R&S®FSW-K10x (LTE Downlink) LTE Downlink Measurement Application User Manual

1173937002
Version 25

ROHDE&SCHWARZ
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This manual applies to the following FSW models with firmware version 6.00 and later:

- R&S®FSW8 (1331.5003K08 / 1312.8000K08)
- R&S®FSW13 (1331.5003K13 / 1312.8000K13)
- R&S®FSW26 (1331.5003K26 / 1312.8000K26)
- R&S®FSW43 (1331.5003K43 / 1312.8000K43)
- R&S®FSW50 (1331.5003K50 / 1312.8000K50)
- R&S®FSW67 (1331.5003K67 / 1312.8000K67)
- R&S®FSW85 (1331.5003K85 / 1312.8000K85)

The following firmware options are described:

- FSW-K100 (EUTRA/LTE FDD downlink measurement application) (order no. 1313.1545.02)
- FSW-K102 (EUTRA/LTE Advanced and MIMO Downlink Measurement Application) (order no. 1313.1568.02)
- FSW-K104 (EUTRA/LTE TDD downlink measurement application) (order no. 1313.1574.02)
- R&S®FSW-K175 (O-RAN Measurements) (1353.2642.02)

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1173.9370.02 | Version 25 | R&S®FSW-K10x (LTE Downlink)

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®FSW is indicated as R&S FSW.

Contents

1 Documentation overview

This section provides an overview of the FSW user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/FSW

Further documents are available at:

www.rohde-schwarz.com/product/FSW

1.1 Getting started manual

Introduces the FSW and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc.

A printed version is delivered with the instrument. A PDF version is available for download on the Internet.

1.2 User manuals and help

Separate user manuals are provided for the base unit and the firmware applications:

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

The contents of the user manuals are available as help in the FSW. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

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

1.3 Service manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

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

https://gloris.rohde-schwarz.com

1.4 Instrument security procedures

Deals with security issues when working with the FSW in secure areas. It is available for download on the internet.

1.5 Printed safety instructions

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

1.6 Specifications and brochures

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

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

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

1.7 Release notes and open-source acknowledgment (OSA)

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

The firmware makes use of several valuable open source software packages. An open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/FSW

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

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

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

1.9 Videos

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

2 Welcome to the LTE measurement application

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

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 FSW User Manual. The latest versions of the manuals are available for download at the product homepage.

https://www.rohde-schwarz.com/manual/fsw.

2.1 Overview of the LTE applications

You can equip the FSW with one or more LTE applications. Each of the applications provides functionality for specific measurement tasks.

FSW-K100

The FSW-K100 is designed to measure LTE FDD signals on the downlink.

The application has the following features:

- Basic signal characteristics (like frequency, channel bandwidth or cyclic prefix).
- Demodulation and configuration of the PDSCH transmitted over a single antenna and without precoding functionality.
- Characteristics of the Synchronization and Reference signals.
- Consideration of various control channels in the measurement (for example the PBCH or the PPDCH).
- Analysis of individual antennas in a MIMO setup.
- Tools to refine and filter the measurement results.
- Various result displays that show the measured signal characteristics in a diagram or a numeric result table.
- Available measurements: EVM, ACLR and SEM.

FSW-K101

The FSW-K101 is designed to measure LTE FDD signals on the uplink.

The application has the following features:

- Basic signal characteristics (like frequency, channel bandwidth or cyclic prefix).

- Demodulation and configuration of the subframes transmitted over a single antenna.
- Characteristics of the demodulation and sounding reference signals.
- Consideration of the PUSCH, PUCCH and PRACH channels.
- Analysis of individual antennas in a MIMO setup.
- Tools to refine and filter the measurement results.
- Various result displays that show the measured signal characteristics in a diagram or a numeric result table.
- Available measurements: EVM, ACLR and SEM.

FSW-K102

The FSW-K102 is designed to measure LTE Advanced systems and MIMO systems on the downlink.

Note that this application only works in combination with either FSW-K100 or -K104.

The application has the following features:

- Support of 1024QAM modulation.
- Simultaneous (or consecutive) capture and subsequent analysis of the data streams of several antennas.
- Control of several analyzers required for MIMO measurements.
- Consideration of the precoding schemes defined in the 3GPP standard.
- Support of carrier aggregation.
- Measurements on multimedia broadcast single frequency networks (MBSFNs).
- Additional measurements: time alignment error, multi-carrier ACLR, cumulative ACLR and multi-SEM.

FSW-K103

The FSW-K103 is designed to measure LTE Advanced systems on the uplink.

Note that this application only works in combination with either FSW-K101 or -K105.

The application has the following features:

- Support of 256QAM modulation.
- Simultaneous (or consecutive) capture and subsequent analysis of the data streams of several antennas.
- Control of several analyzers required for MIMO measurements.
- Consideration of the enhanced PUSCH and PUCCH characteristics.
- Support of carrier aggregation.
- Additional measurements: time alignment error, multi-carrier ACLR and multi SEM.

FSW-K104

The FSW-K104 is designed to measure LTE TDD signals on the downlink.

The features are basically the same as in the FSW-K100 with additional features that allow you to configure TDD subframes. It also provides tools to measure the On/Off Power.

FSW-K105

The FSW-K105 is designed to measure LTE TDD signals on the uplink.

The features are basically the same as in the FSW-K101 with additional features that allow you to configure TDD subframes.

2.2 Installation

Find detailed installing instructions in the Getting Started or the release notes of the FSW.

2.3 Starting the LTE measurement application

The LTE measurement application adds a new application to the FSW.

To activate the application

1. Press the [MODE] key on the front panel of the FSW.

   A dialog box opens that contains all operating modes and applications currently available on your FSW.

2. Select the "LTE" item.

   The FSW opens a new measurement channel for the LTE measurement application.

LTE PC software and LTE measurement application

If you are using the EUTRA/LTE PC Software in combination with an FSW, the "Mode" dialog box also contains a item for this software. It is labeled "LTE Software" and opens the PC software on the FSW.

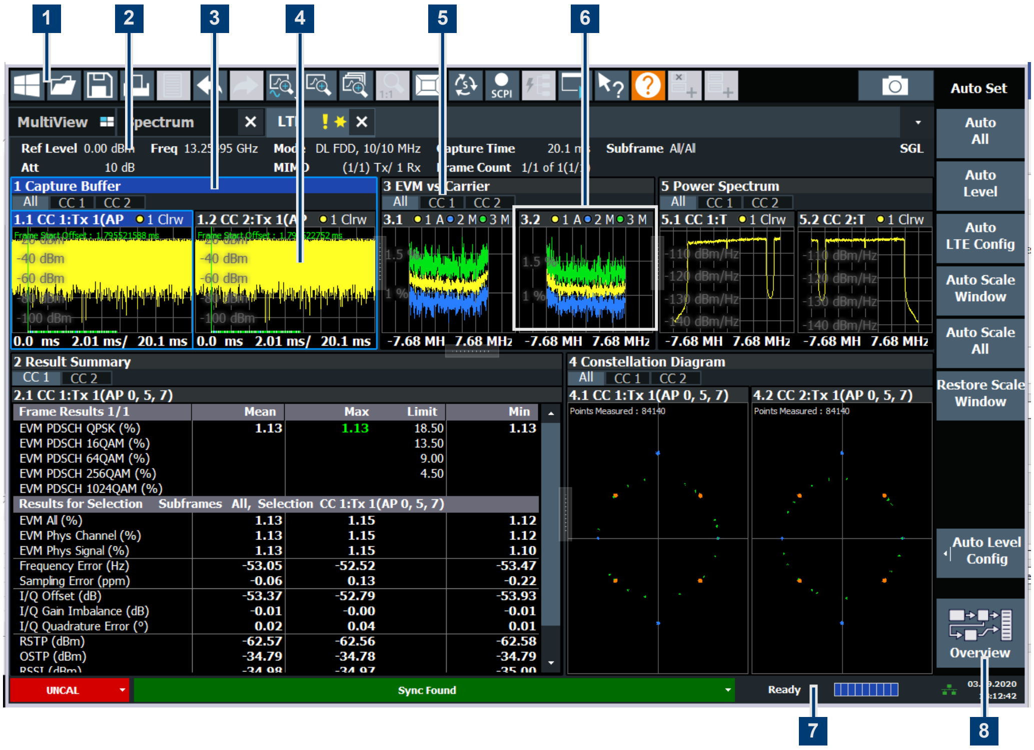
A comprehensive description of the functionality of this software is provided in a separate manual available for download on the internet.

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 70.

2.4 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 = Tabs to select displayed information for multiple data streams
6 = Subwindows (if more than one data stream is displayed at the same time)
7 = Status bar
8 = 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 FSW MSRA User Manual.

Channel bar information

In the LTE measurement application, the FSW 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 FSW 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.

Remote command:

Measurement selection: `CONFigure[:LTE]:MEASurement` on page 220

Result display selection: `LAYout:ADD[:WINDow]?` on page 160

3.1 Selecting measurements

Access: "Overview" > "Select Measurement"

The "Select Measurement" dialog box contains several buttons. Each button represents a measurement. A measurement in turn is 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 Chapter 3.2, "Selecting result displays", on page 19.

Depending on the measurement, the FSW changes the way it captures and processes the raw signal data.

EVM
EVM measurements record, process and demodulate the signal's I/Q data. The result displays available for EVM measurements show various aspects of the LTE signal quality.

For EVM measurements, you can combine the result displays in any way.

For more information on the result displays, see Chapter 3.5, "I/Q measurements", on page 21.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

Time alignment error
Time alignment error (TAE) measurements record, process and demodulate the signal's I/Q data. The result displays available for TAE measurements indicate how well the antennas in a multi-antenna system are aligned.

For TAE measurements, you can combine the result displays in any way.

For more information on the result displays, see Chapter 3.6, "Time alignment error measurements", on page 41.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

Transmit on / off power
Transmit on / off power measurements record and process the signal's I/Q data without demodulating the data. The result displays available for transmit on / off power measurements show various aspects of the transition from on to off power.

For transmit on / off power measurements, you can combine the result displays in any way.

For more information on the result displays, see Chapter 3.7, "Transmit on / off power measurement", on page 42.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

Channel power ACLR
(inludes multi carrier ACLR and cumulative ACLR measurements)

ACLR measurements sweep the frequency spectrum instead of processing I/Q data.

The ACLR measurements evaluates the leakage ratio of neighboring channels and evaluates if the signal is within the defined limits. The measurement provides several result displays. You can combine the result displays in any way.

For more information on the result displays, see Chapter 3.8, "Frequency sweep measurements", on page 46.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

SEM
(inlcudes multi carrier SEM measurements)

SEM measurements sweep the frequency spectrum instead of processing I/Q data.

The SEM measurements tests the signal against a spectrum emission mask and evaluates if the signal is within the defined limits. The measurement provides several result displays. You can combine the result displays in any way.

For more information on the result displays, see Chapter 3.8, "Frequency sweep measurements", on page 46.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

3.2 Selecting result displays

Access:

The FSW opens a menu (the SmartGrid) to select result displays. For more information on the SmartGrid functionality, see the FSW 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 SmartGrid menu.

Remote command: `LAYout:ADD[:WINDow]?` on page 160

Measuring several data streams

When you capture more than one data stream (for example component carriers), 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 certain 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.

3.3 Performing measurements

By default, the application measures the signal continuously. In "Continuous Sweep" mode, the FSW captures and analyzes the data again and again.

- For I/Q measurements, the amount of captured data depends on the capture time.
- For frequency sweep measurement, the amount of captured data depends on the sweep time.

In "Single Sweep" mode, the FSW stops measuring after it has captured the data once. The amount of data again depends on the capture time.

Refreshing captured data

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

For more information, see the documentation of the FSW.

3.4 Selecting the operating mode

Access: [MODE] > "Multi-Standard Radio Analyzer Tab"

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

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 primary 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 primary display indicates the data covered by each application by vertical blue lines labeled with the application name. The blue lines correspond to the channel bandwidth.

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 cannot 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 secondary applications. It can be positioned in any MSRA secondary application or the MSRA primary and is then adjusted in all other secondary applications. Thus, you can easily analyze the results at a specific time in the measurement in all secondary applications and determine correlations.

If the analysis interval of the secondary application contains the marked point in time, 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, you can hide it from view manually. In all result displays, the "AL" label in the window title bar indicates whether 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 FSW MSRA documentation.

3.5 I/Q measurements

Access: [MEAS] > "EVM/Frequency Err/Power"

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

Remote command:

Measurement selection: `CONFigure[:LTE]:MEASurement` on page 220

Result display selection: `LAYout:ADD[:WINDow]?` on page 160

Capture Buffer

The "Capture Buffer" 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 capture buffer uses the auto peak detector to evaluate the measurement data. The auto peak detector determines the maximum and the minimum value of the measured levels for each measurement point and combines both values in one sample point.

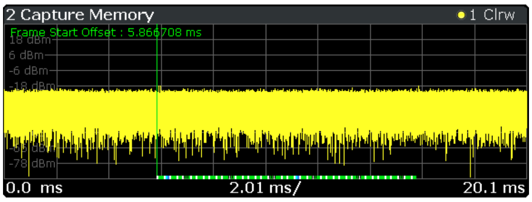


Figure 3-1: Capture buffer without zoom

A colored 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 represents the subframe start. The diagram also 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 is interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.

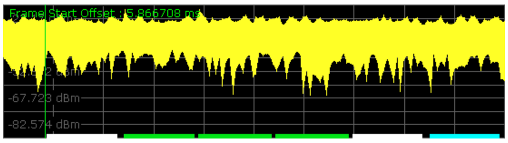


Figure 3-2: Capture buffer after a zoom has been applied

Remote command:
Selection: `LAY:ADD ? '1',LEFT,CBUF`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189
Subframe start offset: `FETCh[:CC<cc>]:SUMMary:TFRame?` on page 199

EVM vs Carrier
The "EVM vs Carrier" 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.

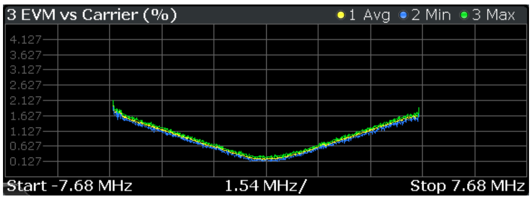
- Average EVM

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 142.

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



Remote command:
Selection `LAY:ADD ? '1',LEFT,EVCA`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

EVM vs Symbol

The "EVM vs Symbol" 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.

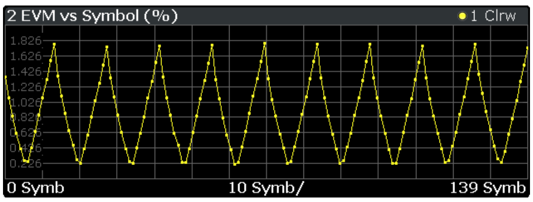
The results are based on an average EVM that is calculated over all subcarriers that are part of a certain OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed subframe.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. Any missing connections from one dot to another mean that the FSW could not determine the EVM for that symbol.

The number of displayed symbols depends on the subframe selection and the length of the cyclic prefix.

For 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:
Selection: `LAY:ADD ? '1',LEFT,EVSY`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

EVM vs RB

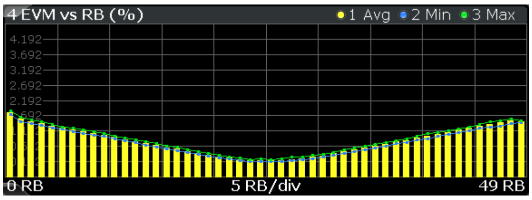
The "EVM vs RB" result display shows the Error Vector Magnitude (EVM) for all resource blocks that can be occupied by the PDSCH.

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 142.

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:
Selection: `LAY:ADD ? '1',LEFT,EVRP`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

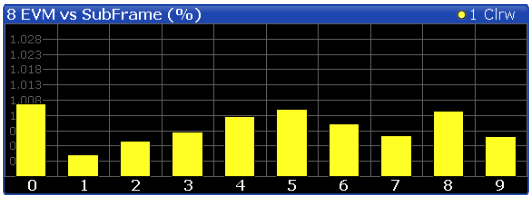
EVM vs Subframe

The "EVM vs Subframe" 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:
Selection: `LAY:ADD ? '1',LEFT,EVSU`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

Frequency Error vs Symbol

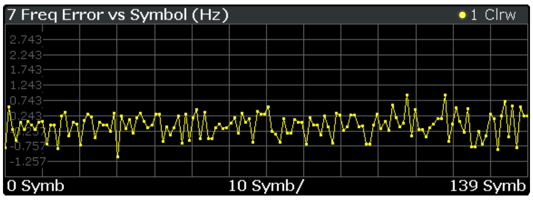
Th e "Frequency Error vs Symbol" result display shows the frequency error of each symbol. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers in the symbol.

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 FSW 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 can be much higher compared to the frequency error display in the numerical 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.



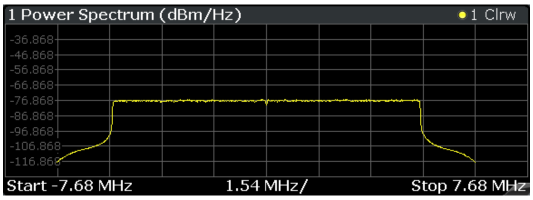
Remote command:
Selection: `LAY:ADD ? '1',LEFT,FEVS`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

Power Spectrum

The "Power Spectrum" shows the power density of the complete capture buffer in dBm/Hz.

The displayed bandwidth depends on the selected channel bandwidth.

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



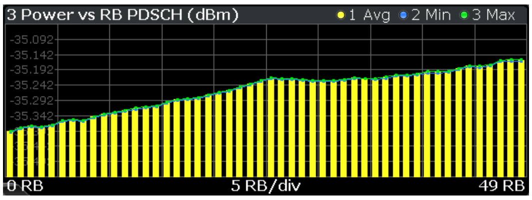
Remote command:
Selection: LAY:ADD ? '1',LEFT,PSPE
Query (y-axis): TRACe:DATA?
Query (x-axis): TRACe<n>[:DATA]:X? on page 189

Power vs Resource Block PDSCH

The "Power vs Resource Block PDSCH" 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 traces 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.



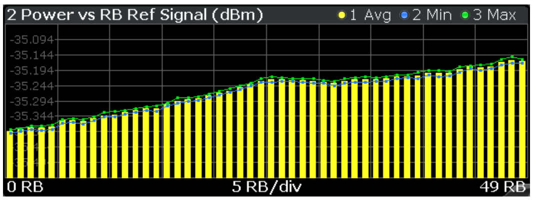
Remote command:
Selection: LAY:ADD ? '1',LEFT,PCRP
Query (y-axis): TRACe:DATA?
Query (x-axis): TRACe<n>[:DATA]:X? on page 189

Power vs Resource Block RS

The "Power vs Resource Block RS" 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 traces 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.



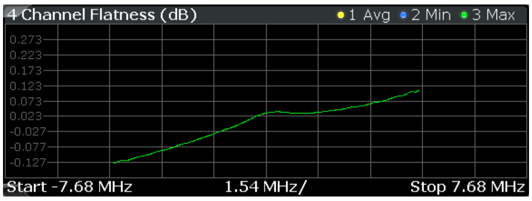
Remote command:
Selection: `LAY:ADD ? '1',LEFT,PVRR`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

Channel Flatness

The "Channel Flatness" 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:
Selection: `LAY:ADD ? '1',LEFT,FLAT`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

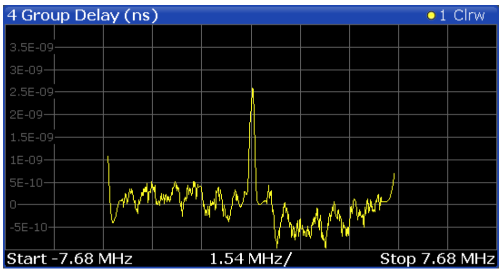
Group Delay

This "Group Delay" shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

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.



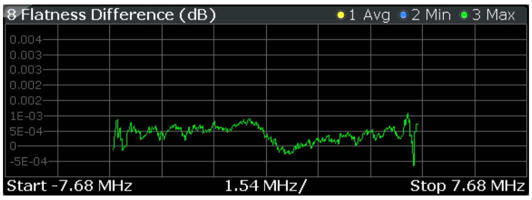
Remote command:
Selection: `LAY:ADD ? '1',LEFT,GDEL`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

Channel Flatness Difference

The "Channel Flatness Difference" 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:
Selection: `LAY:ADD ? '1',LEFT,FDIF`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 189

Constellation Diagram

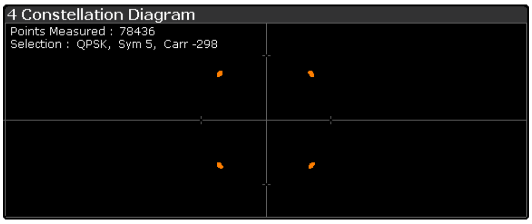
The "Constellation Diagram" shows the in-phase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data.

Each color represents a modulation type.

- : BPSK
- : RBPSK
- : MIXTURE
- : QPSK
- : 16QAM
- : 64QAM
- : 256QAM
- : 1024QAM
- : PSK (CAZAC)

You can filter the results by changing the evaluation range.



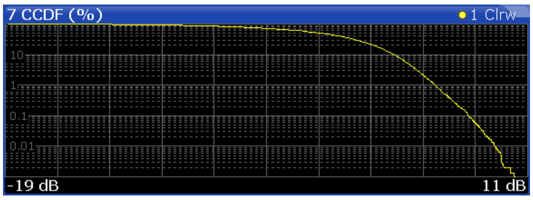
The constellation diagram also contains information about the current evaluation range, including the number of points that are displayed in the diagram.

Remote command:
Selection: LAY:ADD ? '1',LEFT,CONS
Query: TRACe:DATA?

CCDF

The "Complementary Cumulative Distribution Function (CCDF)" 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 %.



In addition to the diagram, the results for the CCDF measurement are summarized in the CCDF table.

Mean	Mean power
Peak	Peak power
Crest	Crest factor (peak power – mean power)
10 %	10 % probability that the level exceeds mean power + [x] dB
1 %	1 % probability that the level exceeds mean power + [x] dB
0.1 %	0.1 % probability that the level exceeds mean power + [x] dB
0.01 %	0.01 % probability that the level exceeds mean power + [x] dB

Remote command:
Selection: LAY:ADD ? '1',LEFT,CCDF
Query (y-axis): TRACe:DATA?
Numerical results: CALCulate<n>:STATistics:CCDF:X<t>? on page 204
Numerical results: CALCulate<n>:STATistics:RESult<res>? on page 204

Allocation Summary

The "Allocation Summary" shows various parameters of the measured allocations in a table.

Each row in the allocation table corresponds to an allocation. A set of several allocations make up a subframe. A horizontal line indicates the beginning of a new subframe.

Special allocations summarize the characteristics of all allocations in a subframe ("ALL") and the complete frame (allocation "ALL" at the end of the table).

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 columns of the table show the following properties for each allocation.
- The location of the allocation (subframe number).
- The ID of the allocation (channel type).
- Number of resource blocks used by the allocation.
- The relative power of the allocation in dB.
  The FSW does not calculate the PHICH power if you turn on boosting estimation.
- The modulation of the allocation.
- The power of each resource element in the allocation in dBm.
- The EVM of the allocation.
  The unit depends on the EVM unit
- The EVM over all codewords in a layer. The layer EVM is calculated for all data allocations, and not for the DMRS or other physical signals.
  The unit depends on the EVM unit

For PDSCH allocations that use beamforming, the table contains two values. One for the PDSCH, and one for the UE-specific reference signal (UE RS).

Click **once** on the header row to open a dialog box that allows you to add and remove columns.

Remote command:
Selection: `LAY:ADD ? '1',LEFT,ASUM`
Query: TRACe:DATA?

Bitstream

The "Bitstream" shows the demodulated data stream for the data allocations.

At the end of the table is a summary of the bitstream for certain configurations.
- Total number of bits or symbols
- Total number of coded bits
- Total number of bit errors
- Bit error rate (BER) in percent
- Bits per second (= coded bits - bit errors)
  The totals are calculated over all PDSCH allocations that contribute to the bit-stream. If the crc fails for one of the allocations, the FSW returns NAN for the total numbers.

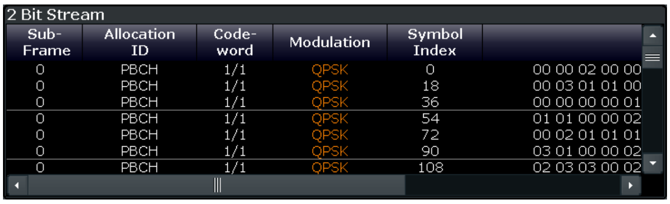
The bitstream summary is displayed under the following conditions.
- Select an ORAN test case.
  The PDSCH reference data must be "ORAN PN23".

Depending on the bitstream format, the numbers represent either bits (bit order) or symbols (symbol order).

- For the bit format, each number represents one raw bit.
- For the symbol format, the bits that belong to one symbol are shown as hexadecimal numbers with two digits.
  (1024QAM: hexadecimal number with three digits)

Resource elements that do not contain data or are not part of the transmission 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**
  Indicates the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

Remote command:
Selection: `LAY:ADD ? '1',LEFT,BSTR`
Query: TRACe:DATA?

Channel Decoder Results

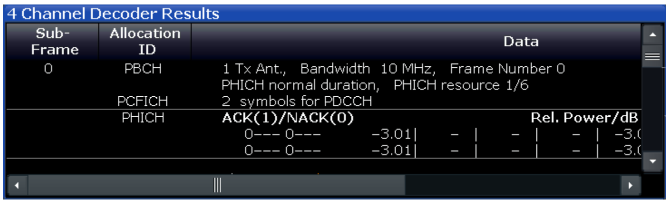
The "Channel Decoder" result display is a numerical result display that shows the characteristics of various channels for a specific subframe.

- 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.

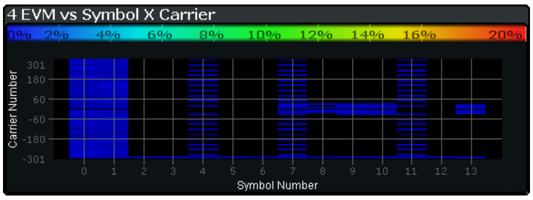
– Rel. Power
  Relative power of the corresponding PDCCH.

  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:
Selection: `LAY:ADD ? '1',LEFT,CDEC`
Query: TRACe:DATA?

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

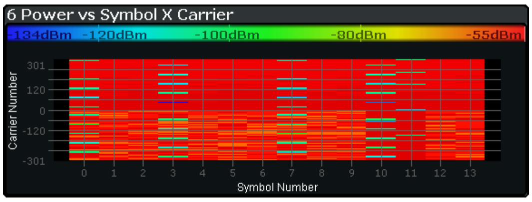
The x-axis represents the symbols. The y-axis represents the subcarriers. Different colors in the diagram area represent the EVM. A color map in the diagram header indicates the corresponding power levels.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,EVSC`
Query: TRACe:DATA?

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

The x-axis represents the symbols. The y-axis represents the subcarriers. Different colors in the diagram area represent the power. A color map in the diagram header indicates the corresponding power levels.



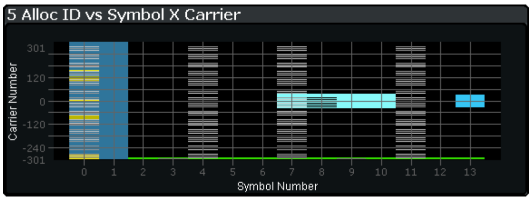
Remote command:
Selection: LAY:ADD ? '1',LEFT,PVSC
Query: TRACe:DATA?

Allocation ID vs Symbol x Carrier

The "Allocation ID vs Symbol x Carrier" result display is a graphical representation of the structure of the analyzed frame. It shows the allocation type of each subcarrier in each symbol of the received signal.

The x-axis represents the OFDM symbols. The y-axis represents the subcarriers.

Each type of allocation is represented by a different color. The legend above the diagram indicates the colors used for each allocation. You can also use a marker to get more information about the type of allocation.



Remote command:
Selection: LAY:ADD ? '1',LEFT,AISC
Query: TRACe:DATA?

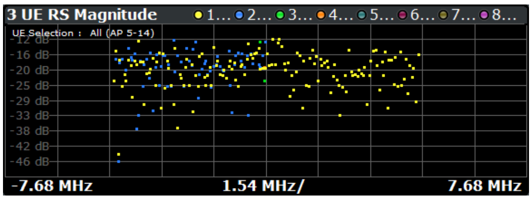
UE RS Magnitude

The "UE RS Weights Magnitude" 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.

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: LAY:ADD ? '1',LEFT,URWM
Querying results: TRACe:DATA?

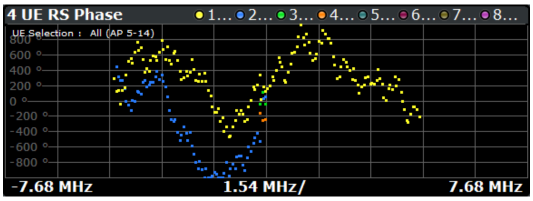
UE RS Phase

The "UE RS Weights Phase" result display shows the phase of the measured weights of the UE specific reference signal carriers. You can use it to calculate the phase difference between different antenna ports.

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

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,URWP`
Query: TRACe:DATA?

Cell RS Magnitude

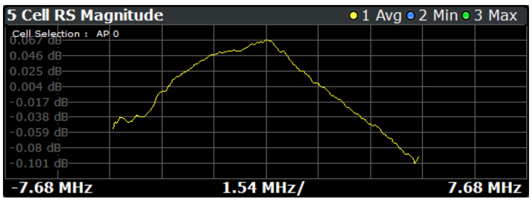
The "Cell RS Weights Magnitude" result display shows the magnitude of the measured weights of the reference signal (RS) carriers specific to the cell. This measurement enables magnitude measurements on antenna port 0 using, for example, the enhanced test models like E-TM 1.1.

You can use the result display 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.

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,CRWM`
Query: TRACe:DATA?

Cell RS Phase

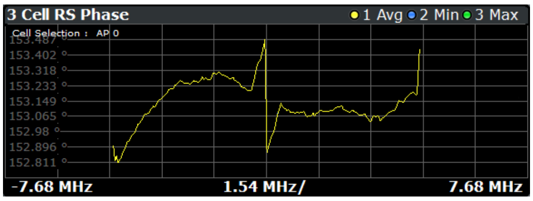
The "Cell RS Weights Phase" result display shows the phase of the measured weights of the reference signal (RS) carriers specific to the cell. This measurement enables phase measurements on antenna port 0 using, for example, the enhanced test models like E-TM 1.1.

You can use the result display to calculate the phase difference between different antenna ports.

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

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,CRWP`
Query: TRACe:DATA?

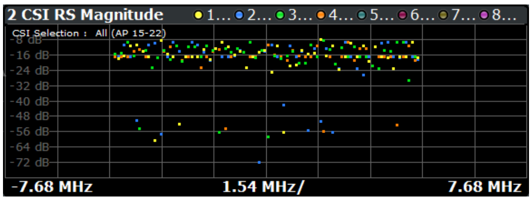
CSI RS Magnitude

The "CSI RS Weights Magnitude" result display shows the magnitude of the measured weights of the CSI-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.

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,IRWM`
Query: TRACe:DATA?

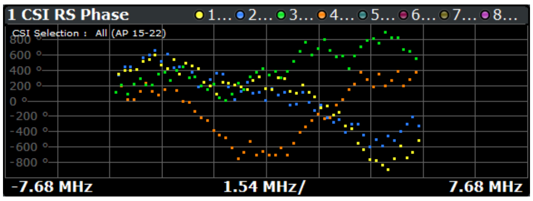
CSI RS Phase

The "CSI RS Weights Phase" result display shows the phase of the measured weights of the CSI-specific reference signal carriers. You can use it to calculate the phase difference between different antenna ports.

