70

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP <Port>

This command selects the antenna port for the beamforming scheme.

The command is available for measurements on a single antenna.

Parameters:
<Port> 5 | 7 | 8

Example: `CONF:DL:SUBF2:ALL3:PREC:AP 5`
Selects antenna port 5 for beamforming in allocation 3 in subframe 2.

Manual operation: See "Beamforming (UE Spec RS)" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CBINdex <CBIndex>

This command selects the codebook index for an allocation with spatial multiplexing precoding scheme.

Parameters:
<CBIndex> 0...15
*RST: 1

Example: `CONF:DL:SUBF2:ALL4:PREC:CBIN 3`
Selects codebook index 3 for allocation 4 in subframe number 2.

Manual operation: See "Spatial Multiplexing" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CDD <State>

This command turns the cyclic delay diversity of an allocation with spatial multiplexing precoding scheme on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:DL:SUBF2:ALL3:PREC:CDD ON`
Turns the cylic delay diversity for allocation 3 in subframe 2 on.

Manual operation: See "Spatial Multiplexing" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CLMapping <Mapping>

This command selects the codeword to layer mapping.

Parameters:

<Mapping> LC11 | LC21 | LC31 | LC41 | LC22 | LC32 | LC42 | LC52 | LC62 | LC72 | LC82

Example: `CONF:DL:SUBF2:ALL3:PREC:CLM LC11`
Assigns codeword-to-layer mapping 1/1 to allocation 3 in subframe 2.

Manual operation: See "Spatial Multiplexing" on page 72
See "Beamforming (UE Spec RS)" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:SCID <ID>

This command selects the scrambling identity (nSCID).

The command is available for antenna ports 7 and 8.

Parameters:

<ID> 0 | 1

Example: `CONF:DL:SUBF2:ALL4:PREC:SCID 1`
Selects scrambling identity 1 for allocation 4 in subframe 2.

Manual operation: See "Beamforming (UE Spec RS)" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme] <Scheme>

This command selects the precoding scheme of an allocation.

Parameters:

<Scheme>

NONE
Do not use a precoding scheme.

BF
Use beamforming scheme.

SPM
Use spatial multiplexing scheme.

TXD
Use transmit diversity scheme.

*RST: NONE

Example: `CONF:DL:SUBF2:ALL3:PREC:SCH SPM`
Selects the spatial multiplexing precoding scheme for allocation 3 in subframe 2.

Manual operation: See "None" on page 71
See "Transmit Diversity" on page 71
See "Spatial Multiplexing" on page 72
See "Beamforming (UE Spec RS)" on page 72

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PSOFfset <PSOFfset>

This command defines the PDSCH start offset for a particular PDSCH allocation.

Parameters:

<PSOFfset> **<numeric value>**
Number between 0 and 4.

COMM
Common PDSCH start offset.

Example: `CONF:DL:SUBF2:ALL2:PSOF 0`
Defines a PDSCH start offset of 0 for the 2nd allocation in the 2nd subframe.

Manual operation: See "Carrier Aggregation" on page 73

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount <ResourceBlocks>

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:

<ResourceBlocks> <numeric value>
*RST: 6

Example: `CONF:DL:SUBF2:ALL5:RBC 25`
Defines 25 resource block for allocation 5 in subframe 2.

Manual operation: See "Number of RB" on page 70

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset <Offset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<Offset> <numeric value>
*RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`
Defines a resource block offset of 3 for allocation 5 in subframe 2.

Manual operation: See "Offset RB" on page 70

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID <ID>

This command defines the ID or N_RNTI.

Parameters:

<ID> ID of the user equipment.

Example: `CONF:DL:SUBF2:ALL5:UEID 5`
Assigns the ID 5 to allocation 5 in subframe 2.

Manual operation: See "ID/N_RNTI" on page 68

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation <Modulation>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum> 1..n
Selects the codeword.

Parameters:

<Modulation>

QPSK
QPSK modulation

QAM16
16QAM modulation

QAM64
64QAM modulation

*RST: QPSK

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

Manual operation: See "Modulation" on page 69

Synchronization Signal

CONFigure[:LTE]:DL[:CC<cci>]:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE
*RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
All antennas are used to transmit the P-SYNC and S-SYNC.