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

Because the beamforming configuration can change between the subframes of one frame, the contents of this result display for Subframe Selection = 'All' might be invalid. Thus, it is recommended to select the precise subframe to be evaluated in order to get valid results.

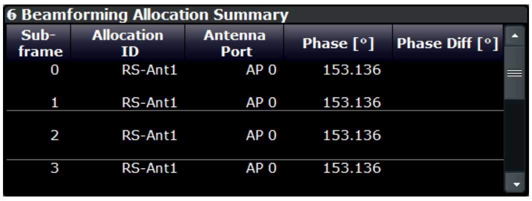
You can select the antenna port you want to show the information for from the corresponding beamforming selection dropdown menu.



Remote command:
Selection: `LAY:ADD ? '1',LEFT,IRWP`
Query: TRACe:DATA?

Beamform Allocation Summary

The "Beamform Allocation Summary" shows the phase characteristics for each PDSCH and (if available) EPDCCH allocation used by the UE-specific reference signals in numerical form.



6 Beamforming Allocation Summary

Sub-frame	Allocation ID	Antenna Port	Phase [°]	Phase Diff [°]
0	RS-Ant1	AP 0	153.136	
1	RS-Ant1	AP 0	153.136	
2	RS-Ant1	AP 0	153.136	
3	RS-Ant1	AP 0	153.136	

The rows in the table represent the allocations. 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.
- **Antenna Port**
  Shows the antenna port used by the allocation.
- **Phase**
  Shows the phase of the allocation.
- **Phase Diff(erence)**
  Shows the phase difference of the allocation relative to the first antenna.

Remote command:
Selection: `LAY:ADD ? '1',LEFT,URWA`
Query: 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<cc>]:SUMMary:EVM:DSQP[:AVERage]?` on page 192
EVM PDSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSST[:AVERage]?` on page 192
EVM PDSCH 64QAM	Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSSF[:AVERage]?` on page 192
EVM PDSCH 256QAM	Shows the EVM for all 256QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSTS[:AVERage]?` on page 193
EVM PDSCH 1024QAM	Shows the EVM for all 1024QAM-modulated resource elements of the PDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DS1K[:AVERage]?` on page 193

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 specific 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<cc>]:SUMMary:EVM[:ALL][:AVERage]? on page 195
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<cc>]:SUMMary:EVM:PCHannel[:AVERage]? on page 195
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<cc>]:SUMMary:EVM:PSIGnal[:AVERage]? on page 195
Frequency Error	Shows the difference in the measured center frequency and the reference center frequency. FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]? on page 196
Sampling Error	Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate. FETCh[:CC<cc>]:SUMMary:SERRor[:AVERage]? on page 199
I/Q Offset	Shows the power at spectral line 0 normalized to the total transmitted power. FETCh[:CC<cc>]:SUMMary:IQOFfset[:AVERage]? on page 196
I/Q Gain Imbalance	Shows the logarithm of the gain ratio of the Q-channel to the I-channel. FETCh[:CC<cc>]:SUMMary:GIMBalance[:AVERage]? on page 196
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<cc>]:SUMMary:QUADerror[:AVERage]? on page 198
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<cc>]:SUMMary:RSTP[:AVERage]? on page 198
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 (for frame type 1, normal CP length)) contains exclusively PDSCH. FETCh[:CC<cc>]:SUMMary:OSTP[:AVERage]? on page 197
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<cc>]:SUMMary:RSSI[:AVERage]? on page 198

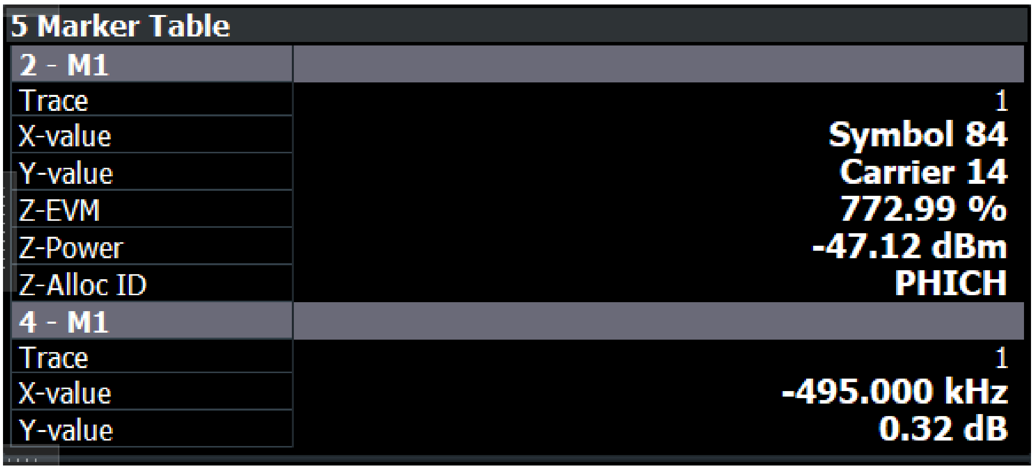
Power	Shows the average time domain power of the analyzed signal. FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]? on page 197
Crest Factor	Shows the peak-to-average power ratio of captured signal. FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]? on page 194

Marker Table

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

This table is displayed automatically if configured accordingly.

Wnd	Shows the window the marker is in.
Type	Shows the marker type and number ("M" for a normal marker, "D" for a delta marker).
Trc	Shows the trace that the marker is positioned on.
Ref	Shows the reference marker that a delta marker refers to.
X- / Y-Value	Shows the marker coordinates (usually frequency and level).
Z-EVM **Z-Power** **Z-Alloc ID**	Shows the "EVM", power and allocation type at the marker position. Only in 3D result displays (for example "EVM vs Symbol x Carrier").



Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:

LAY:ADD? '1',RIGH, MTAB, see LAYout:ADD[:WINDow]? on page 160

Results:

CALCulate<n>:MARKer<m>:X on page 201

CALCulate<n>:MARKer<m>:Y on page 202

CALCulate<n>:MARKer<m>:Z? on page 203

CALCulate<n>:MARKer<m>:Z:ALL? on page 203

3.6 Time alignment error measurements

Access: [MEAS] > "Time Alignment Error"

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) or in a system with component carriers. Therefore, you have to mix the signal of the antennas into one cable that you can connect to the FSW. For more information on configuring and performing a time alignment error measurement see Chapter 4.5, "Performing time alignment measurements", on page 65.

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 21
- "Power Spectrum" on page 25
- "Marker Table" on page 40

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

Remote command:

Measurement selection: `CONFigure[:LTE]:MEASurement` on page 220

Result display selection: `LAYout:ADD[:WINDow]?` on page 160

Time Alignment Error
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.

The application shows the results in a table.

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

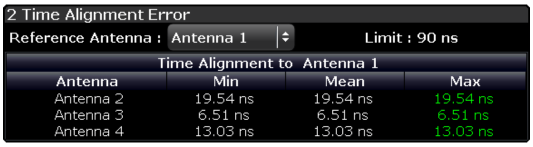
For each antenna, the maximum, minimum and average time delay that has been measured is shown. The minimum and maximum results are calculated only if the measurement covers more than one frame.

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 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, "Time alignment error measurements", on page 130.

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).



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:
Selection: `LAY:ADD ? '1',LEFT,TAL`
Query: `FETCh:TAERror[:CC<cc>]:ANTenna<ant>[:AVERage]?` on page 200
Reference antenna: `CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection` on page 231

3.7 Transmit on / off power measurement

Access: [MEAS] > "Transmit On/Off Power"

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.

Remote command:

Measurement selection: `CONFigure[:LTE]:MEASurement` on page 220

Result display selection: `LAYout:ADD[:WINDow]?` on page 160

Transmit On / Off Power
The transmit on / off power measurement analyzes the transition from transmission ("on" periods) to reception ("off" periods) of an LTE TDD signal over time. Because this transition must happen very fast to use resources efficiently, it can be an issue in TDD systems.

During the transmit power on / off measurement, the FSW verifies if the "off" periods (= no signal transmission) comply to the limits defined by 3GPP. Note that you have to apply a signal to the RF input for this measurement, because the FSW has to capture 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 67.

The results for the transmit on / off power measurement are available in the following displays.

- "Numerical results" on page 43
- "Transmit power on / off diagram" on page 44
- "Transition diagram" on page 45

Remote command:
Selection: `CONF:MEAS TPOO`
Query: TRACe:DATA?
Unit: `UNIT:OPOWer` on page 287

Numerical results ← Transmit On / Off Power
The result summary shows the measurement results in a table. Each line in the table corresponds to one "off" period.

The result summary shows the following information for each "off" period.

- "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 diagram.
- "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.
  You can display the "OFF Power" either as an absolute value in dBm or a relative value in dBm/MHz. To select the unit, use the "Power Unit (dBm/MHz)" softkey available in the "Meas Config" menu.
- "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.

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

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

Note that the beginning and end of a transition period is determined based on the "Off Power Density Limit". This limit is defined in 3GPP 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.

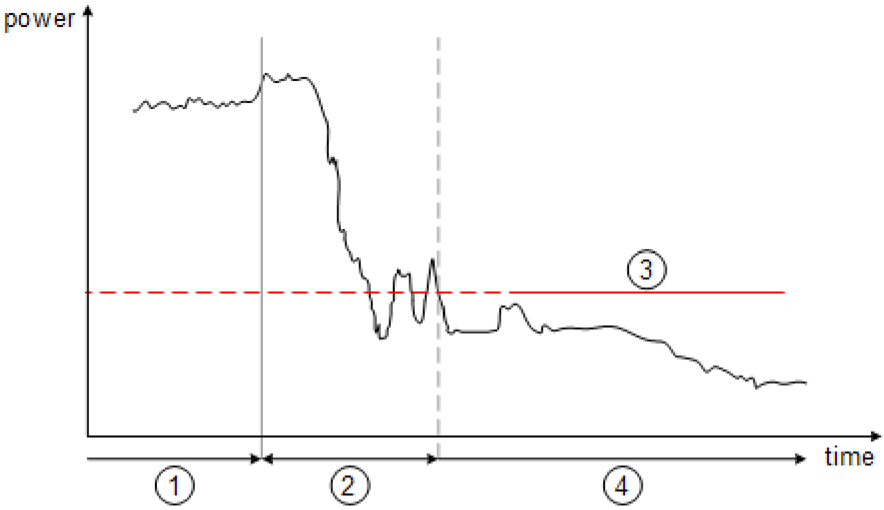
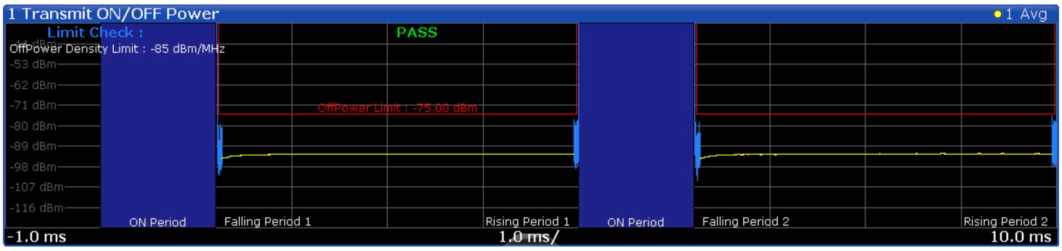


Figure 3-3: Power profile of a TD-LTE On-to-Off transition. The transition lasts from the end of the ON period until the signal is completely below the off power density limit.

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

Transmit power on / off diagram ← Transmit On / Off Power
The diagram shows all TDD frames that were captured and analyzed and contains several elements.

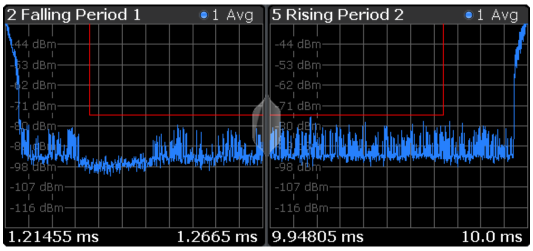
- Yellow trace
  The yellow trace represents the signal power during the "off" periods. The calculation of the trace also accounts for filtering as defined in 3GPP 36.141.
- Blue trace
  The blue trace represents the transition periods (falling and rising).
  Note that the blue trace might not be visible in the diagram because of its steep flank and small horizontal dimensions. You can see the falling and rising transitions in separate diagrams.
- 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.
- Other information
  In addition to these elements, the diagram also shows the overall limit check, the average count and the limit for the mean power spectral density ("Off Power Density Limit").
  The overall limit check only passes if all "off" periods (including the transients) comply with the limits.



Transition diagram ← Transmit On / Off Power
The transition diagrams show the rising and falling periods for each TDD frame in more detail.

You can display the transitions for up to two TDD frames.

The diagrams contain the following elements.
- Blue trace
  The blue trace represents the transition periods (falling and rising).
- Red lines
  Limits as defined by 3GPP.



Adjust Timing ← Transmit On / Off Power
Access: [Sweep] > "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.

Adjust timing also captures data with a reference level optimized for the "on" period to increase the probability for successful synchronization.

Remote command:
`[SENSe:][LTE:]OOPower:ATIMing` on page 170

Noise Cancellation ← Transmit On / Off Power
Access: [Meas Config] > "Noise Cancellation"

Noise cancellation corrects the results by removing the inherent noise of the analyzer, which increases the dynamic range. To do this, the FSW measures its inherent noise and subtracts the measured noise power from the power in the channel that is being analyzed.

Noise cancellation is valid for the current measurement configuration. If you change the measurement configuration in any way, you have to repeat noise cancellation.

Remote command:
`[SENSe:][LTE:]OOPower:NCORrection` on page 287

3.8 Frequency sweep measurements

Access (ACLR): [MEAS] > "Channel Power ACLR"

Access (MC ACLR): [MEAS] > "Multi Carrier ACLR"

Access (Cumulative ACLR): [MEAS] > "Cumulative ACLR"

Access (SEM): [MEAS] > "Spectrum Emission Mask"

Access (Multi Carrier SEM): [MEAS] > "Multi Carrier SEM"

The LTE aplication supports the following frequency sweep measurements.

- Adjacent channel leakage ratio (ACLR)
- Spectrum emission mask (SEM)

Instead of using I/Q data, the frequency sweep measurements sweep the spectrum every time you run a new measurement. Therefore, it is mandatory to feed a signal into the RF input for these measurements. Using previously acquired I/Q data for the frequency sweep measurements is not possible (and vice-versa).

Because each of the frequency sweep measurements uses different settings to obtain signal data it is also not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Make sure to have sufficient bandwidth to be able to capture the whole signal, including neighboring channels.

In addition to the specific diagrams and table (see description below), frequency sweep measurements support the following result displays.

- "Marker Table" on page 40
- Marker peak list
  Both result displays have the same contents as the spectrum application.

Remote command:

Measurement selection: `CONFigure[:LTE]:MEASurement` on page 220

Result display selection: `LAYout:ADD[:WINDow]?` on page 160

Adjacent Channel Leakage Ratio (ACLR)
The adjacent channel leakage ratio (ACLR) measurement is designed to analyze signals that contain multiple signals for different radio standards. Using the ACLR measurement, you can determine the power of the transmit (Tx) channel and the power of the neighboring (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.

When you measure the ACLR in the LTE application, the FSW automatically selects appropriate ACLR settings based on the selected channel bandwidth.

For a comprehensive description of the ACLR measurement, refer to the user manual of the FSW.

Remote command:
Selection: `CONF:MEAS ACLR`

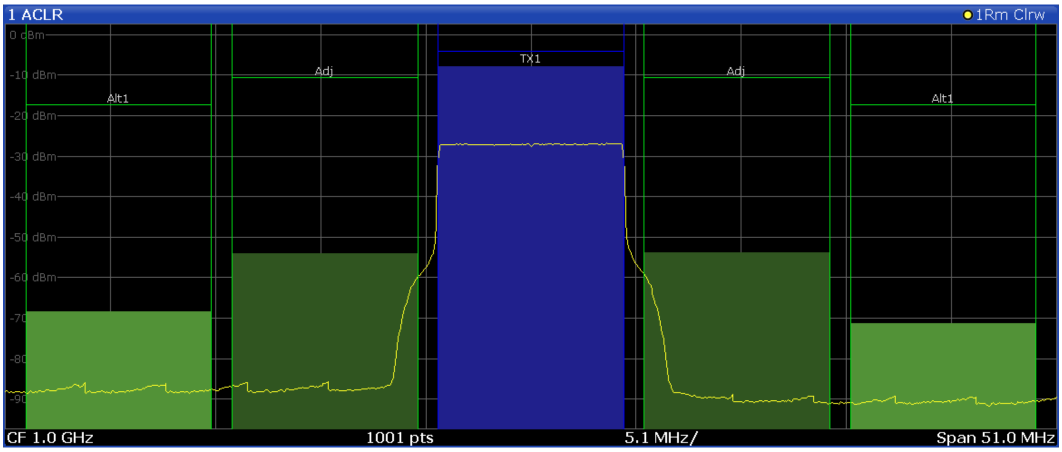
Result diagram ← Adjacent Channel Leakage Ratio (ACLR)
The result diagram is a graphic representation of the signals with a trace that shows the measured signal. Individual channels (Tx and adjacent channels) are indicated by vertical lines and corresponding labels.

In addition, the FSW highlights the channels (blue: Tx channel, green: adjacent channels).

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

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

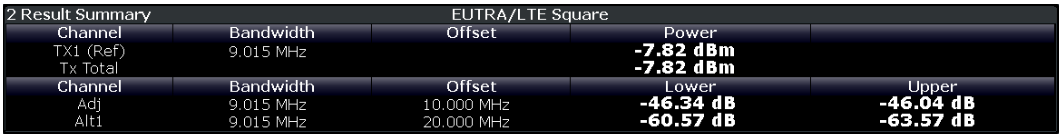
In addition, the FSW tests the ACLR measurement results against the limits defined by 3GPP.



Remote command:
Result query: TRACe:DATA?

Result summary ← Adjacent Channel Leakage Ratio (ACLR)
The result summary shows the signal characteristics in numerical form. Each row in the table corresponds to a certain channel type (Tx, adjacent channel). The columns contain the channel characteristics.

- **Channel**
  Shows the channel type (Tx, adjacent or alternate channel).
- **Bandwidth**
  Shows the channel bandwidth.
- **Offset**
  Shows the channel spacing.
- **Power**
  Shows the power of the Tx channel.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels. The values turn red if the power violates the limits.
- **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:
Result query: `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]?`

Cumulative ACLR
The cumulative ACLR measurement is designed to measure the cumulative ACLR test requirement for non-contiguous spectrum in 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 depends on the channel spacing between the carriers as defined in the test specification.

Remote command:
Selection: `CONF:MEAS CCAC`

Result diagram ← Cumulative ACLR
The result diagram is a graphic representation of the signals with a trace that shows the measured signal. Individual channels (Tx and adjacent channels) are indicated by vertical lines and corresponding labels.

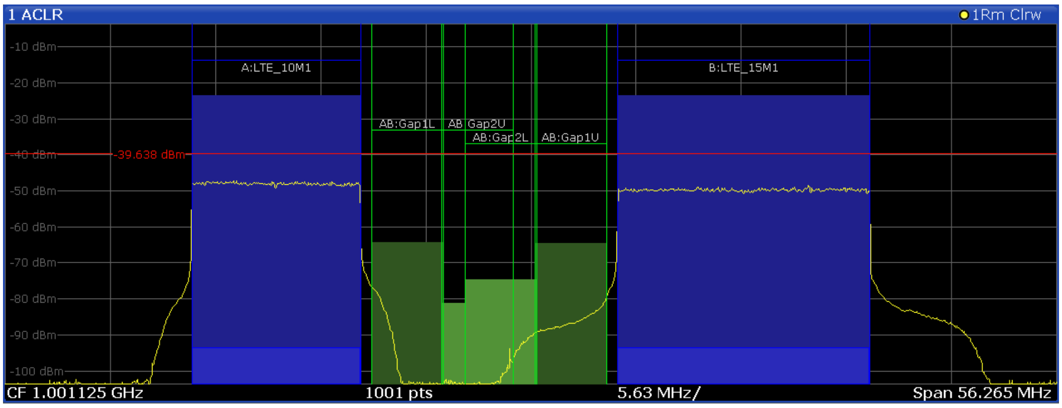
In addition, the FSW highlights the channels (blue: Tx channel, green: adjacent channels).

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 is an absolute value 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 can overlap each other.
- Blue and green bars:
  Represent the integrated power of the transmission channels (blue bars) and gap channels (green bars).



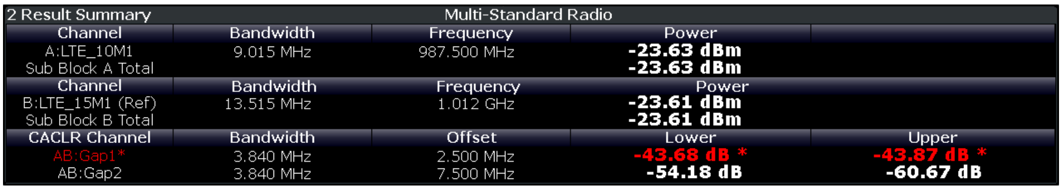
Remote command:
TRACe:DATA?

Result summary ← Cumulative ACLR
The result summary shows the signal characteristics in numerical form. Each row in the table corresponds to a certain channel type (Tx, adjacent channel). The columns contain the channel characteristics.

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:
Result query: `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]?` on page 190
Limit check adjacent: `CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?` on page 205
Limit check alternate: `CALCulate<n>:LIMit<li>:ACPower:ALTernate<alt>:RESult?` on page 207

Multi Carrier ACLR (MC ACLR)
The MC ACLR measurement is basically the same as the Adjacent Channel Leakage Ratio (ACLR) measurement: it measures the power of the transmission channels and neighboring channels and their effect on each other. Instead of measuring a single carrier, the MC ACLR measures several component carriers and the gaps in between. The component carriers do not necessarily have to be next to each other.

In its default state, the MC ACLR measurement measures one neighboring channel above and below the carrier. You can select the type and bandwidth of the neighboring channel (it is either an UTRA or E-UTRA channel) in the Carrier Aggregation panel.

Note that you can configure a different neighboring channel setup with the tools provided by the measurement. These tools are the same as those in the spectrum application. For more information, refer to the documentation of the FSW.

The configuration in its default state complies with the test specifications defined in 36.141.

Remote command:
Selection: `CONF:MEAS MCAC`

Result diagram ← Multi Carrier ACLR (MC ACLR)
The result diagram is a graphic representation of the signals with a trace that shows the measured signal. Individual channels (Tx and adjacent channels) are indicated by vertical lines and corresponding labels.

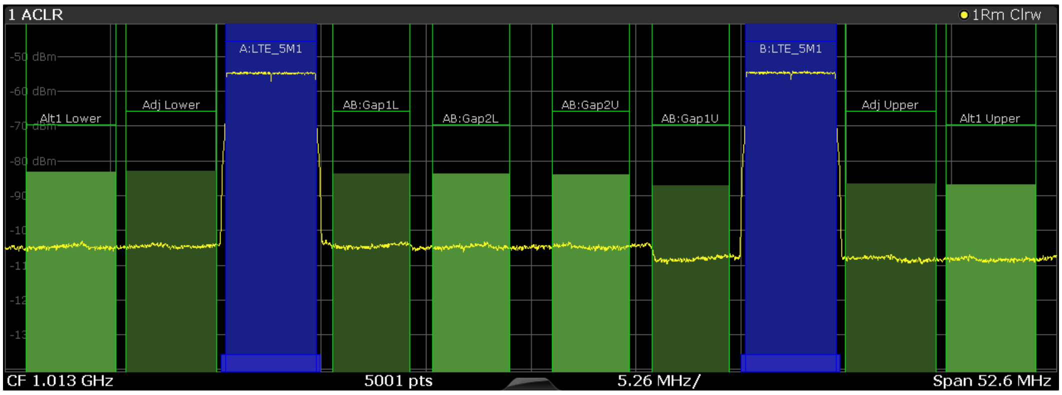
In addition, the FSW highlights the channels (blue: Tx channel, green: adjacent channels).

The x-axis represents the frequency with a frequency span that relates to the LTE channel characteristics and adjacent channel bandwidths. Note that the application automatically determines the center frequency 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 powers of the adjacent channels are values relative to the power of the TX channel. 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 neighboring channels (green lines). Note that the channels can overlap each other.
- Blue and green bars:
  Represent the integrated power of the transmission channels (blue bars) and neighboring channels (green bars).

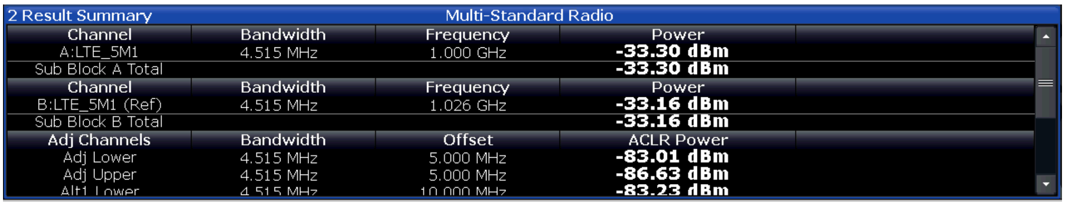


Remote command:
TRACe:DATA?

Result summary ← Multi Carrier ACLR (MC ACLR)
The result summary shows the signal characteristics in numerical form. Each row in the table corresponds to a certain channel type (Tx, adjacent channel). The columns contain the channel characteristics.

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

- **Channel**
  Shows the type of channel.
  The first rows represent the characteristics of the component carriers. The label also indicates their respective bandwidths (for example: LTE_10M1 means the first LTE channel ("_10M**1**) with a 10 MHz bandwidth ("_**10M**1")). The information also includes the total power of all component carriers.
  The other rows represent the neighboring channels (Adj Lower / Upper and Alt1 Lower / Upper).
- **Bandwidth**
  Shows the bandwidth of the channel.
  The bandwidth of the carrier is the sum of the two component carriers.
- **Frequency**
  Shows the center frequency of the component carriers.
- **Offset**
  Frequency offset relative to the center frequency of the aggregated carrier.
- **Power / Lower / Upper / Gap**
  Shows the power of the carrier and the power of the lower and upper neighboring channels relative to the power of the aggregated carrier.



Note that the font of the results turns red if the signal violates the limits defined by 3GPP.

Remote command:
Result query: `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]?` on page 190
Limit check adjacent: `CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?` on page 205
Limit check alternate: `CALCulate<n>:LIMit<li>:ACPower:ALTernate<alt>:RESult?` on page 207

Spectrum Emission Mask (SEM)
Note: The application also provides multi-SEM measurements as a separate measurement. This measurement is basically the same as the SEM measurement, with the difference that it analyzes several sub blocks, each with its own power class definition. The multi-SEM measurement also supports Carrier Aggregation.

The "Spectrum Emission Mask" (SEM) 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.

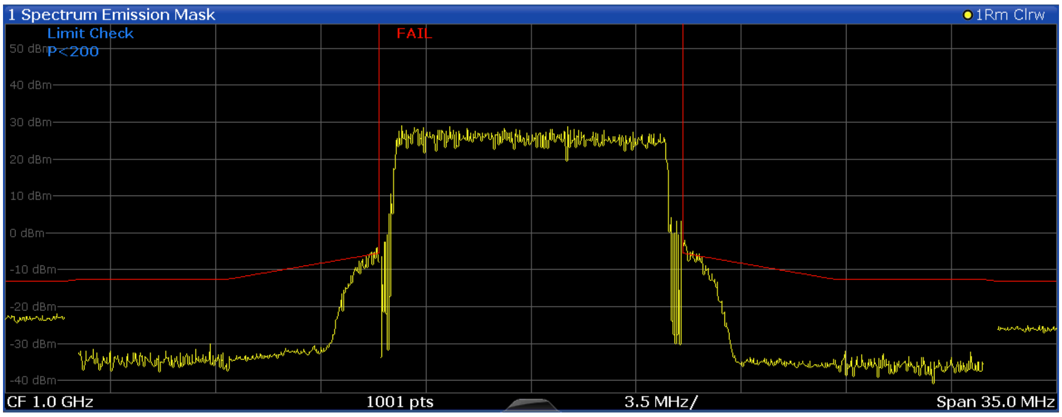
For a comprehensive description of the SEM measurement, refer to the user manual of the FSW.

Remote command:
Selection (SEM): `CONF:MEAS ESP`
Selection (Multi-SEM): `CONF:MEAS MCES`

Result diagram ← Spectrum Emission Mask (SEM)
The result diagram is a graphic representation of the signal with a trace that shows the measured signal. 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 passes. 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 LTE channel bandwidths. The y-axis shows the signal power in dBm.



Remote command:
Result query: TRACe:DATA?

Result summary ← Spectrum Emission Mask (SEM)
The result summary shows the signal characteristics in numerical form. Each row in the table corresponds to a certain SEM range. The columns contain the range characteristics. If a limit fails, the range characteristics turn red.

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the spectrum emission mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the spectrum emission 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 that the trace is below the tolerance limit, positive distances indicate that the trace is above the tolerance limit.

Note that when you perform a multi-SEM measurement, the table is expanded to show information about the subblocks.

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

Marker Peak List

The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

3 Marker Peak List

Wnd	No	X-Value	Y-Value
2	1	1.086245 ms	-75.810 dBm
2	2	2.172490 ms	-6.797 dBm
2	3	3.258736 ms	-76.448 dBm
2	4	4.831918 ms	-76.676 dBm
2	5	6.255274 ms	-76.482 dBm
2	6	6.798397 ms	-6.800 dBm
2	7	9.233084 ms	-76.519 dBm
2	8	10.075861 ms	-76.172 dBm
2	9	11.405574 ms	-6.801 dBm

Tip: To navigate within long marker peak lists, simply scroll through the entries with your finger on the touchscreen.

Remote command:

`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 160

Results:

`CALCulate<n>:MARKer<m>:X` on page 201

`CALCulate<n>:MARKer<m>:Y` on page 202

3.9 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

Test Model	Test scenario	Test described in	Measurement
	Operating band unwanted emissions	chapter 6.6.3	Spectrum emission mask
	Transmitter spurious emissions	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-TM2a	Total power dynamic range	chapter 6.3.2	OSTP (→ "Result Summary")
	Error vector magnitude	chapter 6.5.2	EVM results
	Frequency error	chapter 6.5.1	Frequency error (→ "Result Summary")
E-TM2b	Total power dynamic range	chapter 6.3.2	OSTP (→ "Result Summary")
	Error vector magnitude	chapter 6.5.2	EVM results
	Frequency error	chapter 6.5.1	OSTP (→ "Result Summary")
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-TM3.1a	Total power dynamic range	chapter 6.3.2	OSTP (→ "Result Summary")
	Error vector magnitude	chapter 6.5.2	EVM results
	Frequency error	chapter 6.5.1	Frequency error (→ "Result Summary")
E-TM3.1b	Total power dynamic range	chapter 6.3.2	OSTP (→ "Result Summary")
	Error vector magnitude	chapter 6.5.2	EVM results
	Frequency error	chapter 6.5.1	OSTP (→ "Result Summary")
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

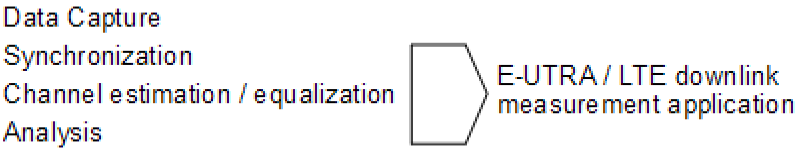
The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k} \hat{a}_{l,k}$	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 structured 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 (orange) is the estimate $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (blue) 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.