Manual operation: See "P-/S-SYNC Tx Antenna" on page 73

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:SYNC:PPOW 0.5`

Sets a relative power of 0.5 dB.

Manual operation: See "P-SYNC Relative Power" on page 74

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:SYNC:SPOW 0.5`

Sets a relative power of 0.5 dB.

Manual operation: See "S-SYNC Relative Power" on page 74

Reference Signal

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:REFS:POW -1.2`

Sets a relative power of -1.2 dB.

Manual operation: See "Rel Power (Reference Signal)" on page 74

Positioning Reference Signal

CONFigure[:LTE]:DL:PRSS:BW <Bandwidth>

This command defines the bandwidth of the positioning reference signal.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW1_40

Default unit: MHz

Example: `CONF:DL:PRSS:BW BW5_00`

Defines a 5 MHz bandwidth for the positiong reference signal.

Manual operation: See "Bandwidth" on page 75

CONFigure[:LTE]:DL:PRSS:CI <PRSConfiguration>

This command selects the configuration index of the Positioning Reference Signal.

Parameters:

<PRSConfiguration> Number of the configuration index.

Example: `CONF:DL:PRSS:CI 2`

Selects configuration index 2 for the positioning reference signal.

Manual operation: See "Configuration Index" on page 75

CONFigure[:LTE]:DL:PRSS:NPRS <NofDLSubframes>

This command defines the number of subframes the Positioning Reference Signal occupies.

Parameters:

<NofDLSubframes> 1 | 2 | 4 | 6

Example: `CONF:DL:PRSS:NPRS 1`

Defines 1 subframe for the poitioning reference signal.

Manual operation: See "Num. Subframes (N_PRS)" on page 76

CONFigure[:LTE]:DL:PRSS:POWer <Power>

This command defines the relative power of the Positioning Reference Signal.

Parameters:

<Power> Default unit: dB

Example: `CONF:DL:PRSS:POW 1`

Defines a relative power of 1 dB for the positioning reference signal.

Manual operation: See "Relative Power (Positioning Reference Signal)" on page 76

CONFigure[:LTE]:DL:PRSS:STATe <State>

This command turns the positioning reference signal on and off.

Parameters:
<State> ON | OFF

Example: `CONF:DL:PRSS:STAT ON`
Turns the positioning reference signal on.

Manual operation: See "Present" on page 75

CONFigure[:LTE]:DL:SFNO <Offset>

This command defines the frame number offset for the positioning reference signal.

Parameters:
<Offset> <numeric value>

Example: `CONF:DL:SFNO 4`
Defines a frame number offset of 4.

Manual operation: See "Frame Number Offset" on page 76

CSI Reference Signal

CONFigure[:LTE]:DL:CSIRs:CI <Index>

This command selects the configuration index for the CSI reference signal.

Parameters:
<Index> MNEM
Number of the configuration index.
Range: 0 to 31

Example: `CONF:DL:CSIR:CI 12`
Selects configuration index 12 for the CSI reference signal.

Manual operation: See "Configuration Index" on page 77

CONFigure[:LTE]:DL:CSIRs:NAP <Ports>

This command selects the number of antenna ports that transmit the CSI reference signal.

Parameters:

<Ports> **TX1**

TX2

TX4

TX8

Example: `CONF:DL:CSIR:NAP TX2`
Selects 2 antenna ports for the CSI reference signal transmission.

Manual operation: See "Antenna Ports" on page 77

CONFigure[:LTE]:DL:CSIRs:OPDSch <State>

This command turns overwriting of PDSCH resource elements for UEs that do not consider the CSI reference signal on and off.

Parameters:

<State> **ON**
The CSI reference signal overwrite PDSCH resource elements.

OFF
PDSCH resource elements remain.

Example: `CONF:DL:CSIR:OPDS ON`
Overwrites PDSCH resource elements if necessary.

Manual operation: See "Overwrite PDSCH" on page 78

CONFigure[:LTE]:DL:CSIRs:POWer <Power>

This command defines the relative power of the CSI reference signal.

Parameters:

<Power> Default unit: dB

Example: `CONF:DL:CSIR:POW 1`
Defines a relative power of 1 dB for the CSI reference signal.

Manual operation: See "Relative Power (CSI Reference Signal)" on page 78

CONFigure[:LTE]:DL:CSIRs:SCI <Configuration>

This command defines the subframe configuration for the CSI reference signal.