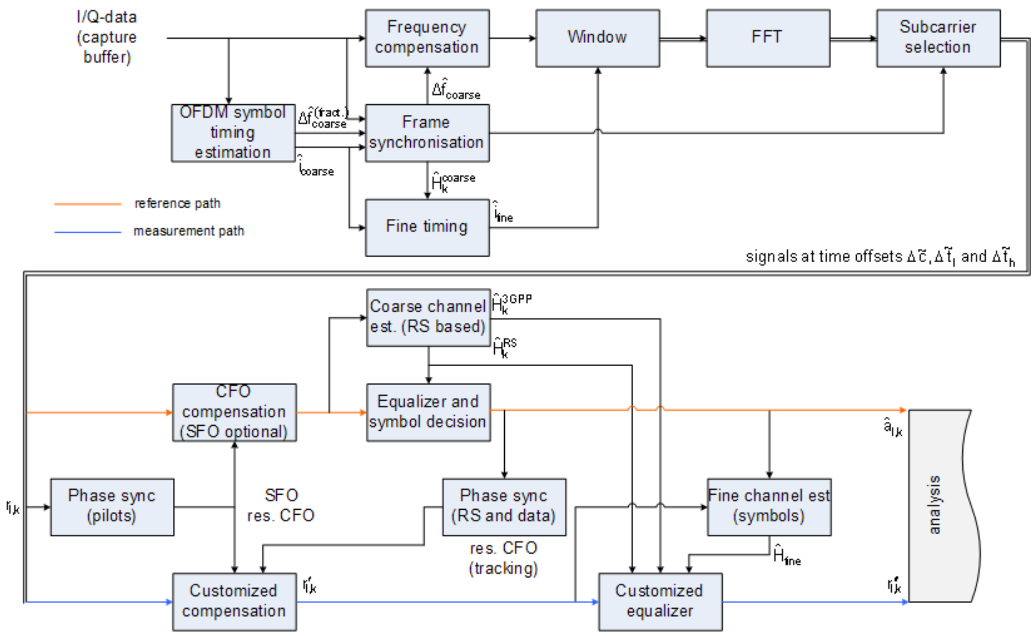


Figure 4-1: Block diagram for the LTE DL measurement application

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

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

Equation 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 equalization

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

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

Equation 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

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

Equation 4-3:

The average EVM of all data subcarriers is then

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

Equation 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

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

Equation 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

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

Equation 4-6:

and the

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

Equation 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.

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 (primary) controls the other analyzers (secondary) in the test setup. The primary analyzer has to be equipped with the LTE MIMO application and provides the reference oscillator source for the secondary analyzers.

► Connect the REF OUT of the primary analyzer to the REF IN connector of the secondary analyzers. Make sure to configure the secondary analyzers 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 primary generator to the REF IN of the secondary device. Make sure to configure the secondary devices 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 primary generator has to trigger the secondary devices 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.

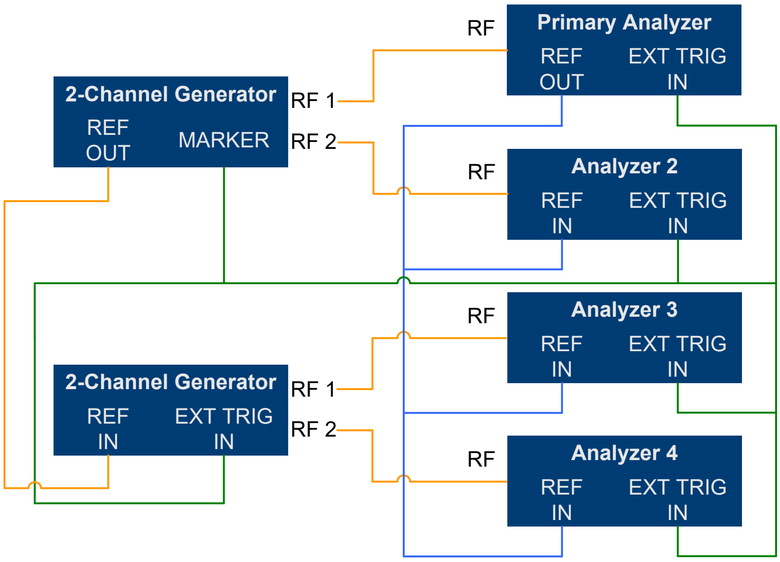


Figure 4-2: MIMO Hardware Setup

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 pre-coding implementation. Because of the bad EVM values, it is not recommended to use this test setup to measure hardware performance.

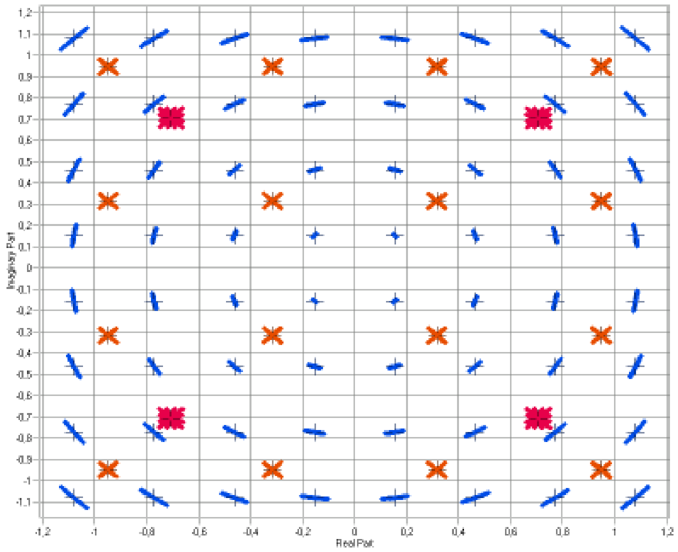


Figure 4-3: Constellation diagram

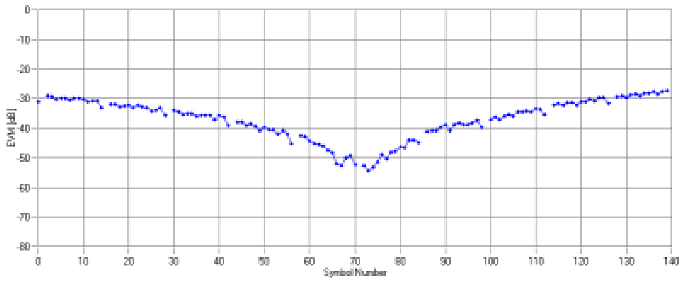


Figure 4-4: EVM vs OFDM symbol number

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 (primary and decondary devices) at the same time.

Connecting the trigger unit

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

► Connect the EXT TRIG inputs of all analyzers (primary **and** secondary) 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 primary analyzer to the TRIG OUT 2 of the trigger unit.

With this setup, all analyzers (including the primary 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 5.2.22, "Trigger configuration", on page 122.

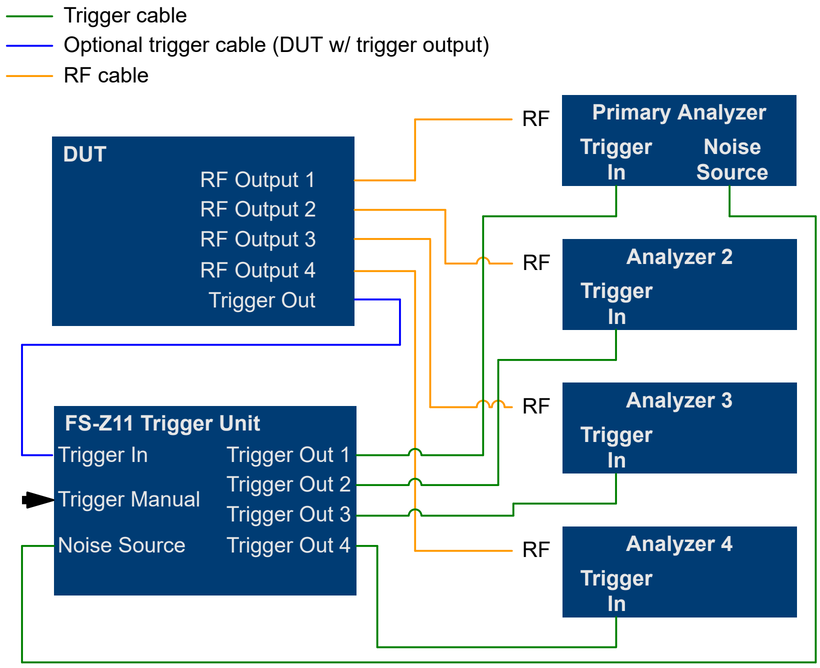


Figure 4-5: MIMO setup with trigger unit

4.5 Performing time alignment measurements

The measurement application allows you to perform time alignment measurements between different antennas.

The measurement supports setups of up to four Tx antennas.

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 4-6.

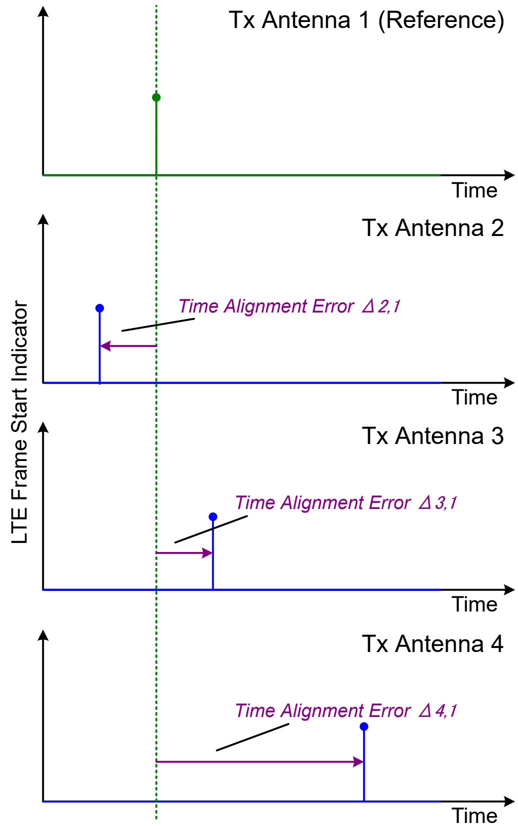


Figure 4-6: Time Alignment Error (4 Tx antennas)

Test setup

Successful Time Alignment measurements require a correct test setup.

A typical hardware test setup is shown in Figure 4-7. Note that the dashed connections are only required for MIMO measurements on 4 Tx antennas.

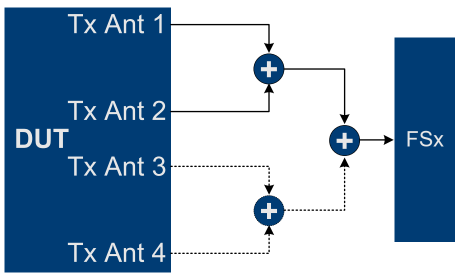


Figure 4-7: Hardware setup

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 measurement 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 describes 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. During the transmitter "Off" periods (the interesting parts of the signal for this measurement), the signal power is very low - measuring such low powers requires a low attenuation at the RF input. On the other hand, the signal power is very high during the transmitter "On" periods - in fact the signal power is usually higher than the maximum allowed RF input level. Measuring high signal levels requires an appropriate test setup as described below.

NOTICE

Risk of instrument damage

The signal power during the "On" transmitter periods in this test scenario is usually higher than the maximum power allowed at the RF input of a spectrum analyzer.

Make sure to set up the measurement appropriately. Not doing so can cause severe damage to the spectrum analyzer.

Test setup

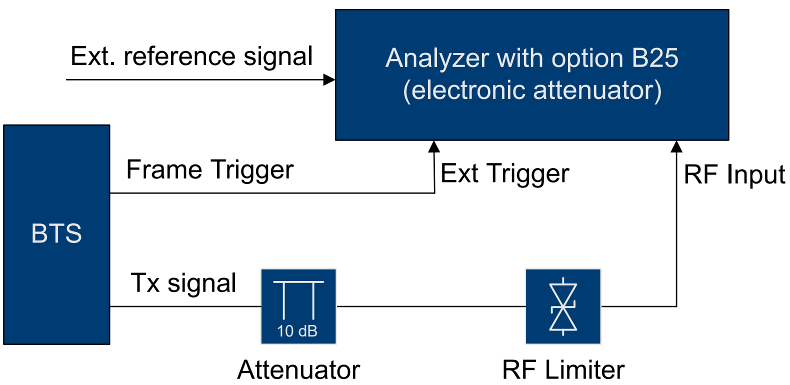


Figure 4-8: Test setup for transmit on / off power measurement

- Connect an RF limiter to the RF input to protect the RF input from damage (see Figure 4-8).
  Table 4-1 shows the specifications that the limiter has to fulfill.
- Insert an additional 10 dB attenuator in front of the RF limiter to absorb possible reflected waves (because of the high VSWR of the limiter). The maximum allowed CW input power of the attenuator must be lower than the maximum output power of the BTS.

Table 4-1: Specifications of the RF limiter in the test setup

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

Measuring the on / off power

- Use test model E-TM1.1 for transmit on / off power measurements according to 36.141, 6.4.
  For more information about loading test model settings, see Chapter 5.2.2, "Test scenarios", on page 80.
- If you are using an external trigger, you have to adjust the timing before you can start the actual measurement.
  The status message in the diagram header shows if timing adjustment is required or not. After timing was successfully adjusted, you can start the measurement. Note that relevant changes of settings might require another timing adjustment. If timing adjustment fails for any reason, the application shows a corresponding message in the diagram header. 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 synchronization state in the header is OK.
- If you are using an R&S FSQ or R&S FSG for the measurement, it is recommended to use the external trigger mode, because for high power signals a successful synchronization is not guaranteed under certain circumstances.

When you start the measurement ("Run Single"), the FSW starts the measurement. The number of measurements that trace averaging is based on depends on the number of frames you have defined. When all measurements are done, the FSW indicates in the numerical result table if the measurement has failed or passed.

4.7 O-RAN measurement guide

The O-RAN alliance specifies specific signal configurations (test cases) for standardized testing of O-RAN equipment. The FSW provides these O-RAN test cases. When you apply one of them, the measurement configuration automatically adjusts to the values of the selected test case.

Basically, you can verify O-RAN based signals by certain bit sequences in the PDSCH and the positions of those sequences. The position of the bit sequence in the PDSCH is unique for each test case.

The type of bit sequence depends on the test case.

- Some test cases use a bit sequence of all 0's.
- Some test cases use an O-RAN specific PN23 bit sequence.

In addition, the data demodulation depends on the test case (before or after descrambling).

As pointed out, these settings are automatically selected, depending on the selected test case.

For valid measurement results, it is essential that the measured signal complies with the selected test case and uses the correct bit sequences in the correct locations. If you get unexpected measurement results, check if the signal is configured correctly. You can do a quick check to validate the signal as follows.

- Check if the selected test case in the "Advanced Settings" is the same as the test case in the "Test Models" dialog.
- Use the Allocation ID vs Symbol x Carrier result display to verify if the correct PDSCH allocations are analyzed. If the signal contains the correct bit sequence, the EVM should be good.
- Use the Bitstream result display to verify if the bits match the O-RAN specifications. Each test case has a typical bit sequence. Make sure to select the bit sequence as the bitstream format.

5 Configuration

LTE measurements require a special application on the FSW, which you activate using the [MODE] key on the front panel.

When you start the LTE application, the FSW 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). After you have started an instance of the LTE application, the application displays the "Meas Config" menu which contains functions to define the characteristics of the signal you are measuring.

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

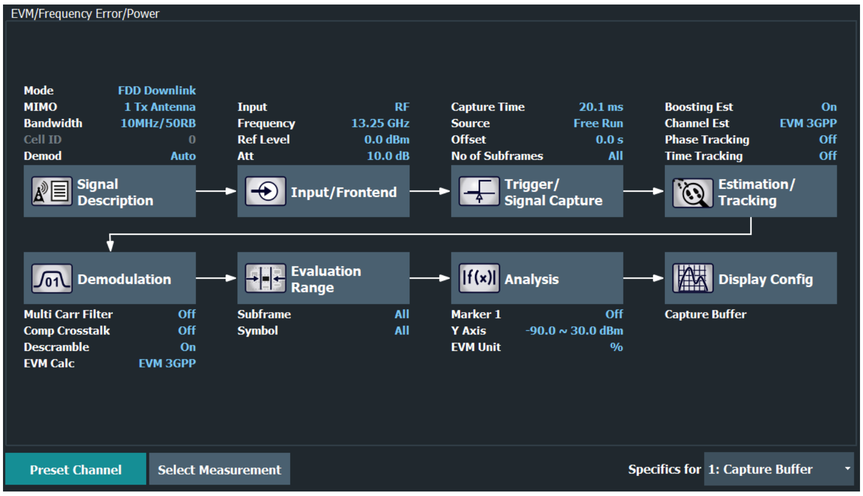
The FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before accepting 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, "Signal characteristics", on page 73.
2. Input / Frontend
   See Chapter 5.2.18, "Input source configuration", on page 109.
3. Trigger / Signal Capture
   See Chapter 5.2.22, "Trigger configuration", on page 122.
   See Chapter 5.2.21, "Data capture", on page 120
4. Estimation / Tracking
   See Chapter 5.2.24, "Measurement error compensation", on page 126.
5. Demodulation
   See Chapter 5.2.25, "Demodulation", on page 127.
6. Evaluation Range
   See Chapter 6.2.2, "Evaluation range", on page 142.
7. Analysis
   See Chapter 6, "Analysis", on page 138.
8. Display Configuration
   See Chapter 3, "Measurements and result displays", on page 17.

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 FSW.

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 "Preset Channel" in the lower left-hand corner of the "Overview" to restore all measurement settings *in the current channel* to their default values.

Note: Do not confuse "Preset Channel" with the [Preset] *key*, which restores the entire instrument to its default values and thus closes *all channels* on the FSW (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 222

Select Measurement
Opens a dialog box to select the type of measurement.

For more information about selecting measurements, see Chapter 3.1, "Selecting measurements", on page 17.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 220

Specific Settings for
The channel can 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 "Specific Settings for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

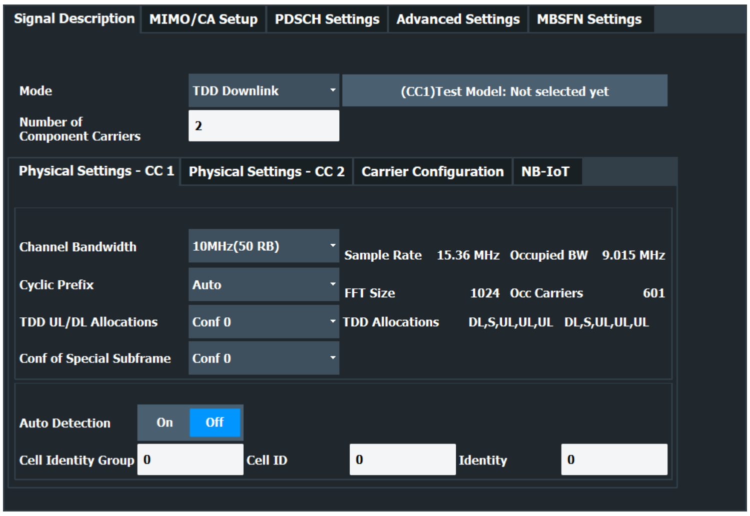
The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

5.2 I/Q measurements

5.2.1 Signal characteristics

Access: "Overview" > "Signal Description" > "Signal Description"

The general signal characteristics contain settings to describe the general physical attributes of the signal.



Selecting the LTE mode

The "Mode" selects the LTE standard 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
- Option xxx-K106 enables testing of 3GPP LTE NB-IoT TDD signals on the downlink

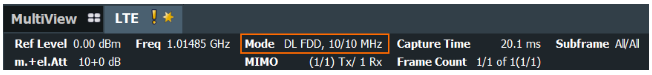
FDD and TDD are **duplexing** methods.

- 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 227
Duplexing mode: `CONFigure[:LTE]:DUPLexing` on page 223

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 FSW features several measurements that support contiguous and non-contiguous intra-band carrier aggregation (the carriers are in the same frequency band).

- I/Q based measurements (EVM, frequency error, etc.) (downlink)
- I/Q based measurements (EVM, frequency error, etc.) (uplink)
- 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 75
- "Features of the I/Q measurements" on page 75
- "Features of the time alignment error measurement" on page 76
- "Features of the transmit power on/off measurement" on page 76
- "Features of the cumulative and MC ACLR measurement" on page 76
- "Remote commands to configure carrier aggregation" on page 77

Basic component carrier configuration ← Carrier Aggregation
The number of component carriers (CCs) you can select depends on the measurement.

- I/Q based measurements (EVM etc.): up to 5 CCs
- Time alignment error: up to 2 CCs
- Transmit on/off power: up to 5 CCs
- Multi-carrier ACLR: up to 5 CCs
- Cumulative ACLR: up to 5 CCs
- Multi-carrier SEM: up to 5 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.
- For each carrier, you can select the "Bandwidth" from the corresponding dropdown menu.
- For all component carriers, the FSW 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.

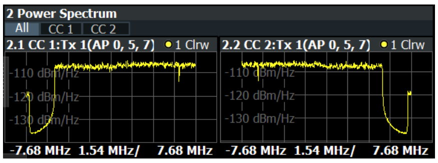
Note that the actual measurement frequency differs from the carrier frequencies: the application calculates that frequency based on the carrier frequencies. It is somewhere in between the carrier frequencies.

The measurement frequency is displayed in the channel bar.

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.

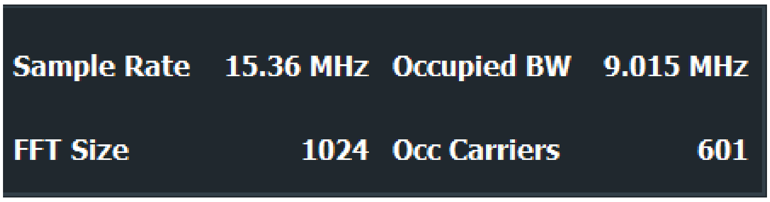
When the defined carrier configuration is not supported by the application, a corresponding error message is displayed. This can be the case, for example, if the carriers occupy a bandwidth that is too large.

Features of the I/Q measurements ← Carrier Aggregation
For measurements on component carriers, results are shown for each component carrier separately. The layout of the diagrams is adjusted like this:



- The first tab ("All") shows the results for all component carriers.
- The other tabs ("CC <x>") show the results for each component carrier individually.

The application also shows the "Occupied Bandwidth" of the aggregated carriers and the "Sample Rate" in a read-only field below the carrier configuration.



Features of the time alignment error measurement ← Carrier Aggregation
When you perform a TAE measurement, you can capture the data of the component carriers either on one FSW ("wideband capture") or on two FSW. When you capture the data with only one FSW, make sure that it has a bandwidth wide enough to capture all component carriers in a single measurement.

You can define the number of devices to measure in the corresponding input field.

You can configure additional signal characteristics of the first and second carrier in the "CC1" and "CC2" tabs.

In case you are testing a MIMO DUT, you can also select the number of antennas the DUT supports. When you select "1 Tx Antenna", the application measures the timing difference between two SISO carriers, when you select more than one antenna, it measures the timing difference between the antennas. In that case, you can select the reference antenna from the dropdown menu in the time alignment error result display.

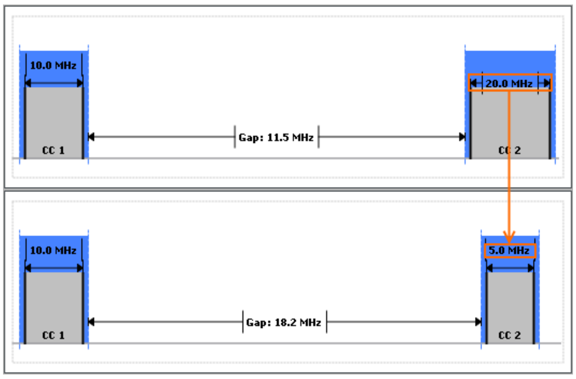
Note that the application shows measurement results for the second component carrier even if only one antenna of the second component carrier is attached (i.e. no combiner is used).

For more information on configuring measurements with multiple analyzers, see "Input Source Configuration Table" on page 83.

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.

In the MC ACLR measurement, you can also define the bandwidth characteristics of the **upper** and **lower** neighboring channels (not represented in the diagram).



Remote commands to configure carrier aggregation ← Carrier Aggregation

Remote command:
Number of carriers: CONFigure[:LTE]:NOCC on page 285
Carrier frequency: [SENSe:]FREQuency:CENTer[:CC<cc>] on page 265
Measurement frequency: SENSe:FREQuency:CENTer?
Offset: [SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet on page 265
Channel bandwidth: CONFigure[:LTE]:DL[:CC<cc>]:BW on page 223
Number of devices: CONFigure[:LTE]:NDEVices on page 288
Lower adjacent channel BW: [SENSe:]POWer:ACHannel:AAChannel on page 288
Upper adjacent channel BW: [SENSe:]POWer:ACHannel:UAAChannel on page 289

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).

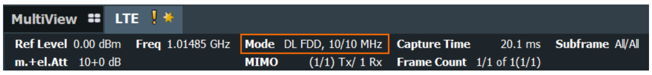
Tip: The "Auto LTE Config" feature (available in the "Auto Set" menu) automatically detects the channel bandwidth.

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, see "Carrier Aggregation" on page 74.

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



Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:BW` on page 223

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<cc>]:CYCPrefix` on page 224

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 ← Configuring TDD Frames

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

Remote command:
Subframe: `CONFigure[:LTE]:DL[:CC<cc>]:TDD:UDConf` on page 226

Conf. of Special Subframe ← Configuring TDD Frames
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:
Special subframe: `CONFigure[:LTE]:DL[:CC<cc>]:TDD:SPSC` on page 226

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 on the "Auto" function.

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<cc>]:PLC:CID` on page 225
Cell Identity Group (setting): `CONFigure[:LTE]:DL[:CC<cc>]:PLC:CIDGroup` on page 225
Cell Identity Group (query): `FETCh[:CC<cc>]:PLC:CIDGroup?` on page 228
Identity (setting): `CONFigure[:LTE]:DL[:CC<cc>]:PLC:PLID` on page 226
Identity (query): `FETCh[:CC<cc>]:PLC:PLID?` on page 228

Exclude Inband NB-IoT
The 3GPP standard specifies several operating modes, or deployments, for NB-IoT transmission. The deployment specifies where the NB-IoT signal is located in the frequency spectrum.

One of these deployments is the inband deployment. In that case, the The NB-IoT signal uses resource blocks within an LTE carrier.

You can exclude the resource blocks used by the NB-IoT signal from the measurement results when you turn on "Exclude Inband NBIoT". When you turn on this feature, you can also define the location of the NB-IoT signal within the LTE carrier as an resource block offset. The resource block offset is a value relative to resource block 0.

This feature is available for automatic PDSCH demodulation.

Remote command:
State: `CONFigure[:LTE]:DL[:CC<cc>]:EINBiot[:STATe]` on page 224
Offset: `CONFigure[:LTE]:DL[:CC<cc>]:NRBoffset` on page 224

5.2.2 Test scenarios

Access: "Overview" > "Signal Description" > "Test Models"

Test scenarios are descriptions of specific LTE signals for standardized testing of DUTs. These test scenarios are stored in `.allocation` files. You can select, manage and create test scenarios in the "Test Models" dialog box.

3GPP test models
Test models are certain signal descriptions defined by 3GPP for various test scenarios. 3GPP calls them E-TM. These E-TM are defined in 3GPP 36.141.

There are three main test model groups E-TM1, E-TM2 and E-TM3). Each of these main groups in turn contain signal descriptions for specific signal configurations (different transmission type, different bandwidth etc.).

Test models 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 is defined by 3GPP. Each E-TM is defined for all bandwidths defined in the standard (1.4 MHz / 3 MHz / 5 MHz / 10 MHz / 15 MHz / 20 MHz).

For an overview of the test scenarios, see Chapter 3.9, "3GPP test scenarios", on page 54.

Remote command:
`MMEMory:LOAD[:CC<cc>]:TMOD:DL` on page 229

ORAN test cases

O-RAN test cases are available for FDD signals.

In addition to the 3GPP test models, you can also use O-RAN test cases. O-RAN test cases are defined by the O-RAN alliance for standardized measurements.

The test cases comply with O-RAN specification O-RAN.WG4.CONF.0-v08.00.

The O-RAN test cases are based on the 3GPP test models (downlink) and fixed reference channels (uplink) and are customized for the O-RAN applications.

For more information about the test cases themselves, see the O-RAN specifications available on the O-RAN website.

For more information about using O-RAN test cases in measurements with the FSW, see Chapter 4.7, "O-RAN measurement guide", on page 68.

Remote command:
`MMEMory:LOAD[:CC<cc>]:TMOD:DL` on page 229

User defined test scenarios

User defined test scenarios are custom signal descriptions for standardized measurements that you can save and restore as you like. To create a custom test scenario, describe a signal as required and then save it with the corresponding button. The FSW stores custom scenarios in `.allocation` files.

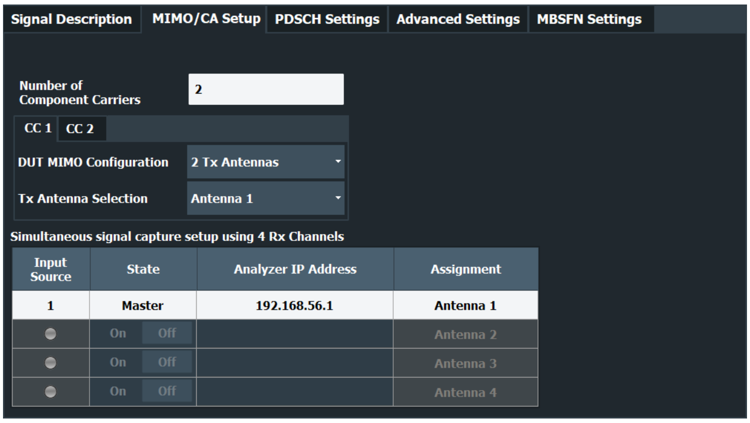
If you do not need test scenarios any longer, you can also delete them.

Remote command:
Save: `MMEMory:STORe<n>[:CC<cc>]:DEModsetting` on page 229
Restore: `MMEMory:LOAD[:CC<cc>]:DEModsetting` on page 228

5.2.3 Configuring MIMO setups

Access: "Overview" > "Signal Description" > "MIMO / CA Setup"

MIMO measurements need a special setup that you can configure with the settings available in the MIMO configuration dialog box.



For more information on MIMO measurements, see Chapter 4.4, "MIMO measurement guide", on page 61.

The "Auto LTE Config" feature (available in the "Auto Set" menu) automatically detects the MIMO configuration.

Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Result displays

For measurements with several input sources, a result display is made up out of several subwindows instead of a single window. Each subwindow corresponds to the data captured by a single input source. The number of subwindows in a result display therefore corresponds to the number of input sources you have selected. For example, if you have selected 4 input channels, the application would show 4 constellation diagrams.

Because this screen layout can make it difficult to read individual results, you have several options to increase the comfort of evaluating the results.

- Display one result display in full screen mode only.
- Open each result display in a separate window.
- Filter the results for a specific antenna port only (see "Beamforming Selection" on page 144).
  Note that a single I/Q data stream can still contain information for several antenna ports.

Functions in the "MIMO Setup" dialog box described elsewhere:

- "Number Of Component Carrier", see "Carrier Aggregation" on page 74.

DUT MIMO Configuration

The "DUT MIMO Configuration" selects the number of antennas in the system you are analyzing.

The number of antennas corresponds to the number of cell-specific reference signals.