Parameters:

<Configuration> Number that selects the subframe configuration.

Range: 0 to 154

Example: `CONF:DL:CSIR:SCI 4`
Selects subframe configuration 4 for the CSI reference signal.

Manual operation: See "Subframe Configuration" on page 78

CONFigure[:LTE]:DL:CSIRs:STATe <State>

This command turns the CSI reference signal on and off.

Parameters:
<State> ON | OFF

Example: `CONF:DL:CSIR:STAT ON`
Turns the CSI reference signal on.

Manual operation: See "Present" on page 77

Control Channel

CONFigure[:LTE]:DL:EPDCch:LOCalized <State>

This command turns localized transmission of the EPDCCH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:EPDC:LOC OFF`
Turns on distributed transmission of the EPDCCH.

Manual operation: See "EPDCCH Localized" on page 86

CONFigure[:LTE]:DL:EPDCch:NPRB <NofPRBPairs>

This command selects the number of resource blocks that the EPDCCH-PRB set uses.

Parameters:

<NofPRBPairs> MNEM | ASEL

Manual operation: See "EPDCCH PRB Pairs" on page 85

CONFigure[:LTE]:DL:EPDCch:POWer <Power>

This command defines the relative power of the EPDCCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example:
```
CONF:DL:EPDC:POW -0.5
```
Sets the relative power to -0.5 dB.

Manual operation: See "EPDCCH Rel Power" on page 86

CONFigure[:LTE]:DL:EPDCch:RBASsign <RBAssignment>

This command defines the resource blocks that the EPDCCH uses.

Parameters:

<RBAssignment>

Example:
```
CONF:DL:EPDC:RBAS 2
```

Manual operation: See "EPDCCH RB Assignment" on page 86

CONFigure[:LTE]:DL:EPDCch:SID <SetID>

This command defines the EPDCCH set ID used to generate EPDCCH reference symbols.

Parameters:

<SetID> Range: 0 to 503
*RST: 0

Example:
```
CONF:DL:EPDC:SID 10
```
Selects set ID 10.

Manual operation: See "EPDCCH Set ID" on page 85

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PBCH:POW -1.1`
Sets the relative power to -1.1 dB.

Manual operation: See "PBCH Relative Power" on page 80

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:PBCH:STAT ON`
Activates the PBCH.

Manual operation: See "PBCH Present" on page 80

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PCF:POW 0`
Sets the relative power to 0 dB.

Manual operation: See "PCFICH Relative Power" on page 81

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:PCF:STAT ON`
Activates the PCFICH.

Manual operation: See "PCFICH Present" on page 81

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:

<Format> -1 | 0 | 1 | 2 | 3

*RST: -1

Example: `CONF:DL:PDCCH:FORM 0`

Sets the PDDCH format to 0.

Manual operation: See "PDCCH Format" on page 84

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH> <numeric value>

*RST: 0

Example: `CONF:DL:PDCCH:NOPD 3`

Sets the number of DPCCHs to 3.

Manual operation: See "Number of PDCCHs" on page 84

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`

Sets the relative power to -1.2 dB.

Manual operation: See "PDCCH Rel Power" on page 84

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration>

NORM
Normal

EXT
Extended

*RST: NORM

Example: `CONF:DL:PHIC:DUR NORM`

Selects normal PHICH duration.

Manual operation: See "PHICH Duration" on page 82

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:DL:PHIC:MITM ON`
Activates PHICH TDD m_i=1 (E-TM)

Manual operation: See "PHICH TDD m_i=1 (E-TM)" on page 82

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng> NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM

Select NGCUSTOM to customize N_g. You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICh:NOGRoups`.

*RST: NG1_6

Example: `CONF:DL:PHIC:NGP NG1_6`
Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.
`CONF:DL:PHIC:NGP NGCUSTOM`
Define a customized value for N_g.
`CONF:DL:PHIC:NOGR 5`
Directly sets the number of PHICH groups in the subframe to 5.

Manual operation: See "PHICH N_g" on page 83

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>

*RST: 0

Example: `CONF:DL:PHIC:NOGR 5`
Sets number of PHICH groups to 5.

Manual operation: See "PHICH Number of Groups" on page 83

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>

*RST: -3.01 dB
Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`
Sets the relative power to -1.3 dB.