The FSW supports measurements on one, two or four antennas.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CONFig` on page 231

Tx Antenna Selection

The "Tx Antenna Selection" selects the antenna(s) you want to analyze. The number of menu items depends on the number of antennas in the system.

Each antenna corresponds to a cell-specific reference signal.

For automatic detection, the FSW analyzes the reference signal to select the antenna. It also determines the order in which the antennas are tested.

Antenna 1	Tests antenna 1 only (AP0).
Antenna 2	Tests antenna 2 only (AP1).
Antenna 3	Tests antenna 3 only (AP2).
Antenna 4	Tests antenna 4 only (AP3).
All	Tests all antennas in the test setup in consecutive order (1-2-3-4). A corresponding number of input sources is required.
Auto (1 antenna)	Measurement on one input source and automatic detection of the connected antenna.
Auto (2 antennas)	Measurement on two input sources and automatic detection of the connected antennas. Requires 2 FSW.
Auto (4 antennas)	Measurement on four input sources and automatic detection of the connected antennas. Requires 4 FSW.

The antenna you have selected is also the reference antenna for time alignment measurements.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection` on page 231

Input Source Configuration Table

MIMO measurements require several FSWs (**input sources**), depending on the number of antennas you are about to measure. One of these analyzers (primary) controls the other analyzers. The LTE measurement application must be installed on the primary analyzer.

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. Configuration of input sources 2 to 4 is only possible if you have 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 primary 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 can assign any antenna to any analyzer in the test setup, a consecutive order is not necessary.

Remote command:
State: `CONFigure[:LTE]:ANTMatrix:STATe<in>` on page 230
IP address: `CONFigure[:LTE]:ANTMatrix:ADDRess<in>` on page 230
Instrument state: `CONFigure[:LTE]:ANTMatrix:LEDState<in>?` on page 230

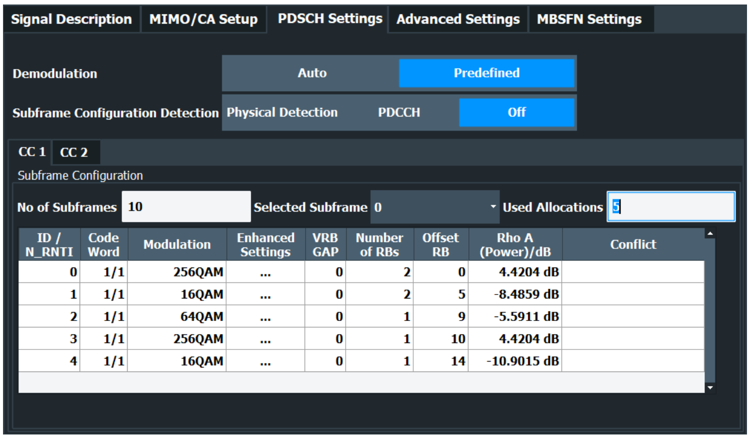
5.2.4 PDSCH demodulation

Access: "Overview" > "Signal Description" > "PDSCH Settings"

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 5.2.5, "PDSCH subframe configuration", on page 86.



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 232

Auto PDSCH Demodulation

Turns automatic demodulation of the PDSCH on and off.

When you turn on this feature, 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 232

5.2.5 PDSCH subframe configuration

Access: "Overview" > "Signal Description" > "PDSCH Settings"

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

Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Every LTE frame (FDD and TDD) contains 10 subframes. (In TDD systems, some sub-frames 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 alloca-tion.

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[:CC<cc>]:CSUBframes` on page 233

Number of allocations: `CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALCount` on page 233

5.2.5.1 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 have the same modulation scheme and power settings.

Remote command:

`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:UEID` on page 238

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, 256QAM or 1024QAM.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>[:CW<cw>]:MODulation` on page 238

Enhanced Settings
Opens a dialog box to configure MIMO functionality.

For more information see Chapter 5.2.5.2, "Enhanced settings", on page 90.

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 pur-

pose ("Localized / Distributed VRB Assignment"). Another bit in the DCI formats controls whether the first or second bit is applied.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:GAP on page 233

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 shows an error message in the "Conflicts" column and the "Error in Subframes" field.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:RBCount
on page 237

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 shows an error message.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:RBOFfset
on page 237

Power

Sets the boosting of the allocation.

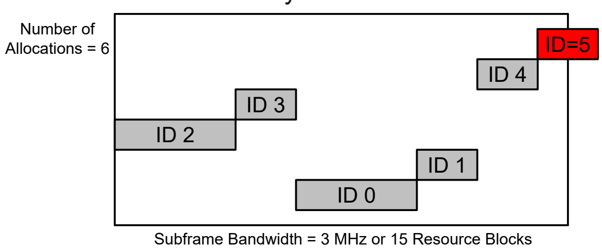
Boosting is the allocation's power relative to the reference signal power.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:POWer
on page 234

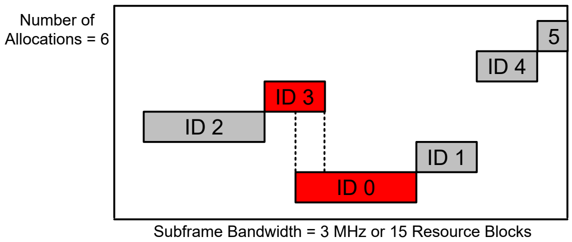
Conflict

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.



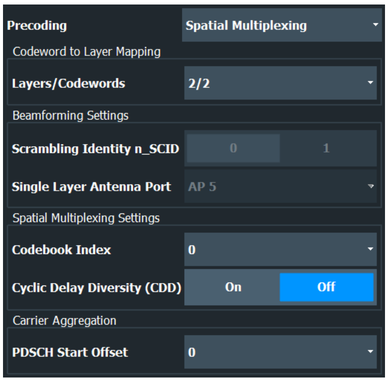
- RB overlap errors
  An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



5.2.5.2 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[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding[:SCHeme]` on page 236

Transmit Diversity

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding[:SCHeme]` on page 236

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 on the "Cyclic Delay Diversity" (CDD).

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding[:SCHeme]` on page 236
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CLMapping` on page 235
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CBINdex` on page 234
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CDD` on page 235

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[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding[:SCHeme]` on page 236
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CLMapping` on page 235
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:SCID` on page 236
`CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:AP` on page 234

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

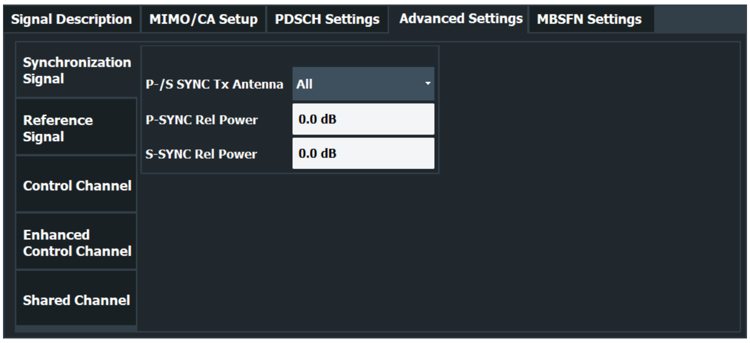
For cross-scheduled UEs, the PDSCH start offset for the secondary carrier is usually not defined for each subframe individually but is constant over several subframes. In case the control channel region of the secondary component carrier is longer than the PDSCH start offset you have defined for the 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 elements with a "#" sign.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PSOFfset on page 237

5.2.6 Synchronization signal configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Synchronization Signal"

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



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

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<cc>]:SYNC:ANTenna on page 239

P-Sync Relative Power
Defines the power of the primary synchronization signal (P-Sync) relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SYNC:PPOWer on page 242

S-Sync Relative Power
Defines the power of the secondary synchronization signal (S-Sync) relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:SYNC:SPOWer on page 242

Custom Sync Weight
Turns custom weighting of the (primary and secondary) synchronization signals on and off (for example for beamforming scenarios).

If you turn on custom weights, you can define the weights applied to the first and second half frames ("1st HF" and "2nd HF"). The signal weights are a complex number and are therefore defined by the real and imaginary parts of the signal. The number of custom weights depends on the number of antennas in your system. If you have more than one antenna, the number of custom weights you can define increases accordingly.

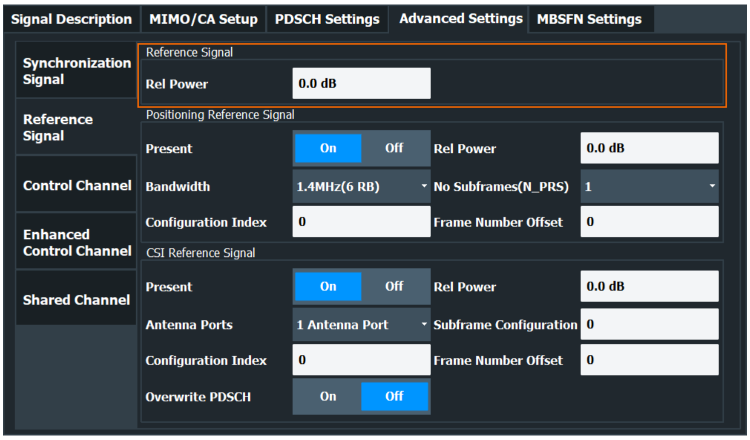
You can apply different weights for up to two frames ("No of Frames" input field). Use the "Selected Frame" field to select the frame you want to define the custom weighting for. If you define weights for more than one frame, make sure that the frame number information in the PBCH protocol is correct and do not use the same frame number in all frames.

Remote command:
State: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe] on page 242
Frame number: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:NOFRame on page 241
1st 1/2 frame real: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>:REAL on page 240
1st 1/2 frame imaginary: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>:IMAGinary on page 239
2nd 1/2 frame real: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>:REAL on page 240
2nd 1/2 frame imaginary: CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>:IMAGinary on page 239

5.2.7 Reference signal configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Reference Signal"

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



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Rel Power (Reference Signal)

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

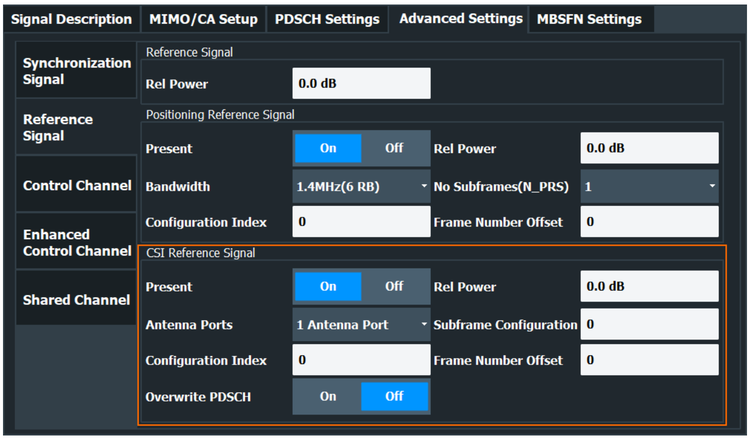
Note that this setting gives you an offset to all other relative power settings.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:REFSig:POWer on page 243

5.2.8 Positioning reference signal configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Reference Signal"

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



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Present

Turns the positioning reference signal on and off.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:PRSS:STATe on page 244

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[:CC<cc>]:PRSS:BW on page 243

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[:CC<cc>]:PRSS:CI on page 244

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PRSS:NPRS` on page 244

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[:CC<cc>]:PRSS:POWer` on page 244

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 it is 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[:CC<cc>]:SFNO` on page 245

5.2.9 Channel state information reference signal configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Reference Signal"

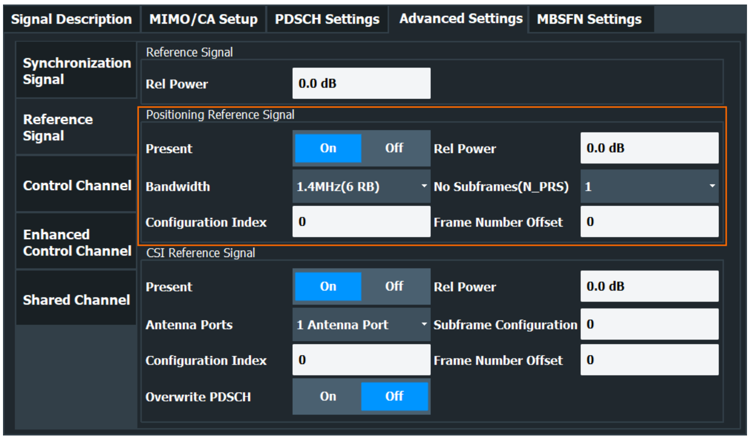
The channel state information reference signal (CSI-RS) settings contain settings to describe the physical attributes and structure of the Channel State Information Reference Signal (CSI-RS).

CSI-RS are used to estimate the channel properties of the signal propagation channel from the base station to the user equipment. 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 up to four antenna ports to the physical antenna is as follows:

- 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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Present

Turns the CSI reference signal on and off.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:STATe` on page 247

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[:CC<cc>]:CSIRs:NAP` on page 246

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[:CC<cc>]:CSIRs:CI` on page 245

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 elements with a "#" sign.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:OPDSch` on page 246

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[:CC<cc>]:CSIRs:POWer` on page 246

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[:CC<cc>]:CSIRs:SCI` on page 247

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

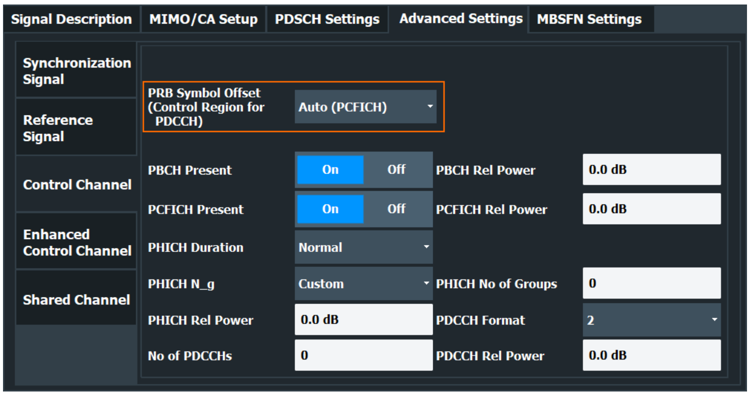
Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations it is necessary to change the expected system frame number of the frame to be analyzed.

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[:CC<cc>]:SFNO` on page 245

5.2.10 PDSCH resource block symbol offset

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Control Channel"



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

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 setting, 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.

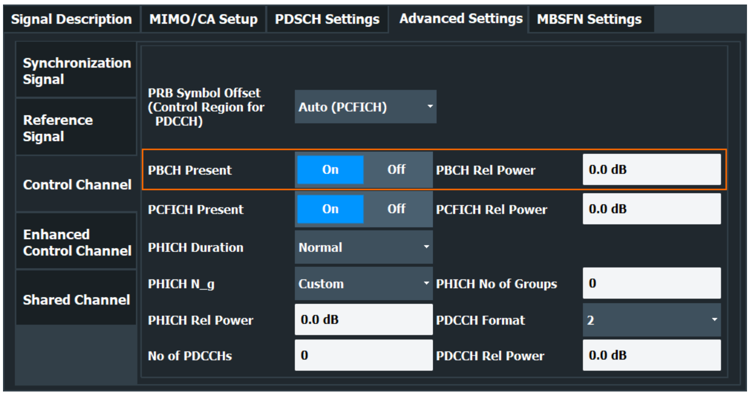
If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct demodulation of a PCFICH signal conforming to 3GPP, the Scrambling of Coded Bits has to be enabled.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PSOFfset` on page 253

5.2.11 PBCH configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Control Channel"

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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

PBCH Present

Includes or excludes the PBCH from the test setup.

Remote command:

`CONFigure[:LTE]:DL[:CC<cc>]:PBCH:STAT` on page 249

PBCH Relative Power

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

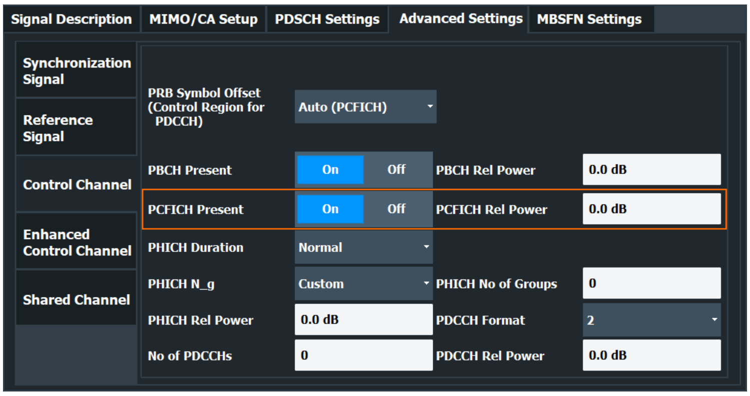
Remote command:

`CONFigure[:LTE]:DL[:CC<cc>]:PBCH:POWer` on page 249

5.2.12 PCFICH configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Control Channel"

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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

PCFICH Present

Includes or excludes the PCFICH from the test setup.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:PCFich:STAT on page 250

PCFICH Relative Power

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

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:PCFich:POWer on page 250

5.2.13 PHICH configuration

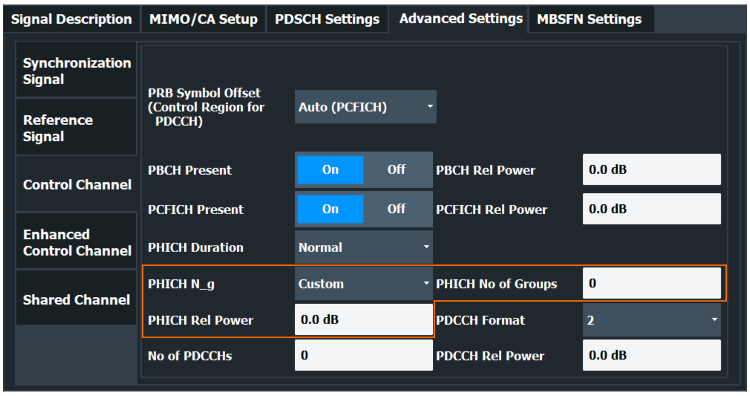
Access: "Overview" > "Signal Description" > "Advanced Settings" > "Control Channel"

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.

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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

PHICH Duration

Selects the duration of the PHICH. Normal and extended durations 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 determination of the PHICH duration.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PHICh:DURation` on page 251

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[:CC<cc>]:PHICh:MITM` on page 252

PHICH N_g

Defines 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 define the number of PHICH groups directly with PHICH Number of Groups.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PHICh:NGParameter` on page 252

PHICH Number of Groups

Defines the number of PHICH groups in a subframe.

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PHICh:NOGRoups` on page 252

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.

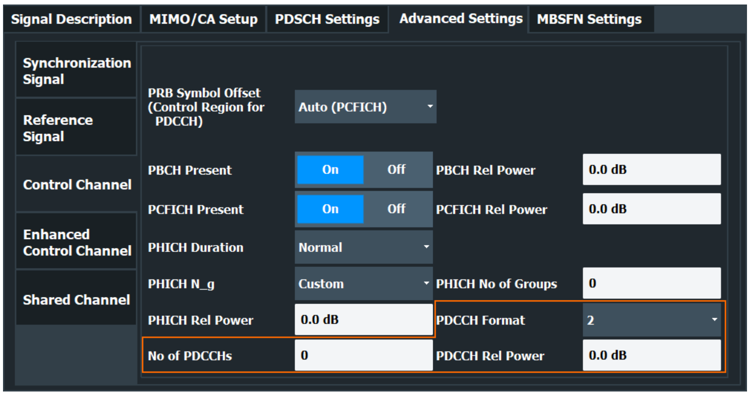
Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PHICh:POWer` on page 253

5.2.14 PDCCH configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Control Channel"

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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

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[:CC<cc>]:PDCCh:FORMat` on page 250

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[:CC<cc>]:PDCCh:NOPD` on page 251

PDCCH Rel Power

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:PDCCh:POWer` on page 251

5.2.15 EPDCCH configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Enhanced Control Channel"

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.

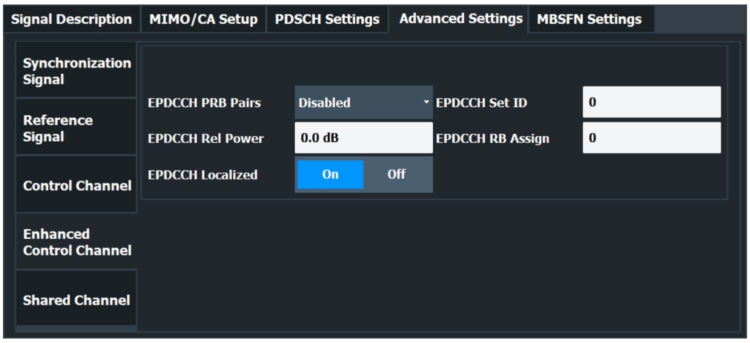
Shared resource blocks of PDSCH and EPDCCH

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. An 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.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

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[:CC<cc>]:EPDCch:NPRB` on page 248

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[:CC<cc>]:EPDCch:SID` on page 249

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:POWer` on page 248

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[:CC<cc>]:EPDCch:RBASsign` on page 248

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[:CC<cc>]:EPDCch:LOCalized` on page 248

5.2.16 Shared channel configuration

Access: "Overview" > "Signal Description" > "Advanced Settings" > "Shared Channel"

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[:CC<cc>]:PDSCh:PB on page 253

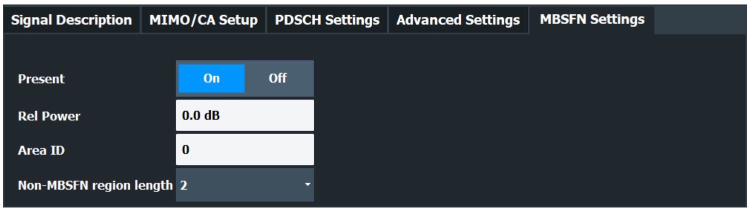
5.2.17 MBSFN characteristics

Access: "Overview" > "Signal Description" > "MBSFN Settings"

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

5.2.17.1 MBSFN configuration

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



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

Present

Includes or excludes an MBSFN from the test setup.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:STATe` on page 255

MBSFN Relative Power

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

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:POWer` on page 255

Area ID

Defines the ID for an MBFSN area.

Radio cells that 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[:CC<cc>]:MBSFn:AI:ID` on page 254

Non-MBSFN Region Length

Selects the length of the MBSFN control data region at the start of the MBSFN subframe.

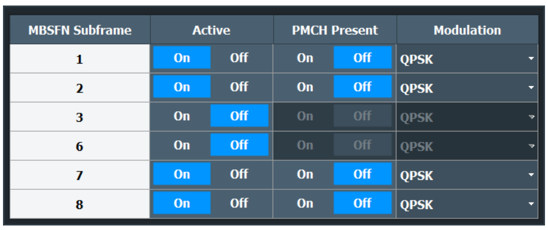
If you select a region length of '1', the first symbol in an MBFSN subframe carries data of the control channel. All other symbols of an MBSFN region may be used by the PMCH.

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[:CC<cc>]:MBSFn:AI:NMRL` on page 254

5.2.17.2 MBSFN subframes

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



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 an MBSFN subframe.

If active, the corresponding subframe contains MBSFN data.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:STATe` on page 256

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[:CC<cc>]:MBSFn:SUBFrame<sf>:PMCH:STATe`
on page 256

Modulation
Selects the modulation scheme for the MBSFN subframe.

Remote command:
`CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:PMCH:MODulation`
on page 255

5.2.18 Input source configuration

The FSW supports several input sources and outputs.

For a comprehensive description of the supported inputs and outputs, refer to the FSW user manual.

5.2.18.1 RF input

Access: "Overview" > "Input / Frontend" > "Input Source" > "Radio Frequency"

Functions to configure the RF input described elsewhere:

- "Input Coupling" on page 119
- "Impedance" on page 120

Direct Path

Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be disabled. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

For an active external frontend, the direct path is always used automatically for frequencies close to zero.

"Auto"	(Default) The direct path is used automatically for frequencies close to zero.
"Off"	The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 259

High Pass Filter 1 to 3 GHz

Activates an additional internal highpass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer to measure the harmonics for a DUT, for example.

This function requires an additional 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-preselector, if available.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 261

YIG-Preselector

Enables or disables the YIG-preselector.

This setting requires an additional option on the FSW.

An internal YIG-preselector at the input of the FSW ensures that image frequencies are rejected. However, image rejection is only possible for a restricted bandwidth. To use the maximum bandwidth for signal analysis you can disable the YIG-preselector at the input of the FSW, which can lead to image-frequency display.

Note: 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.

To use the optional 90 GHz frequency extension (R&S FSW-B90G), the YIG-preselector must be disabled.

The YIG-"Preselector" is off by default.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 261

Input Connector
Determines which connector the input data for the measurement is taken from.

For more information on the optional "Analog Baseband" interface, see the FSW I/Q Analyzer and I/Q Input user manual.

"RF"	(Default:) The "RF Input" connector
"RF Probe"	The "RF Input" connector with an adapter for a modular probe This setting is only available if a probe is connected to the "RF Input" connector. It is not available for an active external frontend.
"Baseband Input I"	The optional "Baseband Input I" connector This setting is only available if the optional "Analog Baseband" interface is installed and active for input. It is not available for the FSW67. For FSW85 models with two input connectors, this setting is only available for "Input 1".

Remote command:
`INPut:CONNector` on page 257

5.2.18.2 External mixer

Access: "Overview" > "Input / Frontend" > "Input Source" > "External Mixer"

Controlling external generators is available with the optional external generator control. The functionality is the same as in the spectrum application.

For more information about using external generators, refer to the FSW user manual.

5.2.18.3 Digital I/Q input

Access: "Overview" > "Input / Frontend" > "Input Source" > "Digital IQ"

Digital I/Q Input State
Enables or disable the use of the "Digital I/Q" input source for measurements.

"Digital I/Q" is only available if the optional "Digital Baseband" is installed.

Remote command:
INPut:SELect on page 262

Input Sample Rate
Defines the sample rate of the digital I/Q signal source. This sample rate must correspond with the sample rate provided by the connected device, e.g. a generator.

If "Auto" is selected, the sample rate is adjusted automatically by the connected device.

The allowed range is from 100 Hz to 20 GHz.

Remote command:
INPut:DIQ:SRATe on page 259
INPut:DIQ:SRATe:AUTO on page 259

Full Scale Level
The "Full Scale Level" defines the level and unit that corresponds to an I/Q sample with the magnitude "1".

If "Auto" is selected, the level is automatically set to the value provided by the connected device.

Remote command:
INPut:DIQ:RANGe[:UPPer] on page 258
INPut:DIQ:RANGe[:UPPer]:UNIT on page 259
INPut:DIQ:RANGe[:UPPer]:AUTO on page 258

Adjust Reference Level to Full Scale Level
If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

Remote command:
INPut:DIQ:RANGe:COUPling on page 258

Connected Instrument
Displays the status of the "Digital Baseband" interface connection.

If an instrument is connected, the following information is displayed:

- Name and serial number of the instrument connected to the "Digital Baseband" interface
- Used port
- Sample rate of the data currently being transferred via the "Digital Baseband" interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1" (Full Scale Level), if provided by connected instrument

Remote command:
INPut:DIQ:CDEVice on page 258

5.2.18.4 Analog baseband

Access: "Overview" > "Input / Frontend" > "Input Source" > "Analog BB"

Analog Baseband Input State
Enables or disable the use of the "Analog Baseband" input source for measurements. "Analog Baseband" is only available if the optional "Analog Baseband" is installed.

Remote command:
`INPut:SELect` on page 262

I/Q Mode
Defines the format of the input signal.

For more information on I/Q data processing modes, see the FSW I/Q Analyzer and I/Q Input User Manual.

"I + jQ" The input signal is filtered and resampled to the sample rate of the application.
Two inputs are required for a complex signal, one for the in-phase component, and one for the quadrature component.

"I Only / Low IF I"
The input signal at the "Baseband Input I" connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband I**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF I**).

"Q Only / Low IF Q"
The input signal at the "Baseband Input Q" connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband Q**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF Q**).

Remote command:
`INPut:IQ:TYPE` on page 262

Input Configuration
Defines whether the input is provided as a differential signal via all four Analog Baseband connectors or as a plain I/Q signal via two single-ended lines.

Note: Both single-ended and differential probes are supported as input; however, since only one connector is occupied by a probe, the "Single-ended" setting must be used for all probes.

"Single-ended" I, Q data only

"Differential" I, Q and inverse I,Q data
(Not available for FSW85)

Remote command:
INPut:IQ:BALanced[:STATe] on page 262

High Accuracy Timing Trigger - Baseband - RF
Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

Note: Prerequisites for previous models of FSW.
For FSW models with a serial number lower than 103000, special prerequisites and restrictions apply for high accuracy timing:
- To obtain this high timing precision, trigger port 1 and port 2 must be connected via the Cable for High Accuracy Timing (order number 1325.3777.00).
- As trigger port 1 and port 2 are connected via the cable, only trigger port 3 can be used to trigger a measurement.
- Trigger port 2 is configured as output if the high accuracy timing option is active. Make sure not to activate this option if you use trigger port 2 in your measurement setup.
- When you first enable this setting, you are prompted to connect the cable for high accuracy timing to trigger ports 1 and 2. If you cancel this prompt, the setting remains disabled. As soon as you confirm this prompt, the cable must be in place - the firmware does not check the connection. (In remote operation, the setting is activated without a prompt.)

For more information, see the FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:
CALibration:AIQ:HATiming[:STATe] on page 257

5.2.18.5 Baseband oscilloscope

Access: "Overview" > "Input / Frontend" > "Input Source" > "Baseband Oscilloscope"

Capturing I/Q data with an oscilloscope is available with the optional baseband oscilloscope inputs. The functionality is the same as in the spectrum application.

For details, see the user manual of the I/Q analyzer.

5.2.18.6 I/Q file

Access: "Overview" > "Input / Frontend" > "Input Source" > "I/Q File"

As an alternative to capturing the measurement (I/Q) data live, you can also load previously recorded I/Q data stored in an `iq.tar` file. The file is then used as the input source for the application.

Available for I/Q based measurements.

For details, see the user manual of the I/Q analyzer.

I/Q Input File State

Enables input from the selected I/Q input file.

If enabled, the application performs measurements on the data from this file. Thus, most measurement settings related to data acquisition (attenuation, center frequency, measurement bandwidth, sample rate) cannot be changed. The measurement time can only be decreased to perform measurements on an extract of the available data only.

Note: Even when the file input is disabled, the input file remains selected and can be enabled again quickly by changing the state.

Remote command:
`INPut:SELect` on page 262

Select I/Q data file

Opens a file selection dialog box to select an input file that contains I/Q data.

The I/Q data must have a specific format (`.iq.tar`) as described in FSW I/Q Analyzer and I/Q Input user manual.

The default storage location for I/Q data files is `C:\R_S\INSTR\USER`.

Remote command:
`INPut:FILE:PATH` on page 260

File Repetitions

Determines how often the data stream is repeatedly copied in the I/Q data memory to create a longer record. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Remote command:
`TRACe:IQ:FILE:REPetition:COUNt` on page 264

Selected Channel

Only available for files that contain more than one data stream from multiple channels: selects the data stream to be used as input for the currently selected channel.

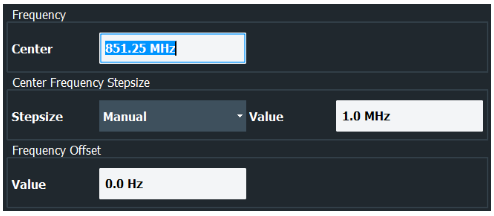
In "Auto" mode (default), the first data stream in the file is used as input for the channel. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc.