Manual operation: See "PHICH Rel Power" on page 83

CONFigure[:LTE]:DL:PSOFfset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<Offset> **AUTO**
Automatically determines the symbol offset.

<numeric value>
Manual selection of the symbol offset.

Range: 0 to 4
*RST: AUTO

Example: `CONF:DL:PSOF 2`
Sets an offset of 2 symbols.

Manual operation: See "PRB Symbol Offset" on page 79

Shared Channel

CONFigure[:LTE]:DL:PDSCh:PB <PDSChPB>

This command selects the PDSCH power ratio.

Note that the power ratio depends on the number of antennas in the system.

Parameters:

<PDSChPB> Numeric value that defines PDSCH P_B which defines the power ratio in dB.

0

1

2

3
See PDSCH Power Ratio for an overview of resulting power ratios.

RAT1
Ratio = 1, regardless of the number of antennas.

Example: `CONF:DL:PDSC:PB 3`
Selects the PDSCH P_B '3'.

Manual operation: See "PDSCH Power Ratio" on page 86

MBSFN Characteristics

CONFigure[:LTE]:DL:MBSFn:AI:ID <Configuration>

Defines the ID of an MBFSN area.

Parameters:

<Configuration> Range: 0 to 255

Example: `CONF:DL:MBSF:AI:ID 2`
Defines an area for the multimedia broadcast network.

Manual operation: See "Area ID" on page 87

CONFigure[:LTE]:DL:MBSFn:AI:NMRL <Configuration>

This command selects the length of the control data region in an MBSFN subframe.

Parameters:

<Configuration> **1**
The first symbol in a subframe carries data of the control channel.

2
The first two symbols in a subframe carries data of the control channel.

Example: `CONF:DL:MBSF:AI:NMRL 2`
Selects two symbols that carry control channel data.

Manual operation: See "Non-MBSFN Region Length" on page 88

CONFigure[:LTE]:DL:MBSFn:POWer <Power>

This command defines the relative power of the MBSFN transmission.

Parameters:
<Power> *RST: 0 dB
Default unit: DB

Example: `CONF:DL:MBSF:POW -1.5`
Defines a relative power of -1.5 dB.

Manual operation: See "MBSFN Relative Power" on page 87

CONFigure[:LTE]:DL:MBSFn:STATe <State>

This command includes or excludes an MBSFN from the test setup.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:DL:MBSF:STAT ON`
Includes an MBSFN in the test setup.

Manual operation: See "Present" on page 87

CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:PMCH:MODulation <Modulation>

This command selects the modulation type for an MBSFN subframe.

Parameters:
<Modulation> QPSK | QAM16 | QAM64 | QAM256
*RST: QPSK

Example: `CONF:DL:MBSF:SUBF2:PMCH:MOD QPSK`
Selects QPSK modulation for the second subframe.

Manual operation: See "Modulation" on page 89

CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:PMCH:STATe <State>

This command turns the PMCH in an MBSFN subframe on and off.

Note that you first have to turn a subframe into a MBSFN subframe with `CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:STATe`.

Parameters:

<State> ON | OFF

Example: `CONF:DL:MBSF:SUBF2:PMCH:STAT ON`
Turns the PMCH in the second subframe on.

Manual operation: See "PMCH Present" on page 89

CONFigure[:LTE]:DL:MBSFn:SUBFrame<subframe>:STATe <State>

This command turns a subframe into an MBSFN subframe.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CONF:DL:MBSF:SUBF2:STAT ON`
Turns the second subframe into an MBSFN subframe.

Manual operation: See "Active" on page 88

7.10.2.2 Input / Frontend

Configuring the Input

Remote commands to configure the input described elsewhere:

- `INPut:COUPling` on page 201
- `INPut:IMPedance` on page 202
- `[SENSe]:SWAPiq` on page 205

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FPS in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:

<State> ON | OFF
*RST: OFF

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Usage: SCPI confirmed

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 89.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA and MC Group Delay measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 89

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FPS. If no additional input options are installed, only RF input is supported.

Parameters:

<Source> **RF**
Radio Frequency ("RF INPUT" connector)

*RST: RF

Defining the Frequency

[SENSe]:FREQuency:CENTer[:CC<cci>] <Frequency>

This command sets the center frequency for RF measurements.