Remote command:
`MMEMory:LOAD:IQ:STReam` on page 264
`MMEMory:LOAD:IQ:STReam:AUTO` on page 264
`MMEMory:LOAD:IQ:STReam:LIST?` on page 264

5.2.19 Frequency configuration

Access: "Overview" > "Input / Frontend" > "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.



The remote commands required to configure the frequency are described in Chapter 7.10.2.3, "Frequency configuration", on page 265.

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.

Center Frequency ← Signal Frequency

Defines the center frequency of the signal and thus the frequency the FSW tunes to.

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

Remote command:
Center frequency: `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 265
Frequency offset: `[SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet` on page 265

Frequency Stepsize ← Signal Frequency

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.

You can define the stepsize in two ways.

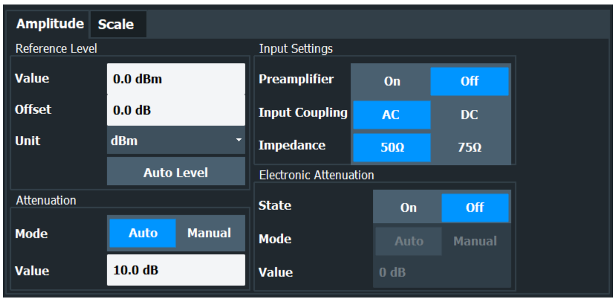
- = Center
  One frequency step corresponds to the current center frequency.
- Manual
  Define any stepsize you need.

Remote command:
Frequency stepsize: `[SENSe:]FREQuency:CENTer:STEP` on page 266

5.2.20 Amplitude configuration

Access: "Overview" > "Input / Frontend" > "Amplitude"

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



The remote commands required to configure the amplitude are described in Chapter 7.10.2.4, "Amplitude configuration", on page 267.

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 for 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 can deteriorate (e.g. EVM), 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 can 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.

The reference level is a value in dBm.

Remote command:
Reference level: `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 267

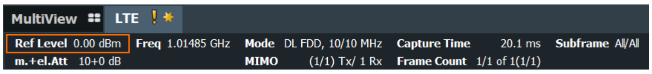
Auto Level ← Reference Level

Automatically determines the ideal reference level. The automatic leveling process measures the signal and defines the ideal reference signal for the measured signal.

Automatic level detection also optimizes RF attenuation.

Auto leveling slightly increases the measurement time, because of the extra leveling measurement prior to each sweep. By default, the FSW automatically defines the time for auto leveling, but you can also define it manually ([Auto Set] > "Auto Level Config" > "Meas Time").

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



Remote command:
Automatic: [SENSe:]ADJust:LEVel<ant> on page 285
Auto level mode: [SENSe:]ADJust:CONFigure:LEVel:DURation:MODE on page 284
Auto level time: [SENSe:]ADJust:CONFigure:LEVel:DURation on page 283

Reference Level Offset ← Reference Level

The reference level offset is 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 are 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.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 267

Attenuating the Signal

Attenuation of the signal becomes 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.

For a comprehensive information about signal attenuation, refer to the user manual of the FSW.

The LTE measurement application provides several attenuation modes.

RF Attenuation ← Attenuating the Signal

Controls the RF (or mechanical) attenuator at the RF input.

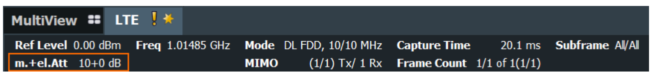
If you select automatic signal attenuation, the attenuation level is coupled to the reference level.

If you select manual signal attenuation, you can define an arbitrary attenuation (within the supported value range).

Positive values correspond to signal attenuation and negative values correspond to signal gain.

Note that when you are using an external frontend, you can define attenuation for the analyzer and the external frontend separately. For more information about external frontends, refer to the user manual of the I/Q analyzer.

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



Remote command:
State: INPut:ATTenuation<ant>:AUTO on page 268
Level: INPut:ATTenuation<ant> on page 268

Electronic Attenuation ← Attenuating the Signal
Controls the optional electronic attenuator.

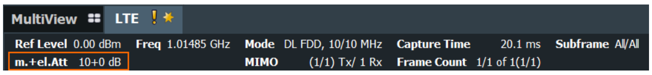
If you select automatic signal attenuation, the attenuation level is coupled to the reference level.

If you select manual signal attenuation, you can define an arbitrary attenuation (within the supported value range).

Positive values correspond to signal attenuation and negative values correspond to signal gain.

Note that the frequency range must not exceed the specification of the electronic attenuator for it to work.

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



Remote command:
Electronic attenuation: INPut:EATT<ant>:STATe on page 271
Electronic attenuation: INPut:EATT<ant>:AUTO on page 270
Electronic attenuation: INPut:EATT<ant> on page 270

Preamplifier
If the (optional) internal preamplifier hardware is installed on the FSW, a preamplifier can be activated for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low output power.

Note: If an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For an active external frontend, a preamplifier is not available.

This function is not available for input from the (optional) "Digital Baseband" interface.

For all FSW models except for FSW85, the following settings are available:

"Off"	Deactivates the preamplifier.
"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

For FSW85 models, the input signal is amplified by 30 dB if the preamplifier is activated.

Remote command:
INPut:GAIN:STATe on page 269
INPut:GAIN[:VALue] on page 269

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

For an active external frontend, input coupling is always DC.

Not available for input from the optional "Analog Baseband" interface.

Not available for input from the optional "Digital Baseband" interface.

AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can 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 specifications document.

Remote command:
`INPut:COUPling` on page 268

Impedance
For some measurements, the reference impedance for the measured levels of the FSW can be set to 50 Ω or 75 Ω.

For an active external frontend, impedance is always 50 Ω.

Select 75 Ω if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type. (That corresponds to 25Ω 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.

Not available for input from the optional "Digital Baseband" interface.

Not available for input from the optional "Analog Baseband" interface. For analog baseband input, an impedance of 50 Ω is always used.

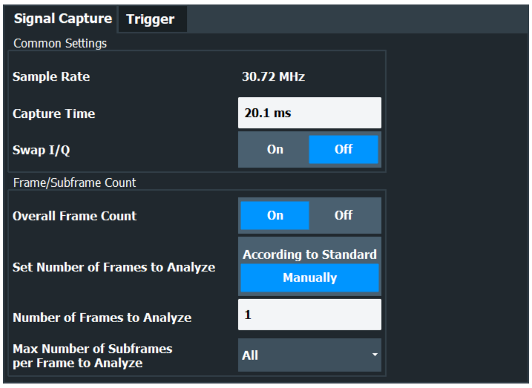
Remote command:
`INPut:IMPedance` on page 270

5.2.21 Data capture

Access: "Overview" > "Trig / Sig Capture" > "Signal 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.

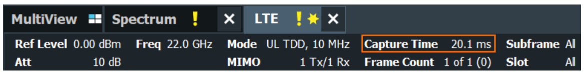


Capture Time

The "Capture Time" corresponds to the time of one measurement. Therefore, it defines the amount of data the application captures during a single measurement (or sweep).

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

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 primary channel actually captures the data. The capture time only defines the LTE analysis interval.

Remote command:
`[SENSe:]SWEep:TIME` on page 273

Swap I/Q

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

Remote command:
`[SENSe:]SWAPiq` on page 273

Overall Frame Count

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

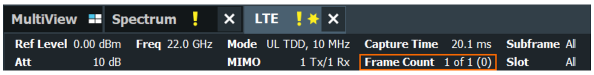
When you turn on the overall frame count, you can define the number of frames to capture and analyze. The measurement runs until all frames have been analyzed, even if it takes more than one capture.

The results are an average of the captured frames.

When you turn off the overall frame count, the application analyzes all LTE frames found in one capture buffer.

The overall frame count is always off when you measure component carrier signals.

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



Remote command:
[SENSe:][LTE:]FRAMe:COUNt:STATe on page 272

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

When you turn on this feature, the FSW captures and evaluates a number of frames the 3GPP standard specifies for EVM tests.

If you want to analyze an arbitrary number of frames, turn off the feature.

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

Remote command:
[SENSe:][LTE:]FRAMe:COUNt:AUTO on page 272

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

If the number of frames you have set last longer than a single measurement, the application continues the measurement until all frames have been captured.

The parameter is read only in the following cases:
- If you turn off the overall frame count.
- If you capture the data according to the standard.

Remote command:
[SENSe:][LTE:]FRAMe:COUNt on page 271

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 272

5.2.22 Trigger configuration

Access: "Overview" > "Trig / Sig Capture" > "Trigger"

A trigger allows you to capture those parts of the signal that you are really interested in.

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).

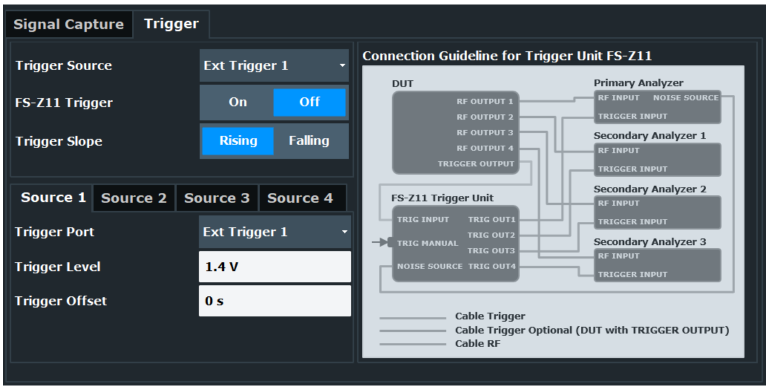
Except for the available trigger sources, the functionality is the same as that of the FSW base system. For MIMO measurements, the application provides additional features to trigger more than one instrument.

For a comprehensive description of the available trigger settings not described here, refer to the documentation of the FSW.

Gated measurements

In addition to the general trigger functions, the frequency sweep measurements (for example ACLR) also support gated measurements.

The functionality is basically the same as in the spectrum application. However, the LTE application automatically selects the correct gate settings (delay and length) according to the TDD configuration.



Trigger Source

The application supports several trigger modes or sources.

- **Free Run**
  Starts the measurement immediately and measures continuously.
- **External <x>**
  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 trigger input.
  Some measurement devices have several trigger ports. When you use one of these, several external trigger sources are available.
- **I/Q Power**
  The trigger event is the magnitude of the sampled I/Q data. The measurement starts when the magnitude of the I/Q data meets or exceeds the trigger level.
- **IF Power**

The trigger event is the level of the intermediate frequency (IF). The measurement starts when the level of the IF meets or exceeds the trigger level.

- **RF Power**
  The trigger event is the level measured at the RF input. The measurement starts when the level of the signal meets or exceeds the trigger level.

For all trigger sources, except "Free Run", you can define several trigger characteristics.

- The trigger "Level" defines the signal level that initiates the measurement.
- The trigger "Offset" is the time that must pass between the trigger event and the start of the measurement. This can be a negative value (a pretrigger).
- The trigger "Drop-out Time" defines the time the input signal must stay below the trigger level before triggering again.
- The trigger "Slope" defines whether triggering occurs when the signal rises to the trigger level or falls down to it.
- The trigger "Holdoff" defines a time period that must at least pass between one trigger event and the next.
- The trigger "Hysteresis" is available for the IF power trigger. It defines a distance to the trigger level that the input signal must stay below to fulfill the trigger condition.

For a detailed description of the trigger parameters, see the user manual of the I/Q analyzer.

Remote command:
Source: `TRIGger[:SEQuence]:SOURce<ant>` on page 278
Level (external): `TRIGger[:SEQuence]:LEVel<ant>[:EXTernal<tp>]` on page 275
Level (I/Q power): `TRIGger[:SEQuence]:LEVel<ant>:IQPower` on page 276
Level (IF power): `TRIGger[:SEQuence]:LEVel<ant>:IFPower` on page 276
Level (RF power): `TRIGger[:SEQuence]:LEVel<ant>:RFPower` on page 277
Offset: `TRIGger[:SEQuence]:HOLDoff<ant>[:TIME]` on page 274
Hysteresis: `TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 275
Drop-out time: `TRIGger[:SEQuence]:DTIMe` on page 274
Slope: `TRIGger[:SEQuence]:SLOPe` on page 277
Holdoff: `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 274

Triggering multiple data streams (MIMO measurements)
For valid MIMO measurements, it is mandatory to capture all signals simultaneously. It is therefore important to apply a trigger in these measurements and configure a trigger for each instrument you use in the setup. The LTE provides some advanced functionality not available for single stream data capture.

The "Trigger Sources" are limited to "Free Run" mode and external trigger. Free run mode analyzes all incoming data, regardless if it contains information or not. An external trigger initiates a measurement when an external trigger signal meets or exceeds a certain level.

When more than one instrument is connected in the setup, you have to configure each instrument individually in the "Source <x>" tabs. In the default state, all instruments use the same settings as the first instrument ("Same as Primary Setting" is on).

The settings for each instrument are the same as in the base unit.

You can also use a trigger unit (R&S FS-Z11)

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 on the trigger unit, 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 on the trigger unit. For more information, see "Measurements with the R&S FS-Z11 trigger unit" on page 64.

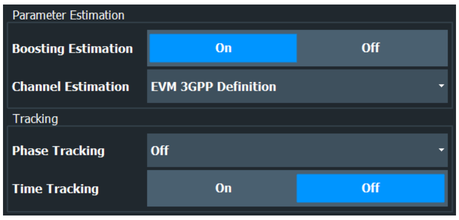
For more information about triggering single stream measurements, see "Trigger Source" on page 123 or the FSW user manual.

Remote command:
Trigger source: `TRIGger[:SEQuence]:SOURce<ant>` on page 278
Trigger slope: `TRIGger[:SEQuence]:SLOPe` on page 277
Trigger port: `TRIGger[:SEQuence]:PORT<ant>` on page 277
Trigger level: `TRIGger[:SEQuence]:LEVel<ant>[:EXTernal<tp>]` on page 275
Trigger offset: `TRIGger[:SEQuence]:HOLDoff<ant>[:TIME]` on page 274
Trigger configuration for secondary analyzer: `TRIGger[:SEQuence]:SMSetting<ant>` on page 278

5.2.23 Parameter estimation and tracking

Access: "Overview" > "Estimation / Tracking"

Parameter estimation and tracking provides functionality to estimate various settings based on the measured signal and functionality to compensate for errors in the signal.



Boosting Estimation

Turns boosting estimation on and off.

Boosting estimation, when you turn it on, automatically sets the relative power settings of all physical channels, the P-Sync and S-Sync by analyzing the signal.

Remote command:
`[SENSe:][LTE:]DL:DEMod:BESTimation` on page 282

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.
- **Off**
  Turns off channel estimation.

Remote command:
[SENSe:][LTE:]DL:DEMod:CESTimation on page 282

Phase
Turns phase tracking on and off.

When you turn on phase tracking, the application compensates the measurement results for the phase error on a symbol level.

"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 283

Time Tracking
Turns time tracking on and off.

Clock deviations (slower or faster sampling time) lead to a drift of the ideal sampling instant over time, causing a rotating constellation diagram.

When you turn on time tracking, the application compensates the measurement results for timing errors on a symbol level.

Remote command:
[SENSe:][LTE:]DL:TRACking:TIME on page 283

5.2.24 Measurement error compensation

Access: "Overview" > "Estimation / Tracking"

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

Phase
Turns phase tracking on and off.

When you turn on phase tracking, the application compensates the measurement results for the phase error on a symbol level.

"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 283

Time Tracking
Turns time tracking on and off.

Clock deviations (slower or faster sampling time) lead to a drift of the ideal sampling instant over time, causing a rotating constellation diagram.

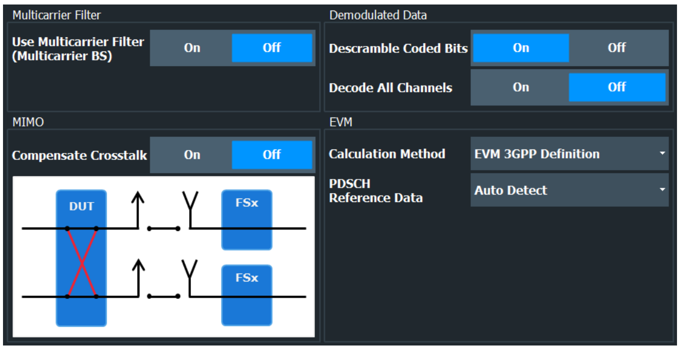
When you turn on time tracking, the application compensates the measurement results for timing errors on a symbol level.

Remote command:
`[SENSe:][LTE:]DL:TRACking:TIME` on page 283

5.2.25 Demodulation

Access: "Overview" > "Demodulation"

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.).

The FSW automatically selects the multicarrier filter when you analyze more than 1 component carrier.

Remote command:
[SENSe:][LTE:]DL:DEMod:MCFilter on page 280

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

Turn on this feature, if you expect crosstalk from the DUT or another component in the test setup. This can become 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 65.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CROSstalk on page 280

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

The scrambling of coded bits affects the bitstream results.

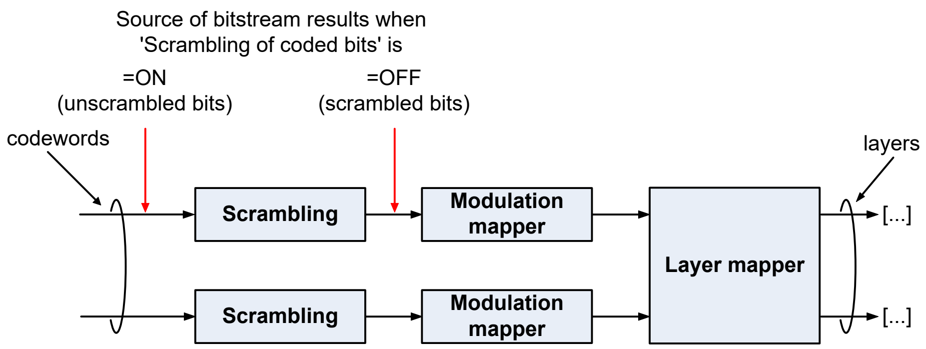


Figure 5-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
[SENSe:][LTE:]DL:DEMod:CBSCrambling on page 280

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

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

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

When you turn off the feature,

- 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 281

EVM Calculation Method
Selects the way the EVM is calculated.

"EVM 3GPP Definition"	Calculates the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the higher 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 281

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

By default, the FSW automatically detects the PDSCH reference values and maps the measured values to the nearest reference point.

"Auto Detect"	Automatically detects the PDSCH reference values.
"All 0"	Assumes the PDSCH to be all 0's, according to test model definitions.
"ORAN PN23"	Assumes the PDSCH to be based on the pseudo random sequence 23, as defined by the ORAN alliance. Note that this type of reference data is automatically selected when you select an ORAN test case. The FSW assumes that the measured signal actually contains the corresponding ORAN PN23 sequence. For this option, each PDSCH has an individual sequence.
"ORAN PN23 All Slots"	Assumes the PDSCH to be based on the pseudo random sequence 23, as defined by the ORAN alliance. Note that this type of reference data is automatically selected when you select an ORAN test case. The FSW assumes that the measured signal actually contains the corresponding ORAN PN23 sequence. For this option, all PDSCH / PDCCH have the same sequence.

Remote command:
`[SENSe:][LTE:]DL:DEMod:PRData` on page 281

Suppress Interferer for Synchronization
Turns the suppression of 5G resources with a 30 kHz subcarrier spacing in signals that use dynamic spectrum sharing on and off.

Measuring LTE signals that contain 5G resources with 30 kHz subcarrier spacing can cause synchronization to fail. Turn on this setting to synchronize such signals successfully.

Remote command:
`[SENSe:][LTE:]DL:DEMod:SISYnc` on page 281

5.2.26 Automatic configuration

Access: [AUTO SET]

The FSW features several automatic configuration routines. When you use one of those, the FSW configures different parameters based on the signal that you are measuring.

Auto leveling
You can use the auto leveling routine for a quick determination of preliminary amplitude settings for the current LTE input signal.

Remote command:
`[SENSe:]ADJust:LEVel<ant>` on page 285

Auto LTE
Determines various signal characteristics, and configures the application accordingly.

- Channel bandwidth
- MIMO configuration

Remote command:
`[SENSe:]ADJust:CONFigure:LTE` on page 284

Auto Scaling
Scales the y-axis for best viewing results. Also see "Automatic scaling of the y-axis" on page 140.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO`
on page 298

5.3 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, "Signal characteristics", on page 73
- Chapter 5.2.6, "Synchronization signal configuration", on page 92
  (note that the time alignment error measurement does not support all synchronization signal settings)
- Chapter 5.2.18, "Input source configuration", on page 109

- Chapter 5.2.19, "Frequency configuration", on page 115
- Chapter 5.2.20, "Amplitude configuration", on page 116
- Chapter 5.2.21, "Data capture", on page 120
- Chapter 5.2.22, "Trigger configuration", on page 122
- Chapter 5.2.25, "Demodulation", on page 127

For more information about configuring component carriers in the time alignment error measurement see Carrier Aggregation.

5.4 On / off power measurements

Several settings supported by on / off power 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, "Signal characteristics", on page 73
- Chapter 5.2.6, "Synchronization signal configuration", on page 92
  (Note that the on / off power measurement does not support all synchronization signal settings.)
- Chapter 5.2.18, "Input source configuration", on page 109
- Chapter 5.2.19, "Frequency configuration", on page 115
- Chapter 5.2.20, "Amplitude configuration", on page 116
- Chapter 5.2.21, "Data capture", on page 120
- Chapter 5.2.22, "Trigger configuration", on page 122

The application also provides several settings that are exclusive to on / off power measurements.

For more information about configuring component carriers in the on / off power measurement see Carrier Aggregation.

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 287

Noise Correction
Turns noise correction for on / off power measurements on and off.

For more information see the manual of the FSW.

Remote command:
`[SENSe:][LTE:]OOPower:NCORrection` on page 287

5.5 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.

Refer to the user manual of the FSW for a detailed description on how to configure ACLR and SEM measurements.

Filter type in SEM measurements

The 5G NR application uses a channel filter for SEM measurements by default. The spectrum application on the other hand uses a Gauss filter. If you need a Gauss filter for the SEM measurement in the 5G NR application, change it manually in the sweep list for the corresponding frequency ranges.

5.5.1 ACLR signal description

Access: [MEAS CONFIG] > "Signal Description"

The signal description for ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.

Functions in the "Signal Description" dialog box described elsewhere:

- LTE mode
- Test Model
- Channel bandwidth

All other settings available for the ACLR measurement are the same as in the spectrum application. For more information, refer to the user manual of the FSW.

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 adjacent channel carrier settings are defined in the 3GPP standard.

Remote command:
[SENSe:]POWer:ACHannel:AACHannel on page 288

Total Limit Pass Mode

Supported only by the LTE and 5G application.

Access (ACLR measurement): "Meas Config" > "CP / ACLR Config" > "Channel Settings" > "Limits"

Access (multi-carrier ACLR measurement): "Meas Config" > "CP / ACLR Config" > "MSR General Settings"

The "Total Limit Pass Mode" selects the logic the ACLR limits are evaluated with if you define both absolute limits and relative limits.

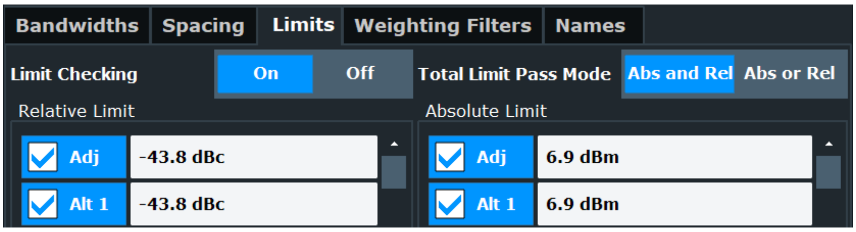


Figure 5-2: Evaluate both absolute and relative limits

If you define only relative or absolute limits, the FSW only evaluates the corresponding limits.

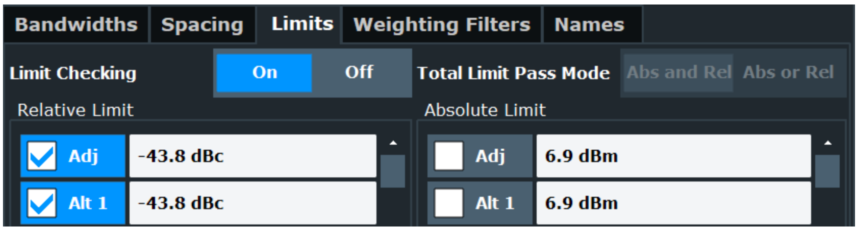


Figure 5-3: Evaluate only relative limits

If you change the limit evaluation method after the measurement, you have to refresh the measurement.

The selected method adjusts the contents of the following result displays.

- ACLR result summary
- MC ACLR result summary
- Cumulative ACLR result summary

The default value is according to 3GPP 38.141-1/2.

"Absolute"	Checks the absolute limits defined for the ACLR. The limit check passes when the signal level is within the absolute limits.
"Relative"	Checks the relative limits defined for the ACLR. The limit check passes when the signal level is within the relative limits.
"Absolute and Relative"	The limit check for both, the absolute and the relative limits, must pass to get an overall pass.

"Absolute or Relative"	The limit check for either the absolute or the relative limits must pass to get an overall pass.

Remote command:
`CALCulate<n>:LIMit<li>:ACPower:PMODe` on page 291

5.5.2 SEM and multi-carrier SEM signal description

Access: [MEAS CONFIG] > "Signal Description"

The signal description for SEM measurements contains settings to describe general physical characteristics of the signal you are measuring.

Functions in the "Signal Description" dialog box described elsewhere:
- LTE mode
- Test Model
- Channel bandwidth
- Cyclic prefix
- TDD configuration
- Component carriers
  (Multi-SEM only)

All other settings available for the SEM measurement are the same as in the spectrum application. For more information, refer to the user manual of the FSW.

Category
Selects the type and category and option of the limit definitions for SEM measurements.

The software supports limit definitions 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

Categories 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 can 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 defines the shape of the SEM.

For medium range base station, you can automatically measure or manually enter the power of the carrier Tx Power.

If you want to check against limits not covered by the "Category", turn on "Check Additional Operating Band Limit". The "Category" feature will be greyed out. Instead, you can select an "Operating Band" for which limits are defined. The FSW then tests against the limits defined in 3GPP 36.141 for the corresponding operating band.

Remote command:
[SENSe:]POWer:SEM:CATegory on page 289
Home BS power: [SENSe:]POWer:SEM:CHBS:AMPower on page 290
Medium BS power mode: [SENSe:]POWer:SEM:CHBS:AMPower:AUTO on page 290
Medium BS power value: [SENSe:]POWer:SEM:CHBS:AMPower on page 290
Operating band limit: [SENSe:]POWer:SEM:OBANd:STATe on page 291
Operating band selection: [SENSe:]POWer:SEM:OBANd on page 291

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 290

Tx Power
Defines the Tx channel power for medium range base stations. The selected channel power has an effect on the shape of the SEM limit line.

You can define the channel power either manually or automatically. For automatic detection, the FSW measures the power of the transmission channel.

Remote command:
State: [SENSe:]POWer:SEM:CHBS:AMPower:AUTO on page 290
Power: [SENSe:]POWer:SEM:CHBS:AMPower on page 290

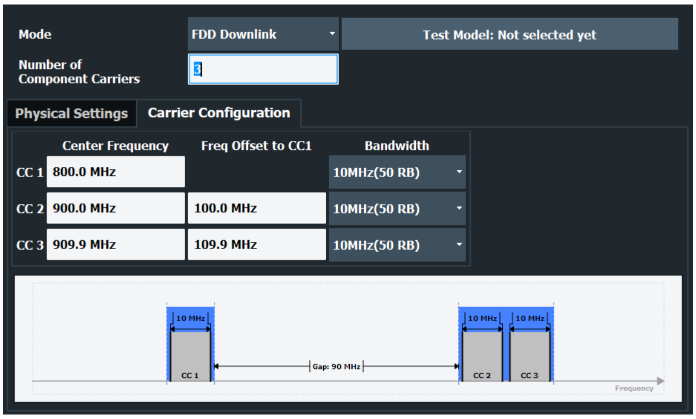
5.5.3 Cumulative ACLR

Access: "Overview" > "Signal Description" > "Physical Settings CC<x>" / "Carrier Configuration"

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.

The signal description for cumulative ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.



Functions in the "Signal Description" dialog box described elsewhere:

- LTE mode
- Test Model
- Channel bandwidth
- Cyclic prefix
- TDD configuration
- Component carriers

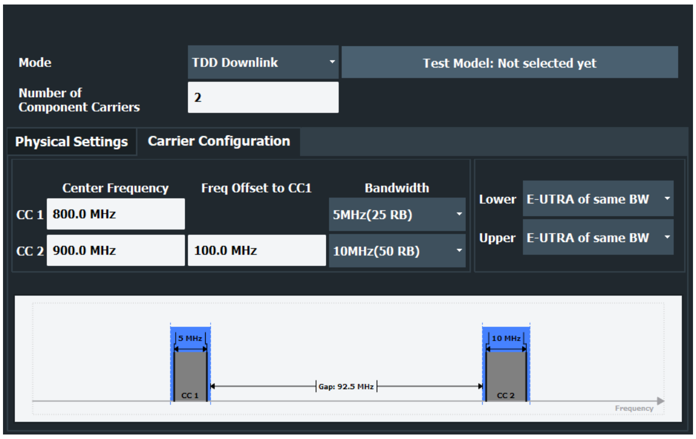
5.5.4 MC ACLR

Access: "Overview" > "Signal Description" > "Physical Settings CC<x>" / "Carrier Configuration"

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.

The signal description for multi carrier (MC) ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.



Functions in the "Signal Description" dialog box described elsewhere:

- LTE mode
- Test Model
- Channel bandwidth
- Cyclic prefix
- TDD configuration
- Component carriers

6 Analysis

The FSW provides various tools to analyze the measurement results.

6.1 General analysis tools

The general analysis tools are tools available for all measurements.

6.1.1 Data export

Access: [TRACE] > "Trace Export Config"

You can export the measurement results to an ASCII file, for example to backup the results or analyze the results with external applications (for example in a Microsoft Excel spreadsheet).

You can also export the I/Q data itself, for example if you want to keep it for later reevaluation.

The data export is available for:

- I/Q measurements
- Time alignment error measurements
- Transmit power on / off measurements

Exporting trace data

1. Select [TRACE] > "Trace Export Config".
2. Select the data you would like to export.
3. Select the results you would like to export from the "Specifics For" dropdown menu.
4. Export the data with the "Export Trace to ASCII File" feature.
5. Select the location where you would like to save the data (as a `.dat` file).

   Note that the measurement data stored in the file depend on the selected result display ("Specifics For" selection).

Exporting I/Q data

1. Select the disk icon in the toolbar.
2. Select "Export" > "I/Q Export".
3. Define a file name and location for the I/Q data.
   The default file type is iq.tar.
4. Later on, you can import the I/Q data using the I/Q file input source.

Data import and export
The basic principle for both trace export and I/Q data export and import is the same as in the spectrum application. For a comprehensive description, refer to the FSW user manual.

Remote command:
Trace export: TRACe<n>[:DATA]? on page 189
I/Q export: MMEMory:STORe<n>:IQ:STATe on page 221
I/Q import: INPut:FILE:PATH on page 260

6.1.2 Microservice export

Access: [icon] / [icon] > "Export" > "Microservice Export"

In addition to exporting the signal configuration locally, you can export the signal configuration in a file format compatible to the cloud-based microservice (.m5g file extension).

For a comprehensive description of the microservice, refer to the microservice user manual.

Remote command:

MMEMory:STORe<n>:MSERvice on page 294

6.1.3 Diagram scale

Access: "Overview" > "Analysis" > "Scale"

You can change the scale of the y-axis in various diagrams. The y-axis scale determines the vertical resolution of the measurement results.

The scale of the x-axis in the diagrams is fix. If you want to get a better resolution of the x-axis, you have to zoom into the diagram.

The remote commands required to configure the y-axis scale are described in Chapter 7.11.4, "Y-axis scale", on page 298.

Manual scaling of the y-axis
The "Y Minimum" and "Y Maximum" properties define a custom scale of the y-axis.

The "Y Minimum" corresponds to the value at the origin. The "Y Maximum" corresponds to the last value on the y-axis. The scale you select applies to the currently active window.

You can restore the original scale anytime with "Restore Scale".

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum
on page 299
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum
on page 299

Automatic scaling of the y-axis
Usually, the best way to view the results is if they fit ideally in the diagram area and display the complete trace. The "Auto Scale Once" automatically determines the scale of the y-axis that fits this criteria in the currently active window.

Tip: You can also scale the windows in the "Auto Set" menu. In addition to scaling the selected window ("Auto Scale Window"), you can change the scale of all windows at the same time ("Auto Scale All").

You can restore the original scale anytime with "Restore Scale".

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO
on page 298

6.1.4 Zoom

The zoom feature allows you to zoom into any graphical result display. This can be a useful tool if you want to analyze certain parts of a diagram in more detail.

The zoom functionality is the same as in the spectrum application.

The following zoom functions are supported.

- : Magnifies the selected diagram area.
- : Magnifies the selected diagram area, but keeps the original diagram in a separate window.
- : Restores the original diagram.

Note that the zoom is a graphical feature that magnifies the data in the capture buffer. Zooming into the diagram does not reevaluate the I/Q data.

For a comprehensive description of the zoom, refer to the FSW user manual.

6.1.5 Markers

Access: "Overview" > "Analysis" > "Marker"

Markers are a tool that help you to identify measurement results at specific trace points. When you turn on a marker, it gives you the coordinates of its position, for example the frequency and its level value or the symbol and its EVM value.

In general, the marker functionality of setting and positioning markers is similar to the spectrum application.

For I/Q measurement, the FSW supports up to four markers, for frequency sweep measurements there are more. Markers give either absolute values (normal markers) or values relative to the first marker (deltamarkers). If a result display has more than one trace, for example the "EVM vs Symbol" result display, you can position the marker on either trace. By default, all markers are positioned on trace 1.

Note that if you analyze more than one bandwidth part, each bandwidth part is represented by a different trace.

The FSW also supports several automatic positioning mechanisms that allow you to move the marker to the maximum trace value (peak), the minimum trace value or move it from peak to subsequent peak.

The marker table summarizes the marker characteristics.

For a comprehensive description, refer to the FSW user manual.

Markers in result displays with a third quantity

In result displays that show a third quantity, for example the "EVM vs Symbol x Carrier" result, the FSW provides an extended marker functionality.

You can position the marker on a specific resource element, whose position is defined by the following coordinates:

- The "Symbol" input field selects the symbol.
- The "Carrier" input field selects the carrier.

Alternatively, you can define the marker position in the "Marker Configuration" dialog box, which is expanded accordingly.

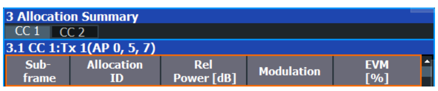
The marker information shows the EVM, the power and the allocation ID of the resource element you have selected as the marker position.

6.2 Analysis tools for I/Q measurements

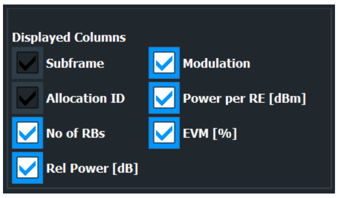
6.2.1 Layout of numerical results

You can customize the displayed information of some numerical result displays or tables, for example the allocation summary.

► Select some point in the header row of the table.



The application opens a dialog box to add or remove columns.



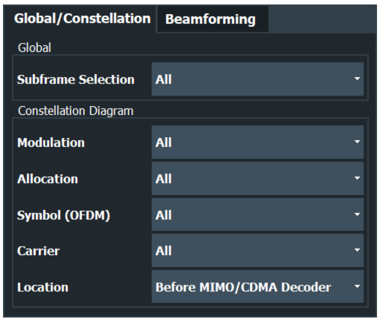
Add and remove columns as required.

6.2.2 Evaluation range

Access (general): "Overview" > "Evaluation Range" > "Global / Constellation"

Access (beamforming): "Overview" > "Evaluation Range" > "Beamforming"

The evaluation range defines the signal parts that are considered during signal analysis.



Configuring component carriers

When you are doing measurements on aggregated carriers, you can configure each carrier separately.

When available, each carrier in the dialog boxes is represented by an additional tab labeled "CC<x>", with <x> indicating the number of the component carrier.

Note that the additional tabs are only added to the user interface after you have selected more than "1" component carrier.

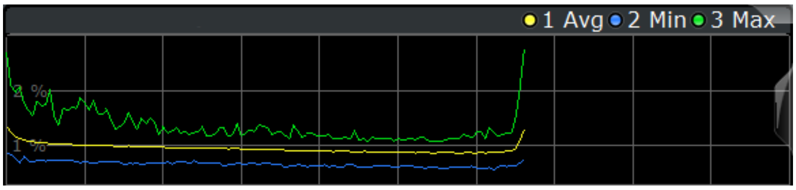
Subframe Selection

The "Subframe" selection filters the results by a specific subframe number.

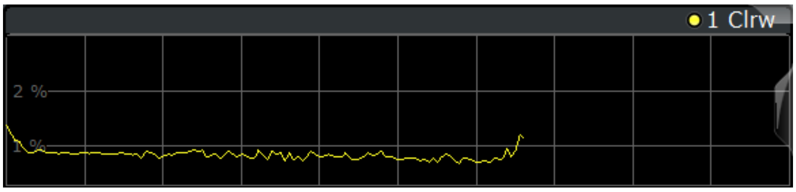
If you apply the filter, only the results for the subframe you have selected are displayed. Otherwise, the FSW shows the results for all subframes that have been analyzed.

The FSW shows three traces if you display the results for all subframes.

- One trace ("Min") shows the minimum values measured over all analyzed subframes.
- One trace ("Max") shows the maximum values measured over all analyzed subframes.
- One trace ("Avg") shows the average values measured over all subframes.



If you filter by a single subframe, the FSW shows one trace that represents the values measured for that subframe only.



You can apply the filter to the following result displays.

- Result Summary
- EVM vs Carrier / EVM vs Symbol / EVM vs Symbol X Carrier
- Channel Flatness / Channel Flatness Difference
- Group Delay
- Power vs Symbol X Carrier
- Constellation Diagram
- Allocation Summary
- Bit Stream
- Time Alignment Error

Remote command:
`[SENSe:][LTE:][CC<cc>:]SUBFrame:SELect` on page 297

Evaluation range for the constellation diagram

The "Evaluation Range" for the constellation diagram selects the information displayed in the constellation diagram.

By default, the constellation diagram contains the constellation points of the complete data that has been analyzed. However, you can filter the results by several aspects.

- Modulation
  Filters the results by the selected type of modulation.
- Allocation
  Filters the results by a certain type of allocation.
- Symbol (OFDM)
  Filters the results by a certain OFDM symbol.
  Filtering by OFDM symbols is available for constellations created before MIMO decoding.
- Carrier
  Filters the results by a certain subcarrier.

Filtering by carrier is available for constellations created before MIMO decoding.
- Symbol (code word)
  Filters the results by a certain codeword symbol.
  Filtering by codeword symbols is available for constellations created after MIMO decoding.
- Codeword
  Filters the results by a certain 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.
  For 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".

Remote command:
Modulation: `[SENSe:][LTE:][CC<cc>:]MODulation:SELect` on page 297
Allocation: `[SENSe:][LTE:][CC<cc>:]ALLocation:SELect` on page 295
Symbol: `[SENSe:][LTE:][CC<cc>:]SYMBol:SELect` on page 297
Carrier: `[SENSe:][LTE:][CC<cc>:]CARRier:SELect` on page 296
Location: `[SENSe:][LTE:][CC<cc>:]LOCation:SELect` on page 296

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.

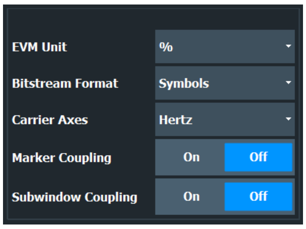
In addition, you can select the antenna port for each type of reference signal separately (UE reference signal, cell reference signal and CSI reference signal).

Remote command:
Cell RS: `CONFigure[:LTE]:DL[:CC<cc>]:BF:AP:CELL` on page 294
UE RS: `CONFigure[:LTE]:DL[:CC<cc>]:BF:AP[:UERS]` on page 295
CSI RS: `CONFigure[:LTE]:DL[:CC<cc>]:BF:AP:CSI` on page 295

6.2.3 Result settings

Access: "Overview" > "Analysis" > "Result Settings"

Result settings define the way certain measurement results are displayed.



EVM Unit

The "EVM Unit" selects the unit for the EVM measurement results in diagrams and numerical result displays.

Possible units are dB and %.

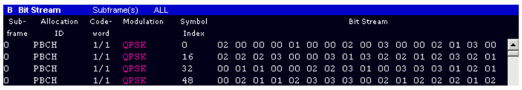
Remote command:
`UNIT:EVM` on page 301

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.

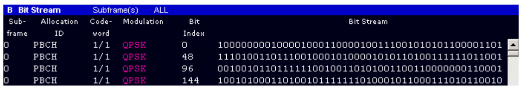
Example:



B Bit Stream Subframe(s) ALL

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	02 00 00 00 01 00 00 02 00 03 00 00 02 01 03 00
0	PBCH	1/1	QPSK	16	02 02 02 03 00 00 03 01 03 02 02 01 02 03 02 01
0	PBCH	1/1	QPSK	32	00 01 01 00 00 02 02 03 01 00 03 03 03 01 02 01
0	PBCH	1/1	QPSK	48	00 02 01 01 02 03 03 03 00 02 01 02 02 02 01 02

Figure 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	001001011011111110010011010100110011000000110001
0	PBCH	1/1	QPSK	144	100101000110100101111111010001011000111010110010

Figure 6-2: Bit stream display in downlink application if the bit stream format is set to "bits"

Remote command:
`UNIT:BSTR` on page 300

Carrier Axes

The "Carrier Axes" selects the unit of the x-axis in result displays that show results over the subcarriers.

- "Hertz"
  X-axis shows the results in terms of the subcarrier frequency.
- "Subcarrier Number"
  X-axis shows the results in terms of the subcarrier number.

Remote command:
UNIT:CAXes on page 301

Marker Coupling
Couples or decouples markers that are active in multiple result displays.

When you turn on this feature, 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<n>:MARKer<m>:COUPling on page 299

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 (for example carrier aggregation).

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:COUPling on page 300

6.3 Analysis tools for frequency sweep measurements

Access: "Overview" > "Analysis"

Access: "Overview" > "Analysis"

The analysis tools available for the frequency sweep measurements are the same as in the spectrum analyzer.

For more information, refer to the FSW user manual.

7 Remote control

The following remote control commands are required to configure and perform LTE measurements in a remote environment. The FSW 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 FSW 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).

SCPI Recorder - automating tasks with remote command scripts

The LTE measurement application also supports the SCPI Recorder functionality.

Using the SCPI Recorder functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, the instrument supports you by showing the corresponding command syntax for the current setting value.

For details see the "Network and Remote Operation" chapter in the FSW User Manual.

7.1 Common suffixes

In the LTE measurement application, the following common suffixes are used in remote commands:

Table 7-1: Common suffixes used in remote commands in the LTE measurement application

Suffix	Value range	Description
<m>	1..4	Marker
<n>	1..16	Window (**in the currently selected channel**)
<t>	1..6	Trace
	1 to 8	Limit line
<al>	0..110	Selects a subframe allocation.
<in>	1..4	Selects an instrument for MIMO measurements.
<ant>	1..4	Selects an antenna for MIMO measurements.
<cc>	1..5	Selects a component carrier. The actual number of supported component carriers depends on the selected measurement
<cluster>	1..2	Selects a cluster (uplink only).
<cw>	1..n	Selects a codeword.
<k>	---	Selects a limit line. Irrelevant for the LTE application.
<sf>	DL: 0..49 UL: 0..9	Selects a subframe.

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, usually, 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, they 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 FSW.

Remote command examples

Note that some remote command examples mentioned in this general introduction are possibly not supported by this particular application.

7.2.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the FSW 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**
  The default unit is used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

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 uppercase 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 do not 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.

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, they are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters can 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. For 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. for 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. Sometimes, you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. For physical quantities, it applies the basic unit (e.g. Hz for 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`

Sometimes, numeric values are 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 if errors occur.

7.2.6.2 Boolean

Boolean parameters represent two states. The "on" state (logically true) is represented by "`ON`" or the 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 149.

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. 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 an `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 Status register

The LTE measurement application uses the standard status registers of the FSW (depending on the measurement type). However, some registers are used differently. Only those differences are described in the following sections.

For details on the common FSW status registers refer to the description of remote control basics in the FSW user manual.

*RST does not influence the status registers.

STATus:QUEStionable:SYNC register

The `STATus:QUEStionable:SYNC` register contains application-specific information. If any errors occur in this register, the status bit #11 in the `STATus:QUEStionable` register is set to 1.

Each active channel uses a separate `STATus:QUEStionable:SYNC` register. Thus, if the status bit #11 in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific `STATus:QUEStionable:SYNC` registers. In this case, you must check the register of each channel to determine which channel caused the error. By default, querying the status of a register always returns the result for the currently selected channel. However, you can specify any other channel name as a query parameter.

Table 7-2: Meaning of the bits used in the STATus:QUEStionable:SYNC register

Bit No.	Meaning
0	Configured frame not found
1	Sync not found

Bit No.	Meaning
2 to 5	Unused
6	Auto level no signal
7	Setting mismatch
8	Signal analysis error
9 to 14	Unused
15	This bit is always 0

7.4 LTE application selection

INSTrument:CREate:DUPLicate

Duplicates the currently selected channel, i.e creates a new 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. "IQAnalyzer" -> "IQAnalyzer 2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

Is not available if the MSRA/MSRT primary channel is selected.

Example:

```
INST:SEL 'IQAnalyzer'
INST:CRE:DUPL
```

Duplicates the channel named 'IQAnalyzer' and creates a new channel named 'IQAnalyzer2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

Adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 155.

<ChannelName> String containing the name of the channel.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds a spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>, <ChannelType>, <ChannelName2>

Replaces a channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 155.

<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 155).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named "IQAnalyzer2" by a new channel of type "IQ Analyzer" named "IQAnalyzer".

Usage: Setting only

INSTrument:DELete <ChannelName>

Deletes a channel.

If you delete the last channel, the default "Spectrum" channel is activated.

Setting parameters:

<ChannelName> String containing the name of the channel you want to delete.
A channel must exist to delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Setting only

INSTrument:LIST?

Queries all active channels. The query is useful to obtain the names of the existing channels, which are required 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 channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 7-3: Available channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> parameter	Default Channel name*)
Spectrum	SANALYZER	Spectrum
1xEV-DO BTS (FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (FSW-K85)	MDO	1xEV-DO MS
3GPP FDD BTS (FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (FSW-K73)	MWCD	3G FDD UE
802.11ad (FSW-K95)	WIGIG	802.11ad
802.11ay (FSW-K97)	EDMG	802.11ay EDMG
Amplifier Measurements (FSW-K18)	AMPLifier	Amplifier
AM/FM/PM Modulation Analysis (FSW-K7)	ADEM	Analog Demod
Avionics (FSW-K15)	AVIonics	Avionics
Bluetooth (FSW-K8)	BTO	Bluetooth
cdma2000 BTS (FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (FSW-K83)	MC2K	CDMA2000 MS
DOCSIS 3.1 (FSW-K192/193)	DOCSis	DOCSIS 3.1
Fast Spur Search (FSW-K50)	SPUR	Spurious
GSM (FSW-K10)	GSM	GSM
HRP UWB (FSW-K149)	UWB	HRP UWB
I/Q Analyzer	IQ	IQ Analyzer
LTE (FSW-K10x)	LTE	LTE
Multi-Carrier "Group Delay" (FSW-K17)	MCGD	MC "Group Delay"
NB-IoT (FSW-K106)	NIOT	NB-IoT
Noise (FSW-K30)	NOISE	Noise
5G NR (FSW-K144)	NR5G	5G NR
*) If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> parameter	Default Channel name*)
OFDM VSA (FSW-K96)	OFDMVSA	OFDM VSA
OneWeb (FSW-K201)	OWEB	OneWeb
Phase Noise (FSW-K40)	PNOISE	Phase Noise
Pulse (FSW-K6)	PULSE	Pulse
"Real-Time Spectrum"	RTIM	"Real-Time Spectrum"
TD-SCDMA BTS (FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (FSW-K77)	MTDS	TD-SCDMA UE
Transient Analysis (FSW-K60)	TA	Transient Analysis
Verizon 5GTF Measurement Application (V5GTF, FSW-K118)	V5GT	V5GT
VSA (FSW-K70)	DDEM	VSA
WLAN (FSW-K91)	WLAN	WLAN
*) 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>

Renames a channel.

Setting parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

Selects a new measurement channel with the defined channel type.

Parameters:

<ChannelType> **LTE**
LTE measurement channel

Example: //Select LTE application
`INST LTE`

7.5 Screen layout

7.5.1 General layout

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel*.

DISPlay:FORMat <Format>

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>

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 164).

Suffix:

<n> Window

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALI
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: SMALI

Example: `DISP:WIND2:SIZE LARG`

DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect

Sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

Example: //Put the focus on window 1
`DISP:WIND1:SEL`

Example: //Put the focus on subwindow 2 in window 1
`DISP:WIND1:SUBW2:SEL`

DISPlay[:WINDow<n>]:TAB<tab>:SELect

Selects a tab in diagrams with multiple subwindows (or views).

Note that selecting a tab does not actually select a subwindow. To select a subwindow, for example to query the results of a subwindow, use `DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect`.

Suffix:

<n> Window

<tab> 1..n
Tab

Example: //Select a tab
`DISP:WIND2:TAB2:SEL`

7.5.2 Layout of a single channel

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.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel*.

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel.

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.

Note: Use this command to select a result display instead of `CALCulate:FEED` (still supported for compatibility reasons, but deprecated).

Query 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 21
See "EVM vs Carrier" on page 22
See "EVM vs Symbol" on page 23
See "EVM vs RB" on page 24
See "EVM vs Subframe" on page 24
See "Frequency Error vs Symbol" on page 25
See "Power Spectrum" on page 25
See "Power vs Resource Block PDSCH" on page 26
See "Power vs Resource Block RS" on page 26
See "Channel Flatness" on page 27
See "Group Delay" on page 27
See "Channel Flatness Difference" on page 28
See "Constellation Diagram" on page 28
See "CCDF" on page 29
See "Allocation Summary" on page 29
See "Bitstream" on page 30
See "Channel Decoder Results" on page 31
See "EVM vs Symbol x Carrier" on page 33
See "Power vs Symbol x Carrier" on page 33
See "Allocation ID vs Symbol x Carrier" on page 34
See "UE RS Magnitude" on page 34
See "UE RS Phase" on page 35
See "Cell RS Magnitude" on page 35
See "Cell RS Phase" on page 36
See "CSI RS Magnitude" on page 36
See "CSI RS Phase" on page 37
See "Beamform Allocation Summary" on page 37
See "Marker Table" on page 40
See "Time Alignment Error" on page 41
See "Marker Peak List" on page 54

Table 7-4: <WindowType> parameter values for LTE downlink measurement application

Parameter value	Window type
I/Q measurements	
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
CRWM	"Cell RS Magnitude"
CRWP	"Cell RS Phase"
EVCA	"EVM vs. Carrier"

Parameter value	Window type
EVRP	"EVM vs. RB"
EVSC	"EVM vs. Symbol X Carrier"
EVSU	"EVM vs. Subframe"
EVSY	"EVM vs. Symbol"
FEVS	"Frequency Error vs. Symbol"
IRWM	"CSI RS Magnitude"
IRWP	"CSI RS Phase"
GDEL	"Group Delay"
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"
URWA	"Beamforming Allocation Summary"
URWM	"UE RS Magnitude"
URWP	"UE RS Phase"
Time alignment error	
CBUF	"Capture Buffer"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
TAL	"Time Alignment Error"
Transmit on / off power	
DIAG	"Diagram"
FALL	"Falling Period 1"
OOPL	"On / Off Power List"
RIS	"Rising Period 1"
ACLR and **SEM** measurements	
DIAG	"Diagram"
PEAK	"Peak List"
MTAB	"Marker Table"
RSUM	"Result Summary"

LAYout:CATalog[:WINDow]?

Queries the name and index of all active windows in the active 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>

Queries the **index** of a particular display window in the active 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.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active channel.

Setting parameters:

<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting 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 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 160 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

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 158 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 does not work, but does not return an error.

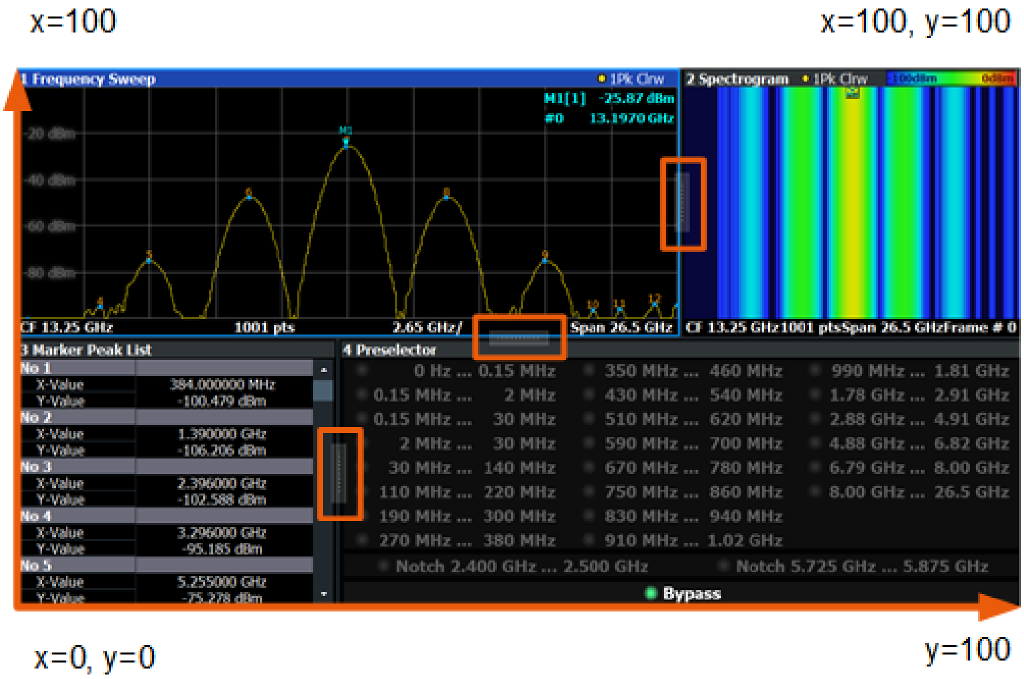


Figure 7-1: SmartGrid coordinates for remote control of the splitters

Setting 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`

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

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. Unlike `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.

Is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:

<n> Window

Query parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 160 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?

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active channel.

The effect of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 160 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see `LAYout:ADD[:WINDow]?` on page 160.

Note that this command is not available in all applications and measurements.

Suffix:

<n> 1..n
Window

Parameters:

<WindowType>

Example: `LAY:WIND2:TYPE?`

7.6 Measurement control

7.6.1 Measurements

ABORt

Aborts the measurement in the current 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 on overlapping execution see Remote control via SCPI.

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 FSW 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 FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`

- **RSIB**: `RSDLLibclr()`

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

INITiate<n>:CONTinuous <State>

Controls the measurement mode for an individual channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1 (some applications can differ)

Example: `INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

INITiate<n>[:IMMediate]

Starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Usage: Asynchronous command

[SENSe:][LTE:]OOPower:ATIMing

Adjusts the timing for on / off power measurements.

Example: //Adjust the on / off power timing
`OOP:ATIM`

Manual operation: See "Adjust Timing" on page 45

[SENSe:]SYNC[:CC<cc>][:STATe]?

Queries the current synchronization state.

Suffix:
<cc> irrelevant

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: //Query synchronization state
`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:SEQuencer:ABORt

Stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 171.

Usage: Event

INITiate:SEQuencer:IMMediate

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 171).

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement is performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and channels it contains.

Note: To synchronize to the end of a measurement sequence using `*OPC`, `*OPC?` or `*WAI`, use `SINGle` Sequencer mode.

Parameters:

<Mode>

SINGle
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitly.

*RST: CONTinuous

SYSTem:SEQuencer <State>

Turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error occurs.

A detailed programming example is provided in the "Operating Modes" chapter in the FSW 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 is performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

7.7 Trace data readout

7.7.1 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

Before querying results, you have to select the measurement window 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.

For measurements on aggregated carriers or multiple antennas, where each measurement window has subwindows, you have to select the subwindow first with DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect.

7.7.1.1 Adjacent channel leakage ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- `TRAC:DATA 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 7.7.1.31, "Return value codes", on page 186.

The following parameters are supported.

- `TRAC:DATA TRACE1`

7.7.1.3 Allocation summary

For the allocation summary, the command returns several values for each line of the table.

- `<subframe>`
- `<allocation ID>`
- `<number of RB>`
- `<relative power>`
- `<modulation>`
- `<absolute power>`
- `<EVM>`
- `<LayerEVM>`

The data format of the return values is always ASCII.

The return values have the following characteristics.

- The `<allocation ID` is encoded.
  For the code assignment, see Chapter 7.7.1.31, "Return value codes", on page 186.
- The unit for `<relative power>` is always dB.
- The `<modulation>` is encoded.

For the code assignment, see Chapter 7.7.1.31, "Return value codes", on page 186.

- The unit for `<absolute power>` is always dBm.
- The unit for `<EVM>` depends on `UNIT:EVM`.
- The unit for `<LayerEVM>` depends on `UNIT:EVM`.

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, 8.2587600145187E-05
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05, 2.9270188222955E-05
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05, 2.5002471912438E-05
...
```

Additional information "ALL"

The allocation summary contains additional lines "ALL" that summarize the number of RB analyzed in each subframe and the average EVM measured in that subframe. This information is added to the return values after all allocations of the subframe have been returned. The "ALL" information has the allocation ID code "-2".

In addition, there is a line at the end of the allocation summary that shows the average EVM over all analyzed subframes. This information is also added as the last return values. The "ALL" information has the subframe ID and allocation ID code "-2".

A query result would thus look like this, for example:

```
//For subframe 0:
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
(...)
//ALL for subframe 0:
0,-2,20,,,,2.45581475911678E-06
//For subframe 1:
1, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
1, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
(...)
//ALL for subframe 1:
1,-2,20,,,,2.45581475911678E-06
(...)
//ALL for all subframes
-2,-2,,,,,2.13196434228374E-06
```

7.7.1.4 Beamform allocation summary

For the beamform allocation summary result display, the command returns four values for each allocation that has been found.

`<Subframe>, <AllocationID>, <Phase>, <PhaseDifference>, ...`

The unit for `<Phase>` and `<PhaseDifference>` is always degrees. The `<Subframe>` has no unit.

The `<allocation ID>` is encoded. For the code assignment see Chapter 7.7.1.31, "Return value codes", on page 186.

7.7.1.5 Bit stream

For the bitstream result display, the number of return values depends on the parameter.

- `TRACE:DATA TRACE1`
  Returns several values and the bitstream for each line of the table.
  `<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`
- `TRACE:DATA TRACE2`
  Returns all informative values of an allocation, including the totals over all PDSCH allocations that contribute to the bitstream, but not the bitstream itself.
  `<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...,<total # bits>, <total # bit errors>, <total # decoded bits>, <total bit error rate>`
- `TRACE:DATA TRACE3`
  Returns all informative values of an allocation, including the totals over all PDSCH allocations that contribute to the bitstream, but not the bitstream itself. The difference to `TRACE2` is that this query also includes the Bit/s result.
  `<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...,<total # bits>, <total # bit errors>, <total # decoded bits>, <total bit error rate>, <bits/second>`

All values have no unit. The format of the bit stream depends on Bit Stream Format.

The `<allocation ID>`, `<codeword>` and `<modulation>` are encoded. For the code assignment see Chapter 7.7.1.31, "Return value codes", on page 186.

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, ...
```

7.7.1.6 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.

- `TRAC:DATA TRACE1`

Note that the command returns positive peak values only.

7.7.1.7 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- `TRAC:DATA 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.
- `TRAC:DATA 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.

7.7.1.8 Cell RS weights phase

For the cell RS weights magnitude result display, the command returns one value for each subcarrier that has been analyzed.

`<Phase>, ...`

The unit degree.

The following parameters are supported.

- `TRAC:DATA TRACE1`
  Returns the phase of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.9 Cell RS weights magnitude

For the cell RS weights magnitude result display, the command returns one value for each subcarrier that has been analyzed.

`<Magnitude>, ...`

The unit is dB.

The following parameters are supported.

- `TRAC:DATA TRACE1`
  Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.10 Channel decoder results

For the channel decoder results, the number and type of return values depend on the parameter.

- `TRAC:DATA 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 7.7.1.31, "Return value codes", on page 186.
  If PBCH decoding was not successful, the command returns NAN.
- `TRAC:DATA 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.
- `TRAC:DATA 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 7.7.1.31, "Return value codes", on page 186.
- `TRAC:DATA 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 7.7.1.31, "Return value codes", on page 186.

- `TRAC:DATA 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 7.7.1.31, "Return value codes", on page 186.

7.7.1.11 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.

- `TRAC:DATA TRACE1`
  Returns the average power over all subframes.
- `TRAC:DATA TRACE2`
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- `TRAC:DATA TRACE3`
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.12 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.

- `TRAC:DATA TRACE1`

Returns the average power over all subframes.

- `TRAC:DATA TRACE2`
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- `TRAC:DATA TRACE3`
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.13 Group delay

For the 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.

- `TRAC:DATA TRACE1`
  Returns the group delay.

7.7.1.14 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.

- `TRAC:DATA TRACE1`
  Returns all constellation points included in the selection.

7.7.1.15 CSI RS weights magnitude

For the CSI 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.

- `TRAC:DATA TRACE1`
  Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.16 CSI RS weights phase

For the CSI RS weights phase result display, the command returns one value for each subcarrier that has been analyzed.

`<Phase>, ...`

The unit degrees.

The following parameters are supported.

- `TRAC:DATA TRACE1`
  Returns the phase of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.17 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.

- `TRAC:DATA TRACE1`
  Returns the average EVM over all subframes
- `TRAC:DATA TRACE2`
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- `TRAC:DATA TRACE3`
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.18 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.

- TRAC:DATA TRACE1
  Returns the average EVM for each resource block over all subframes.
- TRAC:DATA TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a single subframe, it returns nothing.
- TRAC:DATA TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a single subframe, it returns nothing.

7.7.1.19 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.

- TRAC:DATA TRACE1

7.7.1.20 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.

- TRAC:DATA TRACE1

7.7.1.21 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.

- `TRAC:DATA TRACE1`

7.7.1.22 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.

- `TRAC:DATA TRACE1`

7.7.1.23 On/off power

For the on/off power measurement, the number and type of return values depend on the parameter.

- `TRAC:DATA TRACE1`
  Returns the power for the Off power regions.
  `<absolute power>,...`
  The unit is always dBm.
- `TRAC:DATA TRACE2`
  Returns the power for the transient regions.
  `<absolute power>,...`
  The unit is always dBm.
- `TRAC:DATA 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.