Component carrier measurements

- Defining or querying the frequency of the first carrier is possible with `FREQ:CENT:CC1`. The `CC1` part of the syntax is mandatory in that case.
- `FREQ:CENT?` queries the measurement frequency (center of the two carriers).

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: Measurement on one carrier:
`FREQ:CENT 1GHZ`
Defines a center frequency of 1 GHz

Example: Measurement on aggregated carriers:
`FREQ:CENT:CC1 850MHZ`
Defines a center frequency of 850 MHz for the first carrier.

Manual operation: See "Defining the Signal Frequency" on page 90
See "Carrier Aggregation" on page 101
See "Remote commands to configure carrier aggregation" on page 104

[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet <Frequency>

This command defines the general frequency offset or the frequency offset for a component carrier.

The effect of the command depends on the syntax:

- When you omit the `[CC<cci>]` syntax element, the command defines the overall frequency offset.
  In that case, the value is added to the measurement frequency and, in case of measurements with component carriers, the center frequency of the component carriers.
- When you include the `[CC<cci>]` syntax element, the command defines the offset of the component carrier relative the first component carrier.
  In that case, the command is not available for the first component carrier - thus, `...:CC1:...` is not possible.

Parameters:

<Frequency> • General frequency offset: frequency offset in Hz.
• Component carrier offset: frequency offset relative to the first component carrier in Hz.

Example: `FREQ:CENT:OFFS 50HZ`
Adds a frequency offset of 50 Hz to the measurement frequency. If you are measuring component carriers, the value is also added to the center frequencies of those carriers.
`FREQ:CENT:CC2:OFFS 15MHZ`
Defines a frequency offset of 15 MHz for the second component carrier relative to the first component carrier.

Manual operation: See "Defining the Signal Frequency" on page 90
See "Remote commands to configure carrier aggregation" on page 104

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` and `SENS:FREQ DOWN` commands, see `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 197.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Defining the Signal Frequency" on page 90

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

OFF
Decouples the step size.

*RST: SPAN

Example: `FREQ:CENT:STEP:LINK SPAN`

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Parameters:

<Factor> 1 to 100 PCT

*RST: 10

Example: `FREQ:CENT:STEP:LINK:FACT 20PCT`

Configuring the Vertical Axis

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all measurement windows.

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Defining a Reference Level" on page 91

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces, <t> is irrelevant).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Defining a Reference Level" on page 91

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces, <t> is irrelevant).

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Defining a Reference Level" on page 91

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 91

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FPS determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 91

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 92

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

If activated, the input signal is amplified by 20 dB.

If option R&S FPS-B22 is installed, the preamplifier is only active below 7 GHz.

If option R&S FPS-B24 is installed, the preamplifier is active for all frequencies.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 20 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier (option B22/B24)" on page 92

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 92

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command requires the optional Electronic Attenuator.

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example: `INP:EATT 10`
Defines an attenuation level of 10 dB.

Manual operation: See "Attenuating the Signal" on page 91

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command requires the optional Electronic Attenuator.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

Manual operation: See "Attenuating the Signal" on page 91

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command requires the optional Electronic Attenuator.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`

Turns the electronic attenuator on.

Manual operation: See "Attenuating the Signal" on page 91

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FPS or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Defining a Reference Level" on page 91

7.10.2.3 Signal Capture

Data Capture

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example:
`FRAM:COUN:STAT ON`
`FRAM:COUN:AUTO OFF`
Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
Analyzes 20 frames.

Manual operation: See "Number of Frames to Analyze" on page 94

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>

ON
Selects the number of frames to analyze according to the LTE standard.

OFF
Turns manual selection of the frame number on.

Example:
`FRAM:COUN:AUTO ON`
Turns automatic selection of the analyzed frames on.

Manual operation: See "Auto According to Standard" on page 94

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>

ON
You can set the number of frames to analyze.

OFF
The R&S FPS analyzes a single sweep.

*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

Manual operation: See "Overall Frame Count" on page 94

[SENSe][:LTE]:FRAMe:SCOunt <Subframes>

This command selects the maximum number of subframes to analyze.

Selecting a number of subframes different from the default one may become necessary if the capture time is less than 20.1 ms.

Parameters:

<Subframes>

ALL
Analyzes all subframes of a frame (10).

<numeric value>
Number of subframes that the application analyzes.

Range: 1 to 9
*RST: ALL

Example: `FRAM:SCO 3`
Analyzes three subframes.

Manual operation: See "Maximum Number of Subframes per Frame to Analyze" on page 95

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

Manual operation: See "Swap I/Q" on page 94

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength>	Numeric value in seconds. Default unit: s

Example: `SWE:TIME 40ms`
Defines a capture time of 40 milliseconds.

Manual operation: See "Capture Time" on page 93

Trigger

The trigger functionality of the LTE measurement application is the same as that of the R&S FPS.

For a comprehensive description of the available remote control commands for trigger configuration see the documentation of the R&S FPS.

TRIGger[:SEQuence]:HOLDoff<instrument> <Offset>

This command defines the trigger offset.

Parameters:

<Offset>	<numeric value> *RST: 0 s Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

Manual operation: See "Configuring the Trigger" on page 96

TRIGger[:SEQuence]:LEVel<instrument>[:EXTernal] <Level>

This command defines the level for an external trigger.

Parameters:

<Level>	Range: 0.5 V to 3.5 V *RST: 1.4 V Default unit: V

Example: `TRIG:LEV 2V`
Defines a trigger level of 2 V.

Manual operation: See "Configuring the Trigger" on page 96

TRIGger[:SEQuence]:PORT<instrument> <Port>

This command selects the trigger port for measurements with devices that have several trigger ports.

Parameters:

<Port>
PORT1
PORT2
PORT3

Example: `TRIG:PORT PORT1`
Selects trigger port 1.

Manual operation: See "Configuring the Trigger" on page 96

TRIGger[:SEQuence]:SLOPe <Type>

For external and time domain trigger sources you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Configuring the Trigger" on page 96

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the TRIGGER IN connector.

EXT2
Trigger signal from the TRIGGER AUX connector.

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.

*RST: IMMediate

Example:

```
TRIG:SOUR EXT
```

Selects the external trigger input as source of the trigger signal

Manual operation: See "Configuring the Trigger" on page 96

7.10.2.4 Demodulation

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
DL:DEM:MCF ON
```

Turns suppression on of neighboring carriers on.

Manual operation: See "Multicarrier Filter" on page 99

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State> ON | OFF
*RST: ON

Example: `DL:DEM:CBSC ON`
Activate scrambling of coded bits.

Manual operation: See "Scrambling of Coded Bits" on page 100

CONFigure[:LTE]:DL:MIMO:CROSstalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CONF:DL:MIMO:CROS ON`
Turns crosstalk compensation on.

Manual operation: See "Compensate Crosstalk" on page 99

[SENSe][:LTE]:DL:DEMod:DACHannels <State>

This command turns the decoding of all control channels on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `DL:DEM:DACH ON`
Turns decoding of all control channels on.

Manual operation: See "Decode All Channels" on page 100

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation> **TGPP**
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: `DL:DEM:EVMC TGPP`
Use 3GPP method.

Manual operation: See "EVM Calculation Method" on page 100

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference>

AUTO
Automatic identification of reference data.

ALL0
Reference data is 0, according to the test model definition.

Example: `DL:DEM:PRD ALL0`
Sets the reference data of the PDSCH to 0.

Manual operation: See "PDSCH Reference Data" on page 101

7.10.2.5 Parameter Estimation

Estimating Parameters

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DL:DEM:BEST ON`
Turns boosting estimation on.

Manual operation: See "Boosting Estimation" on page 98

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type>

TGPP
3GPP EVM definition

PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

*RST: TGPP

Example: `DL:DEM:CEST TGPP`
Use 3GPP EVM definition for channel estimation.

Manual operation: See "Channel Estimation" on page 98

Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type>

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example: `DL:TRAC:PHAS PILPAY`
Use pilots and payload for phase tracking.

Manual operation: See "Phase" on page 98

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DL:TRAC:TIME ON`
Activates timing tracking.

Manual operation: See "Timing" on page 99

7.10.3 Configuring Time Alignment Measurements

All commands specific to the Transmit On/Off Power measurement are listed below.

Commands to configure Transmit On/Off Power measurement described elsewhere:

- `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 197
- Commands in "Signal Characteristics" on page 170
- Commands in "Synchronization Signal" on page 183

CONFigure[:LTE]:CAGGregation:STATe <State>

This command turns carrier aggregation for Time Alignment measurements on and off.

You can select the number of component carriers with CONFigure:NOCC.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
CONF:CAGG:STAT ON
CONF:NOCC 2
```

Turns carrier aggregation on and selects two component carriers.