7.7.1.24 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.

- `TRAC:DATA TRACE1`

7.7.1.25 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.

- `TRAC:DATA TRACE1`
  Returns the average power over all subframes
- `TRAC:DATA TRACE2`
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- `TRAC:DATA TRACE3`
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.26 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.

- `TRAC:DATA TRACE1`
  Returns the average power over all subframes
- `TRAC:DATA TRACE2`
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- `TRAC:DATA TRACE3`
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

7.7.1.27 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.

- `TRAC:DATA TRACE1`

7.7.1.28 Spectrum emission mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- `TRAC:DATA TRACE1`
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- `TRAC:DATA 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).

7.7.1.29 UE RS weights magnitude

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.

- `TRAC:DATA TRACE1`
  Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.30 UE RS weights phase

For the UE RS phase result display, the command returns one value for each subcarrier that has been analyzed.

`<Phase>, ...`

The unit degrees.

The following parameters are supported.

- `TRAC:DATA TRACE1`
  Returns the phase of the measured weights of the reference signal (RS) carriers over one subframe.

7.7.1.31 Return value codes

<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.

<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
- **-13** = PMCH
- **-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.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = CAZAC
- **7** = mixed modulation
- **8** = BPSK
- **14** = 256QAM
- **15** = 1024QAM

<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

FORMat[:DATA] <Format>

Selects the data format for the data transmission between the FSW and the remote client.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: //Select data format

```
FORM REAL
```

TRACe<n>[:DATA]? <Result>

This command queries the trace data for each measurement point (y-axis values).

In combination with `TRACe<n>[:DATA]:X?`, you can thus query the coordinates of each measurement point.

Suffix:

<n>	Window

Query parameters:

<TraceNumber>	**TRACE1 | TRACE2 | TRACE3** Queries the trace data of the corresponding trace.
LIST	Queries the results for the SEM measurement.
PBCH	Queries the results for the PBCH in the channel decoder.
PCFICH	Queries the results for the PCFICH in the channel decoder.
PHICH	Queries the results for the PHICH in the channel decoder.
PDCCH	Queries the results for the PDCCH in the channel decoder.

Return values:

<TraceData>	For more information about the type of return values in the different result displays, see Chapter 7.7.1, "The TRACe[:DATA] command", on page 172.

Example: //Query 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.
```
TRAC2? TRACE1
```

Usage: Query only

Manual operation: See "Data import and export" on page 139

TRACe<n>[:DATA]:X? <Result>

Queries the horizontal trace data for each measurement point (x-axis values).

In combination with `TRACe<n>[:DATA]?`, you can thus query the coordinates of each measurement point.

Suffix:

<n>	Window

Query parameters:

<TraceNumber>	TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6

Return values:

<TraceData>	The type of value depends on the information displayed on the x-axis of the result display whose contents you query.

Example: //Query trace data of trace 1 in window 2
```
TRAC2? TRACE1
TRAC2:X? TRACE1
```

Usage: Query only

Manual operation: See "Capture Buffer" on page 21
See "EVM vs Carrier" on page 22
See "EVM vs Symbol" on page 23
See "EVM vs RB" on page 24
See "EVM vs Subframe" on page 24
See "Frequency Error vs Symbol" on page 25
See "Power Spectrum" on page 25
See "Power vs Resource Block PDSCH" on page 26
See "Power vs Resource Block RS" on page 26
See "Channel Flatness" on page 27
See "Group Delay" on page 27
See "Channel Flatness Difference" on page 28

7.7.2 Result readout

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]? [<Measurement>]

Queries the 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:

<n> Window

<m> Marker

<sb> irrelevant

Query parameters:

<Measurement>

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 "Result summary" on page 48
See "Result summary" on page 49
See "Result summary" on page 51

7.8 Numeric result readout

7.8.1 Frame results

FETCh[:CC<cc>]:SUMMary:EVM:DSQP:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSQP:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSQP[:AVERage]?

Queries the EVM of all PDSCH resource elements with a QPSK modulation.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:DSQP?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:DSST:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSST:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSST[:AVERage]?

Queries the EVM of all PDSCH resource elements with a 16QAM modulation.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:DSST?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:DSSF:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSSF:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSSF[:AVERage]?

Queries the EVM of all PDSCH resource elements with a 64QAM modulation.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:DSSF?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:DSTS:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSTS:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:DSTS[:AVERage]?

Queries the EVM of all PDSCH resource elements with a 256QAM modulation.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:DSTS?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:DS1K:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:DS1K:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:DS1K[:AVERage]?

Queries the EVM of all resource elements of the PDSCH with a 1024QAM modulation.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:DS1K?`

Usage: Query only

7.8.2 Result for selection

FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]?

Queries the average crest factor as shown in the result summary.

Suffix:
<cc> Component Carrier

Return values:
<CrestFactor> <numeric value>
Crest Factor in dB.

Example: //Query crest factor
`FETC:SUMM:CRES?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM[:ALL]:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM[:ALL]:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]?

Queries the EVM of all resource elements.

Suffix:
<cc> Component Carrier

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: //Query EVM
`FETC:SUMM:EVM?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:PCHannel:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:PCHannel:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]?

Queries the EVM of all physical channel resource elements.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: //Query EVM
`FETC:SUMM:EVM:PCH?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]?

Queries the EVM of all physical signal resource elements.

Suffix:
<cc> Component Carrier

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: //Query EVM
`FETC:SUMM:EVM:PSIG?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:FERRor:MAXimum?
FETCh[:CC<cc>]:SUMMary:FERRor:MINimum?
FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]?

Queries the frequency error.

Suffix:
<cc> Component Carrier

Return values:
<FrequencyError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: //Query average frequency error
`FETC:SUMM:FERR?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:GIMBalance:MAXimum?
FETCh[:CC<cc>]:SUMMary:GIMBalance:MINimum?
FETCh[:CC<cc>]:SUMMary:GIMBalance[:AVERage]?

Queries the I/Q gain imbalance.

Suffix:
<cc> Component Carrier

Return values:
<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: //Query average gain imbalance
`FETC:SUMM:GIMB?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:IQOFfset:MAXimum?
FETCh[:CC<cc>]:SUMMary:IQOFfset:MINimum?
FETCh[:CC<cc>]:SUMMary:IQOFfset[:AVERage]?

Queries the I/Q offset.

Suffix:
<cc> Component Carrier

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: //Query average IQ offset
`FETC:SUMM:IQOF?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:OSTP:MAXimum?
FETCh[:CC<cc>]:SUMMary:OSTP:MINimum?
FETCh[:CC<cc>]:SUMMary:OSTP[:AVERage]?

Queries the OSTP.

Suffix:

<cc> Component Carrier

Return values:

<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: //Query average OSTP
`FETC:SUMM:OSTP?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:POWer:MAXimum?
FETCh[:CC<cc>]:SUMMary:POWer:MINimum?
FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]?

Queries the total power.

Suffix:

<cc> Component Carrier

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: //Query average total power
`FETC:SUMM:POW?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:QUADerror:MAXimum?
FETCh[:CC<cc>]:SUMMary:QUADerror:MINimum?
FETCh[:CC<cc>]:SUMMary:QUADerror[:AVERage]?

Queries the quadrature error.

Suffix:

<cc> Component Carrier

Return values:

<QuadratureError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: //Query average quadrature error
`FETC:SUMM:QUAD?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:RSSI:MAXimum?
FETCh[:CC<cc>]:SUMMary:RSSI:MINimum?
FETCh[:CC<cc>]:SUMMary:RSSI[:AVERage]?

Queries the RSSI.

Suffix:

<cc> Component Carrier

Return values:

<RSSI> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: dBm

Example: //Query average RSSI
`FETC:SUMM:RSSI?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:RSTP:MAXimum?
FETCh[:CC<cc>]:SUMMary:RSTP:MINimum?
FETCh[:CC<cc>]:SUMMary:RSTP[:AVERage]?

Queries the RSTP.

Suffix:

<cc> Component Carrier

Return values:

<RSTP> <numeric value>

Default unit: dBm

Example: //Query RSTP
`FETC:SUMM:RSTP?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:SERRor:MAXimum?
FETCh[:CC<cc>]:SUMMary:SERRor:MINimum?
FETCh[:CC<cc>]:SUMMary:SERRor[:AVERage]?

Queries the sampling error.

Suffix:
<cc> Component Carrier

Return values:
<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: //Query average sampling error
`FETC:SUMM:SERR?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:TFRame?

Queries the (sub)frame start offset as shown in the capture buffer.

Suffix:
<cc> Component Carrier

Return values:
<Offset> Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: //Query subframe start offset
`FETC:SUMM:TFR?`

Usage: Query only

Manual operation: See "Capture Buffer" on page 21

7.8.3 Time alignment error

FETCh:FERRor[:CC<cc>][:AVERage]?

Queries the carrier frequency error.

Suffix:
<cc> Component Carrier

Return values:
<FrequencyError> <numeric value>

Average, minimum or maximum frequency error, depending on the command syntax.

Default unit: Hz

Example: //Query frequency error.
```
FETC:FERR?
```

Usage: Query only

FETCh:TAERror[:CC<cc>]:ANTenna<ant>:MAXimum?
FETCh:TAERror[:CC<cc>]:ANTenna<ant>:MINimum?
FETCh:TAERror[:CC<cc>]:ANTenna<ant>[:AVERage]?

Queries the time alignment error.

Suffix:
<cc> Component Carrier

<ant> Antenna

Return values:
<TAE> Minimum, maximum or average time alignment error, depending on the last command syntax element.

Default unit: s

Example: //Query average TAE between reference antenna and antenna 2
```
FETC:TAER:ANT2?
```

Usage: Query only

Manual operation: See "Time Alignment Error" on page 41

7.8.4 Marker table

CALCulate<n>:DELTamarker<m>:X <Position>

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.

Suffix:

<n> Window

<m> Marker

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

Queries the position of a deltamarker on the y-axis.

If necessary, the command activates the deltamarker 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 measurement mode.

See also `INITiate<n>:CONTinuous` on page 169.

Note that result displays with a third aspect (for example "EVM vs Symbol x Carrier") do not support deltamarkers.

Suffix:

<n> Window

<m> Marker

Return values:

<Result> <numeric value>

Result at the deltamarker position. The return value is a value relative to the position of marker 1.
The type of value and its unit depend on the selected result display.

Example: //Query coordinates of deltamarker 2 in window 4
`CALC4:DELT2:X?`
`CALC4:DELT2:Y?`

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

Moves a marker to a specific 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.

Suffix:

<n> Window

<m> Marker
Note that 3D diagrams only support one marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 40
See "Marker Peak List" on page 54

CALCulate<n>:MARKer<m>:Y <Result>

Queries the position of a marker on the y-axis.

In result displays with a third aspect (for example "EVM vs Symbol x Carrier"), you can also use the command to define the position of the 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 measurement mode.

See also `INITiate<n>:CONTinuous` on page 169.

Suffix:

<n> Window

<m> Marker
Note that 3D diagrams only support one marker.

Parameters:

<Result> <numeric value>

Result at the marker position.
The type of value and its unit depend on the selected result display.

Example: //Query coordinates of marker 2 in window 4

```
CALC4:MARK2:X?
CALC4:MARK2:Y?
```

Example: //Define position of marker in 3D diagram

```
CALC:MARK:X 16
CALC:MARK:Y 6
```

Manual operation: See "Marker Table" on page 40
See "Marker Peak List" on page 54

CALCulate<n>:MARKer<m>:Z?

Queries the marker position on the z-axis of three-dimensional result displays.

Returns the type of value displayed in the selected result display (EVM, Power or Allocation ID).

Suffix:
<n> Window

<m> Marker

Return values:
<Position> <numeric value>

Default unit: Depends on result display

Example: //Query marker position
`CALC:MARK:Z?`

Usage: Query only

Manual operation: See "Marker Table" on page 40

CALCulate<n>:MARKer<m>:Z:ALL?

Queries the marker position on the z-axis of three-dimensional result displays.

Instead of returning a certain type of value (EVM, Power **or** Allocation ID), which is possible with `CALCulate<n>:MARKer<m>:Z?`, this command returns all types of values (EVM, Power **and** Allocation ID), regardless of the result display type.

Suffix:
<n> Window

<m> irrelevant

Return values:
<Position> <numeric value>

EVM
EVM at the marker position.

Power
Power at the marker position.

Allocation ID
Allocation ID at the marker position.

Modulation
Modulation type at the marker position.

Example: //Query EVM, Power and Allocation ID at the marker position.
`CALC:MARK:Z:ALL?`

Usage: Query only

Manual operation: See "Marker Table" on page 40

7.8.5 CCDF table

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

Queries the results of the CCDF.

Suffix:

<n> Window

<t> Trace

Query parameters:

<Probability>

P0_01
Level value for 0.01 % probability

P0_1
Level value for 0.1 % probability

P1
P1: Level value for 1 % probability

P10
Level value for 10 % probability

Return values:

<CCDF Result>

Example:

```
CALC:STAT:CCDF:X1? P10
```

Returns the level values that are over 10 % above the mean value.

Usage: Query only

Manual operation: See "CCDF" on page 29

CALCulate<n>:STATistics:RESult<res>? <ResultType>

Queries the results of a measurement for a specific trace.

Suffix:

<n> Window

<res> Trace

Query parameters:

<ResultType>

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example: `CALC:STAT:RES2? ALL`
Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage: Query only

Manual operation: See "CCDF" on page 29

7.9 Limit check result readout

7.9.1 Limits for graphical result displays

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? [<Result>]

Queries the limit check results for the adjacent channels during ACLR measurements.

Suffix:

<n> irrelevant

 irrelevant

Query parameters:

<Result> **REL**
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

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: //Query results of the adjacent channel limit check
`CALC:LIM:ACP:ACH:RES?`

Example: //Query results of the adjacent channel limit check
`CALC:LIM:ACP:ACH:RES? ABS`

Usage: Query only

Manual operation: See "Result summary" on page 49
See "Result summary" on page 51

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:ABSolute

Queries the absolute limit check results for adjacent channels (ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n> irrelevant

 irrelevant

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: //Query results of the adjacent channel limit check
`CALC:LIM:ACP:ACH:RES:ABS?`

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:RELative

Queries the relative limit check results for the adjacent channels (ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  ACLR: CALCulate<n>:LIMit<li>:ACPower:PMODe.

Suffix:

<n> irrelevant

 irrelevant

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: //Query results of the adjacent channel limit check
`CALC:LIM:ACP:ACH:RES:REL?`

CALCulate<n>:LIMit<li>:ACPower:ALTernate<alt>:RESult? [<Result>]

Queries the limit check results for the alternate channels during ACLR measurements.

Suffix:

<n> irrelevant

 irrelevant

<alt> irrelevant

Query parameters:

<Result> **REL**
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

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: //Query results of the alternate channel limit check
`CALC:LIM:ACP:ALT:RES?`

Example: //Query results of the alternate channel limit check
`CALC:LIM:ACP:ACH:RES? ABS`

Usage: Query only

Manual operation: See "Result summary" on page 49
See "Result summary" on page 51

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:ABSolute

Queries the absolute limit check results for the alternate channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n>	irrelevant
	irrelevant
<ch>	irrelevant

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: //Query results of the alternate channel limit check
`CALC:LIM:ACP:ALT:RES:ABS?`

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:RELative

Queries the relative limit check results for the alternate channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n>	irrelevant
	irrelevant
<ch>	irrelevant

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: //Query results of the alternate channel limit check
`CALC:LIM:ACP:ALT:RES:REL?`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult?

Queries the ACLR power limit check results for the gap channels (MC ACLR measurements).

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:ACLR:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:ABSolute?

Queries the absolute power limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:ACLR:RES:ABS?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:RELative?

Queries the relative power limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:ACLR:RES:REL?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult?

Queries the limit check results for the gap channels (MC ACLR measurements).

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:ABSolute?

Queries the absolute limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:RES:ABS?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:RELative?

Queries the relative limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:

<n> irrelevant

 irrelevant

<gap> irrelevant

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: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:RES:REL?`

Usage: Query only

CALCulate<n>:LIMit<li>:OOPower:OFFPower?

Queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Suffix:

<n> irrelevant

 irrelevant

Return values:

<Results> Returns one value for every "Off" period.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: //Query the results for the limit check during the signal OFF periods
`CALC:LIM:OOP:OFFP?`

Usage: Query only

CALCulate<n>:LIMit<li>:OOPower:TRANsient? <Result>

Queries the results of the limit check during the transient periods of the On/Off power measurement.

Suffix:

<n> irrelevant

 irrelevant

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:
<LimitCheck> Returns one value for every "Off" period.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: //Query the limit check result of rising transients
`CALC:LIM:OOP:TRAN? RIS`

Usage: Query only

7.9.2 Limits for numerical result display

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM[:ALL]:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]:RESult?

Queries the results of the EVM limit check of all resource elements.

Suffix:
<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSQP:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSQP[:AVERage]:RESult?

Queries the results of the EVM limit check of all PDSCH resource elements with a QPSK modulation.

Suffix:
<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:DSQP:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSSF:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSSF[:AVERage]:RESult?

Queries the results of the EVM limit check of all PDSCH resource elements with a 64QAM modulation.

Suffix:

<n>	irrelevant
	irrelevant
<cc>	Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:DSSF:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSST:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSST[:AVERage]:RESult?

Queries the results of the EVM limit check of all PDSCH resource elements with a 16QAM modulation.

Suffix:

<n>	irrelevant
	irrelevant
<cc>	Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:DSST:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSTS:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DSTS[:AVERage]:RESult?

Queries the results of the EVM limit check of all PDSCH resource elements with a 256QAM modulation.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:DSTS:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DS1K:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:DS1K[:AVERage]:RESult?

Queries the results of the EVM limit check of all PDSCH resource elements with a 1024QAM modulation.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query EVM limit check results
`CALC:LIM:SUMM:EVM:DS1K:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:PCHannel:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]:RESult?

Queries the results of the EVM limit check of all physical channel resource elements.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query physical channel limit check result
`CALC:LIM:SUMM:EVM:PCH:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:PSIGnal:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]:RESult?

Queries the results of the EVM limit check of all physical signal resource elements.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query physical signal limit check result
`CALC:LIM:SUMM:EVM:PSIG:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:FERRor:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:FERRor[:AVERage]:RESult?

Queries the result of the frequency error limit check.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query frequency error limit check result
`CALC:LIM:SUMM:SERR:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:GIMBalance:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:GIMBalance[:AVERage]:RESult?

Queries the result of the gain imbalance limit check.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query gain imbalance limit check result
`CALC:LIM:SUMM:GIMB:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:IQOFfset:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:IQOFfset[:AVERage]:RESult?

Queries the result of the I/Q offset limit check.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query I/Q offset limit check result
`CALC:LIM:SUMM:IQOF:MAX:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:QUADerror:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:QUADerror[:AVERage]:RESult?

Queries the result of the quadrature error limit check.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query quadrature error limit check results
`CALC:LIM:SUMM:QUAD:RES?`

Usage: Query only

CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:SERRor:MAXimum:RESult?
CALCulate<n>:LIMit<li>[:CC<cc>]:SUMMary:SERRor[:AVERage]:RESult?

Queries the results of the sampling error limit check.

Suffix:

<n> irrelevant

 irrelevant

<cc> Component Carrier

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: //Query sample error limit check result
`CALC:LIM:SUMM:SERR:RES?`

Usage: Query only

7.10 Configuration

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, "Screen layout", on page 158.

CONFigure[:LTE]:MEASurement <Measurement>

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.

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.

*RST: EVM

Example: //Select measurement
`CONF:MEAS EVM`

Manual operation: See "EVM" on page 17
See "Time alignment error" on page 18
See "Transmit on / off power" on page 18
See "Channel power ACLR" on page 18
See "SEM" on page 18
See "Transmit On / Off Power" on page 42
See "Adjacent Channel Leakage Ratio (ACLR)" on page 47
See "Cumulative ACLR" on page 48
See "Multi Carrier ACLR (MC ACLR)" on page 50
See "Spectrum Emission Mask (SEM)" on page 52
See "Select Measurement" on page 72

MMEMory:STORe<n>:IQ:STATe <Value>,<FileName>

Saves I/Q data to a file.

Suffix:
<n> irrelevant

Parameters:
<Value> 1

<FileName> String containing the path and name of the target file.

Example:
```
MMEM:STOR:IQ:STAT 'C:
\R_S\Instr\user\data.iq.tar'
```
Saves I/Q data to the specified file.

Manual operation: See "Data import and export" on page 139

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST:SEL '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 72

7.10.2 I/Q measurements

7.10.2.1 Signal description

Signal characteristics

CONFigure[:LTE]:DUPLexing <Duplexing>

Selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example:

//Select time division duplex
`CONF:DUPL TDD`

Manual operation: See "Selecting the LTE mode" on page 74

CONFigure[:LTE]:DL[:CC<cc>]:BW <Bandwidth>

Selects the channel bandwidth.

Suffix:

<cc> Component Carrier

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00 | NB_1rb | NB_6rb

*RST: BW10_00

Example:

//Single carrier measurement:
//Define channel bandwidth
`CONF:DL:BW BW1_40`

Example:

//Aggregated carrier measurement:
//Selects two carriers, one with a bandwidth of 5 MHz, the other with 10 MHz.
```
CONF:NOCC 2
CONF:DL:CC1:BW BW10_00
CONF:DL:CC2:BW BW5_00
```

Manual operation: See "Remote commands to configure carrier aggregation" on page 77
See "Channel Bandwidth / Number of Resource Blocks" on page 77

CONFigure[:LTE]:DL[:CC<cc>]:CYCPrefix <PrefixLength>

Selects the cyclic prefix.

Suffix:
<cc> Component Carrier

Parameters:
<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: //Single carrier measurements:
//Select an extended cyclic prefix
`CONF:DL:CYCP EXT`

Example: //Aggregated carrier measurements:
//Select an extended cyclic prefix for the first carrier
`CONF:DL:CC1:CYCP EXT`

Manual operation: See "Cyclic Prefix" on page 78

CONFigure[:LTE]:DL[:CC<cc>]:EINBiot[:STATe] <State>

Turns the exclusion of resource blocks used by an NB-IoT inband deployment from the LTE measurement results on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Exclude resource blocks used for NB-IoT
`CONF:DL:EINB ON`

Manual operation: See "Exclude Inband NB-IoT" on page 80

CONFigure[:LTE]:DL[:CC<cc>]:NRBoffset <Offset>

Defines an the location of the NB-IoT signal within the LTE carrier as a resource block offset.

Prerequisites for this command

- Turn on exclusion of inband NB-IoT (`CONFigure[:LTE]:DL[:CC<cc>]:EINBiot[:STATe]`).

Suffix:
<cc> Component Carrier

Parameters:
<Offset> <numeric value> (integer only)

*RST: 0

Example: //Define offset for NB-IoT carrier

```
CONF:DL:EINB ON
CONF:DL:NRB 12
```

Manual operation: See "Exclude Inband NB-IoT" on page 80

CONFigure[:LTE]:DL[:CC<cc>]:PLC:CID <CellID>

Defines the cell ID.

Suffix:
<cc> Component Carrier

Parameters:
<CellID> **AUTO**
Automatically defines the cell ID.

<numeric value> (integer only)
Number of the cell ID.

Range: 0 to 503

Example: //Select two carriers an define a cell ID for each

```
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 79

CONFigure[:LTE]:DL[:CC<cc>]:PLC:CIDGroup <GroupNumber>

Selects the cell ID group.

Suffix:
<cc> Component Carrier

Parameters:
<GroupNumber> **AUTO**
Automatic selection

0...167 (integer only)
Manual selection

*RST: AUTO

Example: //Select cell identity group

```
CONF:DL:PLC:CIDG 134
```

//Turn on automatic cell identity group detection

```
CONF:DL:PLC:CIDG AUTO
```

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 79

CONFigure[:LTE]:DL[:CC<cc>]:PLC:PLID <Identity>

Defines the physical layer cell identity for downlink signals.

Suffix:
<cc> Component Carrier

Parameters:
<Identity> **AUTO**
Automatic selection
0...2 (integer only)
Manual selection
*RST: AUTO

Example: //Select physical layer cell identity
`CONF:DL:PLC:PLID 1`

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 79

CONFigure[:LTE]:DL[:CC<cc>]:TDD:SPSC <Configuration>

Selects the special TDD subframe configuration.

Suffix:
<cc> Component Carrier

Parameters:
<Configuration> <numeric value> (integer only)
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:
//Select subframe configuration 7, available only with a normal cyclic prefix
`CONF:DL:CYCP NORM`
`CONF:DL:TDD:SPSC 7`

Example: //Carrier aggregation measurements:
//Select special subframe configuration 2 for the first carrier
`CONF:DL:CC1:TDD:SPSC 2`

Manual operation: See "Conf. of Special Subframe" on page 79

CONFigure[:LTE]:DL[:CC<cc>]:TDD:UDConf <Configuration>

Selects the subframe configuration for TDD signals.

Suffix:
<cc> Component Carrier

Parameters:
<Configuration> <numeric value> (integer only)

Range: 0 to 6
*RST: 0

Example: //Single carrier measurements:
//Selects allocation configuration
`CONF:DL:TDD:UDC 4`

Example: //Carrier aggregation measurements:
//Select allocation configuration for the first carrier
`CONF:DL:CC1:TDD:UDC 4`

Manual operation: See "TDD UL/DL Allocations" on page 78

CONFigure[:LTE]:LDIRection <Direction>

Selects the link direction.

Parameters:
<Direction> **DL**
Selects the mode to analyze downlink signals.
UL
Selects the mode to analyze uplink signals.

Example: //Select downlink mode
`CONF:LDIR DL`

Manual operation: See "Selecting the LTE mode" on page 74

FETCh[:CC<cc>]:CYCPrefix?

Queries the cyclic prefix type that has been detected.

Suffix:
<cc> Component Carrier

Return values:
<PrefixType> The command returns -1 if no valid result has been detected yet.
NORM
Normal cyclic prefix length detected
EXT
Extended cyclic prefix length detected

Example: //Query current cyclic prefix length type
`FETC:CYCP?`

Usage: Query only

FETCh[:CC<cc>]:PLC:CIDGroup?

Queries the cell identity group that has been detected.

Suffix:
<cc> | Component Carrier

Return values:
<CIDGroup> | The command returns -1 if no valid result has been detected yet.
Range: 0 to 167

Example: //Query the current cell identity group
`FETC:PLC:CIDG?`

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 79

FETCh[:CC<cc>]:PLC:PLID?

Queries the cell identity that has been detected.

Suffix:
<cc> | Component Carrier

Return values:
<Identity> | The command returns -1 if no valid result has been detected yet.
Range: 0 to 2

Example: //Query the current cell identity
`FETC:PLC:PLID?`

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 79

MMEMory:LOAD[:CC<cc>]:DEModsetting <File>

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.

Suffix:
<cc> | Component Carrier

Parameters:
<File> | String containing the path and name of the file.

Example: //Load allocation file
`MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Manual operation: See "User defined test scenarios" on page 81

MMEMory:LOAD[:CC<cc>]:TMOD:DL <TestModel>

Loads an EUTRA test model (E-TM).

The EUTRA test models are in accordance with 3GPP 36.141.

You can also select an O-RAN test case with the command.

Suffix:
<cc> Component Carrier

Setting parameters:
<TestModel> **<string>**
String that contains the name of the test model, e.g. `'E-TM1_1__20MHz'` (E-TM1.1). To select a test model for a different bandwidth, replace "20MHz" with either "1_4MHz", "3MHz", "5MHz", "10MHz" or "15MHz".
Alternatively, a string that contains the name of the O-RAN test case, e.g. `'TC 3.2.3.7.1'`.

Example: //Select test model 2 for a 10 MHz bandwidth.
`MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`

Example: //Select O-RAN test case
`MMEM:LOAD:TMOD:DL 'TC 3.2.3.7.1'`

Usage: Setting only

Manual operation: See "3GPP test models" on page 80
See "ORAN test cases" on page 81

MMEMory:STORe<n>[:CC<cc>]:DEModsetting <FileName>

Saves the signal description.

Suffix:
<n> irrelevant

<cc> irrelevant

Parameters:
<FileName> String containing the path and name of the file.
The file extension is `.allocation`.

Example: //Save signal description
`MMEM:STOR:DEM 'c:\TestSignal.allocation'`

Manual operation: See "User defined test scenarios" on page 81

MIMO setup

CONFigure[:LTE]:ANTMatrix:ADDRess<in> <Address>

Defines the network address of an analyzer in the test setup.

Suffix:
<in> Instrument

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 "Input Source Configuration Table" on page 83

CONFigure[:LTE]:ANTMatrix:LEDState<in>?

Queries the state of one of the instruments in a MIMO setup.

Suffix:
<in> Instrument

Return values:
<Color>
GREEN
Connection to the instrument has been successfully established.
GREY
Instrument connection has been turned off with `CONFigure[:LTE]:ANTMatrix:STATe<in>`.
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 "Input Source Configuration Table" on page 83

CONFigure[:LTE]:ANTMatrix:STATe<in> <State>

Includes or excludes an analyzer from a MIMO setup.

Suffix:
<in> Instrument

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: `CONF:LTE:ANTM:STAT2 ON`
Includes the second analyzer in the test setup.

Manual operation: See "Input Source Configuration Table" on page 83

CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection <Antenna>

Selects the antenna for measurements with MIMO setups.

For time alignment error measurements, the command selects the reference antenna.

Suffix:
<cc> Component Carrier

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

Example: //Select a MIMO setup with two antennas and test antenna number two

```
CONF:DL:MIMO:CONF TX2
CONF:DL:MIMO:ASEL ANT2
```

Manual operation: See "Time Alignment Error" on page 41
See "Tx Antenna Selection" on page 83

CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CONFig <NoOfAntennas>

Sets the number of antennas in the MIMO setup.

Suffix:
<cc> Component Carrier

Parameters:
<NoOfAntennas>

TX1
Use one Tx-antenna

TX2
Use two Tx-antennas

TX4
Use four Tx-antennas

*RST: TX1

Example: //Select MIMO configuration with two antennas