CONFigure:NOCC <Carriers>

This command selects the number of component carriers evaluated in the Time Alignment measurement.

Parameters:

<Carriers> Number of the component carriers that you would like to measure. The range depends on the measurement.
For more information see "Carrier Aggregation" on page 103.

*RST: 1

Example:

```
CONF:NOCC 2
```

Selects 2 carriers.

Manual operation: See "Remote commands to configure carrier aggregation" on page 104

7.10.4 Configuring Transmit On/Off Power Measurements

All commands specific to the Transmit On/Off Power measurement are listed below.

Commands to configure Transmit On/Off Power measurement described elsewhere:

- CONFigure[:LTE]:DL[:CC<cci>]:BW
- CONFigure[:LTE]:DL[:CC<cci>]:CYCPrefix
- CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection
- CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig
- CONFigure[:LTE]:DL[:CC<cci>]:PLC:CID
- CONFigure[:LTE]:DL[:CC<cci>]:PLC:CIDGroup
- CONFigure[:LTE]:DL[:CC<cci>]:PLC:PLID
- CONFigure[:LTE]:DL[:CC<cci>]:SYNC:ANTenna
- CONFigure[:LTE]:DL:SYNC:PPOWer
- CONFigure[:LTE]:DL:SYNC:SPOWer
- CONFigure[:LTE]:DL[:CC<cci>]:TDD:SPSC
- CONFigure[:LTE]:DL[:CC<cci>]:TDD:UDConf
- CONFigure[:LTE]:DUPLexing
- CONFigure[:LTE]:LDIRection

- FETCh[:CC<cci>]:PLC:CIDGroup?
- FETCh[:CC<cci>]:PLC:PLID?
- MMEMory:LOAD:TMOD:DL
- [SENSe]:FREQuency:CENTer[:CC<cci>] on page 197
- [SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet on page 198
- [SENSe]:SWAPiq
- Commands in chapter 7.10.2.2, "Input / Frontend", on page 196

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames> <numeric value>

Example: `CONF:OOP:NFR 10`
Defines 10 frames to be analyzed.

Manual operation: See "Number of Frames" on page 102

[SENSe][:LTE]:OOPower:NCORrection <NoiseCorrection>

This command turns noise correction for On/Off Power measurements on and off.

Parameters:

<NoiseCorrection> ON | OFF

Manual operation: See "Noise Correction" on page 102

7.10.5 Configuring Frequency Sweep Measurements

Please refer to the documentation of the R&S FPS base unit for a comprehensive list and description of remote commands necessary to configure and perform frequency sweep measurements (ACLR and SEM).

All commands specific to the LTE application are listed below.

[SENSe]:POWer:ACHannel:AACHannel <Bandwidth>

This command selects the bandwidth of the adjacent channel for ACLR measurements.

In case of MC ACLR measurements, the command selects the bandwidth of the lower adjacent channel.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example:
`POW:ACH:AACH UTRA384`
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

Manual operation: See "Assumed Adjacent Channel Carrier" on page 105

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category>

A
Category A (Wide Area base station)

B1
Category B Opt 1 (Wide Area base station)

B2
Category B Opt 2 (Wide Area base station)

HOME
Home base station

LARE
Local Area base station

MED
Medium Range base station

*RST: A

Example:
`POW:SEM:CAT B`
Selects SEM category B.

Manual operation: See "Category" on page 106

[SENSe]:POWer:SEM:CHBS:AMPower <Power>

This command defines the aggregated maximum power for home base stations or the TX power for medium range base stations.

In case of medium range base stations, the command is available after [SENSe]:POWer:SEM:CHBS:AMPower:AUTO has been turned off.

Parameters:

<Power>	Numeric value Default unit: dBm

Example: `POW:SEM:CHBS:AMP 0`
Defines a power of 0 dBm.

Manual operation: See "Category" on page 106
See "Aggregated Maximum Power Of All TX Ports (P)" on page 106
See "TX Power" on page 106

[SENSe]:POWer:SEM:CHBS:AMPower:AUTO <State>

This command turn automatic detection of the TX channel power on and off.

The command is available for measurements on Medium Range base stations. When you turn it off, you can define the TX channel power manually with [SENSe]:POWer:SEM:CHBS:AMPower.

Parameters:

<State>	ON | OFF *RST: OFF

Example: `POW:SEM:CHBS:AMP:AUTO ON`
Turns on automatic detection of the TX channel power.

Manual operation: See "Category" on page 106
See "TX Power" on page 106

7.11 Analysis

7.11.1 Evaluation Range

CONFigure[:LTE]:DL:BF:AP <Port>

This command selects the antenna port for beamforming measurements.

The availabilty of ports depends on the number of transmit antennas and number of beamforming layers.

Parameters:

<Port>

AP_5_7 (antenna ports 5, 7)

AP8 (antenna ports 8)

AP9 (antenna ports 9)

AP10 (antenna ports 10)

Example: `CONF:DL:BF:AP AP816`
Selects antenna ports 8 and 16.

Manual operation: See "Beamforming Selection" on page 111

[SENSe][:LTE]:ALLocation:SELect <Allocation>

This command filters the displayed results in the constellation diagram by a particular type of allocation.

Parameters:

<Allocation>

ALL
Shows the results for all allocations.

<numeric_value>
Shows the results for a particular allocation type.
Allocation types are mapped to numeric values. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.

*RST: ALL

Example: `ALL:SEL 2`
Shows the results for PDSCH allocation 2.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 110

[SENSe][:LTE]:CARRier:SELect <Carrier>

This command filters the displayed results in the constellation diagram by a particular subcarrier.

Parameters:

<Carrier> **ALL**
Shows the results for all subcarriers.
<numeric_value>
Shows the results for a particular subcarrier.
*RST: ALL

Example: `CARR:SEL 1`
Shows the results for subcarrier 1.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 110

[SENSe][:LTE]:LOCation:SELect <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location> **AMD**
After the MIMO decoder
BMD
Before the MIMO decoder
*RST: BMD

Example: `LOC:SEL AMD`
Use data from after the MIMO decoder.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 110

[SENSe][:LTE]:MODulation:SELect <Modulation>

This command filters the displayed results in the constellation diagram by a particular type of modulation.

Parameters:

<Modulation> **ALL**
Shows the results for all modulation types.
<numeric_value>
Shows the results for a particular modulation type.
Modulation types are mapped to numeric values. For the code assignment see chapter 7.7.1.25, "Return Value Codes", on page 146.
*RST: ALL

Example: `MOD:SEL 3`
Shows the results for all elements with a 16QAM modulation

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 110

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

Manual operation: See "Subframe Selection" on page 109

[SENSe][:LTE]:SYMBol:SELect <Symbol>

This command filters the displayed results in the constellation diagram by a particular OFDM symbol.

Parameters:

<Symbol> **ALL**
Shows the results for all subcarriers.

<numeric_value>
Shows the results for a particular OFDM symbol.

*RST: ALL

Example: `SYMB:SEL 2`
Shows the results for the second OFDM symbol.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 110

7.11.2 Y-Axis Scale

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces, <t> is irrelevant).

Usage: SCPI confirmed

Manual operation: See "Y-Axis Scale" on page 111

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for all traces in the selected result display.

The suffix <t> is irrelevant.

Parameters:

<Value> <numeric value>

*RST: depends on the result display

The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 111

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for all traces in the selected result display.

The suffix <t> is irrelevant.

Parameters:

<Value> <numeric value>

*RST: depends on the result display

The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 111

7.11.3 Result Settings

CALCulate:MARKer:COUPling <State>

This command couples or decouples markers in different result displays to each other.

Parameters:

<State> ON | OFF

Example: `CALC:MARK:COUP ON`
Couples the markers to each other.

Manual operation: See "Marker Coupling" on page 113

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:
<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

Manual operation: See "Bit Stream Format" on page 112

UNIT:CAXes <Unit>

This command selects the scale of the x-axis for result displays that show subcarrier results.

Parameters:
<Unit>

CARR
Shows the number of the subcarriers on the x-axis.

HZ
Shows the frequency of the subcarriers on the x-axis.

Example: `UNIT:CAX HZ`
Selects frequency scale for the x-axis.

Manual operation: See "Carrier Axes" on page 113

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:
<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

Manual operation: See "EVM Unit" on page 112

List of Commands

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