```
CONF:DL:MIMO:CONF TX2
```

Manual operation: See "DUT MIMO Configuration" on page 83

PDSCH settings

[SENSe:][LTE:]DL:FORMat:PSCD <Format>

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: //Select user configuration and do not check the received signal
`DL:FORM:PSCD OFF`

Manual operation: See "PDSCH Subframe Configuration Detection" on page 85

[SENSe:][LTE:]DL:DEMod:AUTO <State>

Turns automatic demodulation on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: ON

Example: //Turn on auto demodulation
`DL:DEM:AUTO ON`

Manual operation: See "Auto PDSCH Demodulation" on page 85

CONFigure[:LTE]:DL[:CC<cc>]:CSUBframes <Subframes>

Selects the number of configurable subframes in the downlink signal.

Suffix:
<cc> Component Carrier

Parameters:
<Subframes> Range: 0 to 39
*RST: 1

Example: //Define the number of configurable subframes
`CONF:DL:CSUB 5`

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALCount <Allocations>

Defines the number of allocations in a downlink subframe.

Suffix:
<cc> Component Carrier

<sf> Subframe

Parameters:
<Allocations> <numeric value>
*RST: 1

Example: //Define number of allocations in a subframe
`CONF:DL:SUBF2:ALC 5`

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:GAP <VRBGap>

Turns the VRB Gap on and off.

Suffix:
<cc> Component Carrier

<sf> Subframe

<al> Allocation

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: //Select localized VRBs for allocation 5 in subframe 2
`CONF:DL:SUBF2:ALL5:GAP 0`

Manual operation: See "VRB Gap" on page 88

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:POWer <Power>

Defines the (relative) power of an allocation in a downlink subframe.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: dB

Example: //Define relative power for allocation 5 in subframe 2.
`CONF:DL:SUBF2:ALL5:POW -1.3`

Manual operation: See "Power" on page 89

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:AP <Port>

Selects the antenna port for the beamforming scheme.

The command is available for measurements on a single antenna.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<Port> 5 | 7 | 8

Example: //Select antenna port for beamforming in allocation 3 in subframe 2.
`CONF:DL:SUBF2:ALL3:PREC:AP 5`

Manual operation: See "Beamforming (UE Spec RS)" on page 91

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CBINdex <CodebookIndex>

Selects the codebook index for an allocation with spatial multiplexing precoding scheme.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<CodebookIndex> 0...15

*RST: 1

Example: //Select codebook index for allocation 4 in subframe number 2.
`CONF:DL:SUBF2:ALL4:PREC:CBIN 3`

Manual operation: See "Spatial Multiplexing" on page 90

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:CDD <State>

Turns the cyclic delay diversity of an allocation with spatial multiplexing precoding scheme on and off.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on cyclic delay diversity for allocation 3 in subframe 2
`CONF:DL:SUBF2:ALL3:PREC:CDD ON`

Manual operation: See "Spatial Multiplexing" on page 90

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding: CLMapping <Mapping>

Selects the codeword to layer mapping.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<Mapping> LC11 | LC21 | LC22 | LC31 | LC32 | LC41 | LC42 | LC52 | LC62 | LC72 | LC82

Example: //Select codeword-to-layer mapping for allocation 3 in subframe 2.
`CONF:DL:SUBF2:ALL3:PREC:CLM LC11`

Manual operation: See "Spatial Multiplexing" on page 90
See "Beamforming (UE Spec RS)" on page 91

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding:SCID <Identity>

Selects the scrambling identity (nSCID).

The command is available for antenna ports 7 and 8.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<Identity> 0 | 1

Example: //Select scrambling identity for allocation 4 in subframe 2
`CONF:DL:SUBF2:ALL4:PREC:SCID 1`

Manual operation: See "Beamforming (UE Spec RS)" on page 91

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PRECoding[:SCHeme] <Scheme>

Selects the precoding scheme of an allocation.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> 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: //Select precoding scheme for allocation 3 in subframe 2
`CONF:DL:SUBF2:ALL3:PREC:SCH SPM`

Manual operation: See "None" on page 90
See "Transmit Diversity" on page 90
See "Spatial Multiplexing" on page 90
See "Beamforming (UE Spec RS)" on page 91

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:PSOFfset <StartOffset>

Defines the PDSCH start offset for a particular PDSCH allocation.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<StartOffset> **<numeric value>**
Number between 0 and 4.

COMM
Common PDSCH start offset.

Example: //Defines a PDSCH start offset for the allocation 2 in subframe 2
`CONF:DL:SUBF2:ALL2:PSOF 0`

Manual operation: See "Carrier Aggregation" on page 92

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:RBCount <ResourceBlocks>

Selects the number of resource blocks of an allocation in a downlink subframe.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<ResourceBlocks> <numeric value>
*RST: 6

Example: //Define resource blocks for allocation 5 in subframe 2
`CONF:DL:SUBF2:ALL5:RBC 25`

Manual operation: See "Number of RB" on page 89

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:RBOFfset <Offset>

Defines the resource block offset of an allocation in a downlink subframe.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<Offset> <numeric value>

*RST: 0

Example: //Define resource block offset for allocation 5 in subframe 2

```
CONF:DL:SUBF2:ALL5:RBOF 3
```

Manual operation: See "Offset RB" on page 89

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>:UEID <ID>

Defines the ID or N_RNTI.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

Parameters:

<ID> ID of the user equipment.

Example: //Assign ID to allocation 5 in subframe 2

```
CONF:DL:SUBF2:ALL5:UEID 5
```

Manual operation: See "ID/N_RNTI" on page 87

CONFigure[:LTE]:DL[:CC<cc>]:SUBFrame<sf>:ALLoc<al>[:CW<cw>]:MODulation <Modulation>

Selects the modulation of an allocation in a downlink subframe.

Suffix:

<cc> Component Carrier

<sf> Subframe

<al> Allocation

<cw> Codeword

Parameters:

<Modulation>

QPSK
QPSK modulation

QAM16
16QAM modulation

QAM64
64QAM modulation

QAM256
256QAM modulation

Q1K
1024QAM modulation
*RST: QPSK

Example: //Select modulation for the second codeword in allocation 5 in subframe 2
`CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`

Manual operation: See "Modulation" on page 88

Synchronization signal

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:ANTenna <Antenna>

Selects the antenna that transmits the P-SYNC and the S-SYNC.

Suffix:
<cc> Component Carrier

Parameters:
<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE
*RST: ALL

Example: //Transmit the P-SYNC and S-SYNC on all antennas
`CONF:DL:SYNC:ANT ALL`

Manual operation: See "P-/S-SYNC Tx Antenna" on page 92

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>: IMAGinary <Imaginary>

Defines the signal weight for the imaginary part of the signal in the first half frame.

Prerequisites for this command

- Turn on custom sync signal weight (`CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe]`).

Suffix:
<cc> Component Carrier

<ant> Antenna

<fr> 0 | 1
Frame

Parameters:

<Imaginary> Range: -1 to 1
*RST: 0.000

Example: //Define imaginary part of sync signal weight for 1 antenna
```
CONF:DL:SYNC:CSW ON
CONF:DL:SYNC:CSW:ANT1:FHFR:IMAG 0.500
```

Manual operation: See "Custom Sync Weight" on page 93

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:FHFRame<fr>:REAL <Real>

Defines the signal weight for the real part of the signal in the first half frame.

Prerequisites for this command

- Turn on custom sync signal weight (`CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe]`).

Suffix:

<cc> Component Carrier

<ant> Antenna

<fr> 0 | 1
Frame

Parameters:

<Real> Range: -1 to 1
*RST: 1.000

Example: //Define imaginary part of sync signal weight for 1 antenna
```
CONF:DL:SYNC:CSW ON
CONF:DL:SYNC:CSW:ANT1:FHFR:REAL 0.500
```

Manual operation: See "Custom Sync Weight" on page 93

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:SHFRame<fr>:IMAGinary <Imaginary>

Defines the signal weight for the imaginary part of the signal in the second half frame.

Prerequisites for this command

- Turn on custom sync signal weight (`CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe]`).

Suffix:

<cc> Component Carrier

<ant> Antenna

<fr> 0 | 1
Frame

Parameters:

<Imaginary> Range: -1 to 1
*RST: 0.000

Example: //Define imaginary part of sync signal weight for antenna 1
```
CONF:DL:SYNC:CSW ON
CONF:DL:SYNC:CSW:ANT1:SHFR:IMAG 0.500
```

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:ANTenna<ant>:SHFRame<fr>:REAL <Real>

Defines the signal weight for the real part of the signal in the second half frame.

Prerequisites for this command

- Turn on custom sync signal weight (CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe]).

Suffix:

<cc> Component Carrier

<ant> Antenna

<fr> 0 | 1
Frame

Parameters:

<Real> Range: -1 to 1
*RST: 1.000

Example: //Define real part of sync signal weight for antenna 1
```
CONF:DL:SYNC:CSW ON
CONF:DL:SYNC:CSW:ANT1:SHFR:REAL 0.500
```

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight:NOFRame <Frames>

Defines the number of frames to apply custom synchronization weighting for.

Suffix:

<cc> Component Carrier

Parameters:

<Frames> Range: 1 to 2
*RST: 1

Example: //Define custom weight for 1 antenna in 2 frames

```
CONF:DL:SYNC:CSW ON
CONF:DL:SYNC:CSW:NOFR 2
CONF:DL:SYNC:CSW:ANT1:FHFR0:IMAG 0.500
CONF:DL:SYNC:CSW:ANT1:FHFR0:REAL 0.500
CONF:DL:SYNC:CSW:ANT1:SHFR0:IMAG 0.500
CONF:DL:SYNC:CSW:ANT1:SHFR0:REAL 0.500
CONF:DL:SYNC:CSW:ANT1:FHFR1:IMAG 0.500
CONF:DL:SYNC:CSW:ANT1:FHFR1:REAL 0.500
CONF:DL:SYNC:CSW:ANT1:SHFR1:IMAG 0.500
CONF:DL:SYNC:CSW:ANT1:SHFR1:REAL 0.500
```

Manual operation: See "Custom Sync Weight" on page 93

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:CSWeight[:STATe] <State>

Turns custom synchronization signal weighting on and off.

Suffix:

<cc> Component Carrier

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on synchronization signal weighting

```
CONF:DL:SYNC:CSW ON
```

Manual operation: See "Custom Sync Weight" on page 93

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:PPOWer <Power>

Defines the relative power of the P-SYNC.

Suffix:

<cc> Component Carrier

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: dB

Example: //Define relative power for P-SYNC

```
CONF:DL:SYNC:PPOW 0.5
```

Manual operation: See "P-Sync Relative Power" on page 93

CONFigure[:LTE]:DL[:CC<cc>]:SYNC:SPOWer <Power>

Defines the relative power of the S-SYNC.

Suffix:

<cc> Component Carrier

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: dB

Example: //Define relative power for S-SYNC
`CONF:DL:SYNC:SPOW 0.5`

Manual operation: See " S-Sync Relative Power" on page 93

Reference signal

CONFigure[:LTE]:DL[:CC<cc>]:REFSig:POWer <Power>

Defines the relative power of the reference signal.

Suffix:

<cc> Component Carrier

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: dB

Example: //Define a relative power for reference signal
`CONF:DL:REFS:POW -1.2`

Manual operation: See "Rel Power (Reference Signal)" on page 94

Positioning reference signal

CONFigure[:LTE]:DL[:CC<cc>]:PRSS:BW <Bandwidth>

Defines the bandwidth of the positioning reference signal.

Suffix:

<cc> Component Carrier

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW1_40
Default unit: MHz

Example: //Define bandwidth for the positioning reference signal
`CONF:DL:PRSS:BW BW5_00`

Manual operation: See "Bandwidth" on page 95

CONFigure[:LTE]:DL[:CC<cc>]:PRSS:CI <Configuration>

Selects the configuration index of the positioning reference signal.

Suffix:
<cc> Component Carrier

Parameters:
<Configuration> <numeric value> (integer only)
*RST: 0

Example: //Select configuration index for the positioning reference signal
`CONF:DL:PRSS:CI 2`

Manual operation: See "Configuration Index" on page 95

CONFigure[:LTE]:DL[:CC<cc>]:PRSS:NPRS <Subframes>

Defines the number of subframes the positioning reference signal occupies.

Suffix:
<cc> Component Carrier

Parameters:
<Subframes> 1 | 2 | 4 | 6

Example: //Define subframes used by positioning reference signal
`CONF:DL:PRSS:NPRS 1`

Manual operation: See "Num. Subframes (N_PRS)" on page 96

CONFigure[:LTE]:DL[:CC<cc>]:PRSS:POWer <Power>

Defines the relative power of the positioning reference signal.

Suffix:
<cc> Component Carrier

Parameters:
<Power> Default unit: dB

Example: //Define relative power of positioning reference signal
`CONF:DL:PRSS:POW 1`

Manual operation: See "Relative Power (Positioning Reference Signal)" on page 96

CONFigure[:LTE]:DL[:CC<cc>]:PRSS:STATe <State>

Turns the positioning reference signal on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on the positioning reference signal.
`CONF:DL:PRSS:STAT ON`

Manual operation: See "Present" on page 95

CONFigure[:LTE]:DL[:CC<cc>]:SFNO <Offset>

Defines the frame number offset for the positioning reference signal.

Suffix:
<cc> Component Carrier

Parameters:
<Offset> <numeric value> (integer only)

Example: //Define frame number offset
`CONF:DL:SFNO 4`

Manual operation: See "Frame Number Offset" on page 96

CSI reference signal

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:CI <Index>

Selects the configuration index for the CSI reference signal.

Suffix:
<cc> Component Carrier

Parameters:
<Index> Number of the configuration index.
Range: 0 to 31

Example: //Select configuration index
`CONF:DL:CSIR:CI 12`

Manual operation: See "Configuration Index" on page 98

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:NAP <AntennaPorts>

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

Suffix:
<cc> Component Carrier

Parameters:
<AntennaPorts> **TX1**
TX2
TX4
TX8

Example: //Select 2 antenna ports for CSI reference signal transmission
`CONF:DL:CSIR:NAP TX2`

Manual operation: See "Antenna Ports" on page 97

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:OPDSch <State>

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

Suffix:
<cc> Component Carrier

Parameters:
<State> **ON | 1**
The CSI reference signal overwrites PDSCH resource elements.
OFF | 0
PDSCH resource elements remain.
*RST: OFF

Example: //Overwrite PDSCH resource elements if necessary
`CONF:DL:CSIR:OPDS ON`

Manual operation: See "Overwrite PDSCH" on page 98

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:POWer <Power>

Defines the relative power of the CSI reference signal.

Suffix:
<cc> Component Carrier

Parameters:
<Power> *RST: 0
Default unit: dB

Example: //Define relative power for the CSI reference signal.
`CONF:DL:CSIR:POW 1`

Manual operation: See "Relative Power (CSI Reference Signal)" on page 98

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:SCI <Configuration>

Defines the subframe configuration for the CSI reference signal.

Suffix:

<cc> Component Carrier

Parameters:

<Configuration> Number that selects the subframe configuration.

Range: 0 to 154

Example: //Select subframe configuration for CSI reference signal

```
CONF:DL:CSIR:SCI 4
```

Manual operation: See "Subframe Configuration" on page 98

CONFigure[:LTE]:DL[:CC<cc>]:CSIRs:STATe <State>

Turns the CSI reference signal on and off.

Suffix:

<cc> Component Carrier

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on CSI reference signal

```
CONF:DL:CSIR:STAT ON
```

Manual operation: See "Present" on page 97

Control channel

CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:LOCalized <State>

Turns localized transmission of the EPDCCH on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: ON

Example: //Turn on distributed transmission of the EPDCCH
`CONF:DL:EPDC:LOC OFF`

Manual operation: See "EPDCCH Localized" on page 106

CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:NPRB <ResourceBlocks>

Selects the number of resource blocks that the EPDCCH-PRB set uses.

Suffix:
<cc> Component Carrier

Parameters:
<ResourceBlocks> 0 | 2 | 4 | 8
When you select "0", the EPDCCH i not active.

Example: //Select number of EPDCCH-PRB resource blocks
`CONF:DL:EPDC:NPRB 4`

Manual operation: See "EPDCCH PRB Pairs" on page 105

CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:POWer <Power>

Defines the relative power of the EPDCCH.

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: //Define relative power of EPDCCH
`CONF:DL:EPDC:POW -0.5`

Manual operation: See "EPDCCH Rel Power" on page 106

CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:RBASsign <ResourceBlocks>

Defines the resource blocks that the EPDCCH uses.

Suffix:
<cc> Component Carrier

Parameters:
<ResourceBlocks>

Example: //Define number of EPDCCH resource blocks
`CONF:DL:EPDC:RBAS 2`

Manual operation: See "EPDCCH RB Assignment" on page 106

CONFigure[:LTE]:DL[:CC<cc>]:EPDCch:SID <SetID>

Defines the EPDCCH set ID used to generate EPDCCH reference symbols.

Suffix:
<cc> Component Carrier

Parameters:
<SetID> Range: 0 to 503
*RST: 0

Example: //Select EPDCC set ID
`CONF:DL:EPDC:SID 10`

Manual operation: See "EPDCCH Set ID" on page 106

CONFigure[:LTE]:DL[:CC<cc>]:PBCH:POWer <Power>

Defines the relative power of the PBCH.

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: dB

Example: //Define PBCH power
`CONF:DL:PBCH:POW -1.1`

Manual operation: See "PBCH Relative Power" on page 100

CONFigure[:LTE]:DL[:CC<cc>]:PBCH:STAT <State>

Turns the PBCH on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: ON

Example: //Turn on PBCH
`CONF:DL:PBCH:STAT ON`

Manual operation: See "PBCH Present" on page 100

CONFigure[:LTE]:DL[:CC<cc>]:PCFich:POWer <Power>

Defines the relative power of the PCFICH.

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: dB

Example: //Define relative PCFICH power
`CONF:DL:PCF:POW 0`

Manual operation: See "PCFICH Relative Power" on page 101

CONFigure[:LTE]:DL[:CC<cc>]:PCFich:STAT <State>

Turns the PCFICH on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: ON

Example: //Turn on PCFICH
`CONF:DL:PCF:STAT ON`

Manual operation: See "PCFICH Present" on page 101

CONFigure[:LTE]:DL[:CC<cc>]:PDCCh:FORMat <Format>

Selects the PDCCH format.

Suffix:
<cc> Component Carrier

Parameters:
<Format> -1 | 0 | 1 | 2 | 3
*RST: -1

Example: //Select PDCCH format
`CONF:DL:PDCCH:FORM 0`

Manual operation: See "PDCCH Format" on page 104

CONFigure[:LTE]:DL[:CC<cc>]:PDCCh:NOPD <Quantity>

Sets the number of PDCCHs.

Suffix:
<cc> Component Carrier

Parameters:
<Quantity> <numeric value>
*RST: 0

Example: //Select number of PDCCHs
`CONF:DL:PDCCH:NOPD 3`

Manual operation: See "Number of PDCCHs" on page 104

CONFigure[:LTE]:DL[:CC<cc>]:PDCCh:POWer <Power>

Defines the relative power of the PDCCH.

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: dB

Example: //Define relative power for PDCCH
`CONF:DL:PDCCH:POW -1.2`

Manual operation: See "PDCCH Rel Power" on page 104

CONFigure[:LTE]:DL[:CC<cc>]:PHICh:DURation <Duration>

Selects the PHICH duration.

Suffix:
<cc> Component Carrier

Parameters:
<Duration> **NORM**
Normal
EXT
Extended
*RST: NORM

Example: //Select PHICH duration
`CONF:DL:PHIC:DUR NORM`

Manual operation: See "PHICH Duration" on page 102

CONFigure[:LTE]:DL[:CC<cc>]:PHICh:MITM <State>

Includes or excludes the use of the PHICH special setting for enhanced test models.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Activate PHICH TDD m_i=1 (E-TM)
`CONF:DL:PHIC:MITM ON`

Manual operation: See "PHICH TDD m_i=1 (E-TM)" on page 102

CONFigure[:LTE]:DL[:CC<cc>]:PHICh:NGParameter <Method>

Selects the method that determines the number of PHICH groups in a subframe.

Suffix:
<cc> Component Carrier

Parameters:
<Method> AUTO | NG1_6 | NG1_2 | NG1 | NG2 | NGCustom
Select `NGCUSTOM` to customize N_g. You can then define the number of PHICH groups with `CONFigure[:LTE]:DL[:CC<cc>]:PHICh:NOGRoups`.
*RST: NG1_6

Example: //Number of PHICH groups in the subframe depends on the number of resource blocks
`CONF:DL:PHIC:NGP NG1_6`
//Define a custom number of PHICH groups
`CONF:DL:PHIC:NGP NGCUSTOM`
`CONF:DL:PHIC:NOGR 5`

Manual operation: See "PHICH N_g" on page 103

CONFigure[:LTE]:DL[:CC<cc>]:PHICh:NOGRoups <NoOfGroups>

Defines the number of PHICH groups.

Suffix:
<cc> Component Carrier

Parameters:
<NoOfGroups> <numeric value> (integer only)
*RST: 0

Example: //Define number of PHICH groups
`CONF:DL:PHIC:NOGR 5`

Manual operation: See "PHICH Number of Groups" on page 103

CONFigure[:LTE]:DL[:CC<cc>]:PHICh:POWer <Power>

Defines the relative power of the PHICH.

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>

*RST: -3.01 dB
Default unit: DB

Example: //Define the relative power of the PHICH
`CONF:DL:PHIC:POW -1.3`

Manual operation: See "PHICH Rel Power" on page 103

CONFigure[:LTE]:DL[:CC<cc>]:PSOFfset <Offset>

Defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Suffix:
<cc> Component Carrier

Parameters:
<Offset> **AUTO**
Automatically determines the symbol offset.

<numeric value>
Manual selection of the symbol offset.

Range: 0 to 4
*RST: AUTO

Example: //Define PRB symbol offset
`CONF:DL:PSOF 2`

Manual operation: See "PRB Symbol Offset" on page 99

Shared channel

CONFigure[:LTE]:DL[:CC<cc>]:PDSCh:PB <PowerRatio>

Selects the PDSCH power ratio.

Note that the power ratio depends on the number of antennas in the system.

Suffix:
<cc> Component Carrier

Parameters:
<PowerRatio> 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: //Select PDSCH P_B
`CONF:DL:PDSC:PB 3`

Manual operation: See "PDSCH Power Ratio" on page 106

MBSFN characteristics

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:AI:ID <ID>

Defines the ID of an MBFSN area.

Suffix:
<cc> Component Carrier

Parameters:
<ID> Range: 0 to 255

Example: //Select an area for the multimedia broadcast network
`CONF:DL:MBSF:AI:ID 2`

Manual operation: See "Area ID" on page 108

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:AI:NMRL <Configuration>

Selects the length of the control data region in an MBSFN subframe.

Suffix:
<cc> Component Carrier

Parameters:
<Configuration>

1
The first symbol in a subframe carries data of the control channel.

2
The first two symbols in a subframe carry data of the control channel.

Example: //Select length of control channel data
`CONF:DL:MBSF:AI:NMRL 2`

Manual operation: See "Non-MBSFN Region Length" on page 108

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:POWer <Power>

Defines the relative power of the MBSFN transmission.

Suffix:
<cc> Component Carrier

Parameters:
<Power> *RST: 0 dB
Default unit: dB

Example: //Define relative power for MBSFN transmission
`CONF:DL:MBSF:POW -1.5`

Manual operation: See "MBSFN Relative Power" on page 108

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:STATe <State>

Includes or excludes an MBSFN from the test setup.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Include an MBSFN in the test setup
`CONF:DL:MBSF:STAT ON`

Manual operation: See "Present" on page 108

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:PMCH:MODulation <Modulation>

Selects the modulation type for an MBSFN subframe.

Suffix:
<cc> Component Carrier
<sf> Subframe

Parameters:
<Modulation> QPSK | QAM16 | QAM64 | QAM256 | Q1K
*RST: QPSK

Example: //Selects modulation for MBSFN subframe
`CONF:DL:MBSF:SUBF2:PMCH:MOD QPSK`

Manual operation: See "Modulation" on page 109

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:PMCH:STATe <State>

Turns the PMCH in an MBSFN subframe on and off.

Note that you first have to turn a subframe into an MBSFN subframe with `CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:STATe`.

Suffix:

<cc> Component Carrier

<sf> Subframe

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on PMCH in second subframe

`CONF:DL:MBSF:SUBF2:PMCH:STAT ON`

Manual operation: See "PMCH Present" on page 109

CONFigure[:LTE]:DL[:CC<cc>]:MBSFn:SUBFrame<sf>:STATe <State>

Turns a subframe into an MBSFN subframe.

Suffix:

<cc> Component Carrier

<sf> Subframe

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn the second subframe into an MBSFN subframe

`CONF:DL:MBSF:SUBF2:STAT ON`

Manual operation: See "Active" on page 109

7.10.2.2 Input configuration

Remote commands to configure the input described elsewhere:

- `INPut:COUPling` on page 268
- `INPut:IMPedance` on page 270
- `[SENSe:]SWAPiq` on page 273

CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

For more information, see the FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CAL:AIQ:HAT:STAT ON`

Manual operation: See "High Accuracy Timing Trigger - Baseband - RF" on page 114

INPut:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

If an external frontend is active, the connector is automatically set to `RF`.

Parameters:

<ConnType>

RF
RF input connector

RFPRobe
Active RF probe

*RST: RF

Example: `INP:CONN RF`
Selects input from the RF input connector.

Manual operation: See "Input Connector" on page 111

INPut:DIQ:CDEVice

Queries the current configuration and the status of the digital I/Q input from the optional "Digital Baseband" interface.

For details see the section "Interface Status Information" for the optional "Digital Baseband" interface in the FSW I/Q Analyzer User Manual.

Return values:
<Value>

Example: `INP:DIQ:CDEV?`
Result:
`1,SMW200A,101190,BBMM 1 OUT,`
`100000000,200000000,Passed,Passed,1,1.#QNAN`

Manual operation: See "Connected Instrument" on page 112

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Manual operation: See "Adjust Reference Level to Full Scale Level" on page 112

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:
<Level> Range: 1 µV to 7.071 V
*RST: 1 V
Default unit: DBM

Manual operation: See "Full Scale Level" on page 112

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Manual operation: See "Full Scale Level" on page 112

INPut:DIQ:RANGe[:UPPer]:UNIT <Level>

Defines the unit of the full scale level. The availability of units depends on the measurement application you are using.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<Level> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: Volt

Manual operation: See "Full Scale Level" on page 112

INPut:DIQ:SRATe <SampleRate>

Specifies or queries the sample rate of the input signal from the optional "Digital Baseband" interface.

Parameters:

<SampleRate> Range: 1 Hz to 20 GHz
*RST: 32 MHz
Default unit: HZ

Example: `INP:DIQ:SRAT 200 MHz`

Manual operation: See "Input Sample Rate" on page 112

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Manual operation: See "Input Sample Rate" on page 112

INPut:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

If an external frontend is active, the direct path is always used.

Parameters:

<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See "Direct Path" on page 110

INPut:FILE:PATH <FileName>[, <AnalysisBW>]

Selects the I/Q data file to be used as input for further measurements.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

Parameters:

<FileName> String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.
Default unit: HZ

Example: `INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'`
Uses I/Q data from the specified file as input.

Example:

```
//Load an IQW file
INP:SEL:FIQ
INP:FILE:PATH 'C:\R_S\Instr\user\data.iqw'
//Define the sample rate
TRAC:IQ:SRAT 10MHz
//Define the measurement time
SENSe:SWEep:TIME  0.001001
//Start the measurement
INIT:IMM
```

Manual operation: See "Select I/Q data file" on page 115
See "Data import and export" on page 139

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 FSW to measure the harmonics for a DUT, for example.

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-preselector, if available.)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Manual operation: See "High Pass Filter 1 to 3 GHz" on page 110

INPut:FILTer:YIG[:STATe] <State>

Enables or disables the YIG filter.

Parameters:

<State> ON | OFF | 0 | 1

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 110

INPut:IQ:BALanced[:STATe] <State>

Defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 single-ended lines.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Differential

OFF | 0
Single ended

*RST: 1

Example: `INP:IQ:BAL OFF`

Manual operation: See "Input Configuration" on page 113

INPut:IQ:TYPE <DataType>

Defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ
The input signal is filtered and resampled to the sample rate of the application.
Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I
The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the in-phase component of the input signal is down-converted first (Low IF I).

Q
The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example: `INP:IQ:TYPE Q`

Manual operation: See "I/Q Mode" on page 113

INPut:SELect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the FSW.

If no additional input options are installed, only RF input or file input is supported.

For FSW85 models with two RF input connectors, you must select the input connector to configure first using INPut:TYPE.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file
(selected by INPut:FILE:PATH on page 260)
Not available for Input2.

DIQ
Digital IQ data (only available with optional "Digital Baseband" interface)
For details on I/Q input see the FSW I/Q Analyzer User Manual.
Not available for Input2.

AIQ
Analog Baseband signal (only available with optional "Analog Baseband" interface)
Not available for Input2.

*RST: RF

Example:

```
INP:TYPE INP1
```

For FSW85 models with two RF input connectors: selects the 1.00 mm RF input connector for configuration.

```
INP:SEL RF
```

Manual operation:
See "Digital I/Q Input State" on page 111
See "Analog Baseband Input State" on page 113
See "I/Q Input File State" on page 115

INPut:TYPE <Input>

The command selects the input path.

Parameters:

<Input>

INPUT1
Selects RF input 1.
1 mm [RF Input] connector

INPUT2
Selects RF input 2.
For FSW85 models with two RF input connectors:
1.85 mm [RF2 Input] connector
For all other models: not available

*RST: INPUT1

Example:

//Select input path

```
INP:TYPE INPUT1
```

MMEMory:LOAD:IQ:STReam <Channel>

Only available for files that contain more than one data stream from multiple channels: selects the data stream to be used as input for the currently selected channel.

Automatic mode (MMEMory:LOAD:IQ:STReam:AUTO) is set to OFF.

Parameters:

<Channel> String containing the channel name.

Example:
```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
MMEM:LOAD:IQ:STR 'Channel2'
```

Manual operation: See "Selected Channel" on page 115

MMEMory:LOAD:IQ:STReam:AUTO <State>

Only available for files that contain more than one data stream from multiple channels: automatically defines which data stream in the file is used as input for the channel.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The data stream specified by MMEMory:LOAD:IQ:STReam is used as input for the channel.

ON | 1
The first data stream in the file is used as input for the channel. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc.

*RST: 1

Manual operation: See "Selected Channel" on page 115

MMEMory:LOAD:IQ:STReam:LIST?

Returns the available channels in the currently loaded input file.

Example:
```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
```

Usage: Query only

Manual operation: See "Selected Channel" on page 115

TRACe:IQ:FILE:REPetition:COUNt <RepetitionCount>

Determines how often the data stream is repeatedly copied in the I/Q data memory. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Parameters:

<RepetitionCount> integer

Example: `TRAC:IQ:FILE:REP:COUN 3`

Manual operation: See "File Repetitions" on page 115

7.10.2.3 Frequency configuration

[SENSe:]FREQuency:CENTer[:CC<cc>] <Frequency>

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).

Suffix:

<cc> Component Carrier

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: //Define frequency for measurement on one carrier:
`FREQ:CENT 1GHZ`

Example: //Define frequency for measurement on aggregated carriers:
`FREQ:CENT:CC1 850MHZ`

Manual operation: See "Remote commands to configure carrier aggregation" on page 77
See "Center Frequency" on page 116

[SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet <Offset>

Defines the general frequency offset.

For measurements on multiple component carriers, the command defines the frequency offset for a component carrier. The effect of the command depends on the syntax:

- When you omit the `[CC<cc>]` 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<cc>]` 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.

Suffix:
<cc> Component Carrier

Parameters:
<Offset> <numeric value>

• General frequency offset: frequency offset in Hz.
• Component carrier offset: frequency offset relative to the first component carrier in Hz.

Default unit: Hz

Example: //Add 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:OFFS 50HZ`

Example: //Define a frequency offset of 15 MHz for the second component carrier relative to the first component carrier.
`FREQ:CENT:CC2:OFFS 15MHZ`

Manual operation: See "Remote commands to configure carrier aggregation" on page 77
See "Center Frequency" on page 116

[SENSe:]FREQuency:CENTer:STEP <StepSize>

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<cc>]` on page 265.

Parameters:
<StepSize> For f_{max}, refer to the specifications document.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example: //Set the center frequency to 110 MHz.
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Frequency Stepsize" on page 116

7.10.2.4 Amplitude configuration

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.

Range: see specifications document
*RST: 0 dBm
Default unit: DBM

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See "Reference Level" on page 117

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Reference Level Offset" on page 118

INPut:ATTenuation<ant> <Attenuation>

Defines the RF attenuation level.

Prerequisites for this command

- Decouple attenuation from reference level (`INPut:ATTenuation<ant>:AUTO`).

Suffix:

<ant> irrelevant

Parameters:

<Attenuation> *RST: 10 dB
Default unit: dB

Example: //Define RF attenuation
```
INP:ATT:AUTO OFF
INP:ATT 10
```

Manual operation: See "RF Attenuation" on page 118

INPut:ATTenuation<ant>:AUTO <State>

Couples and decouples the RF attenuation to the reference level.

Suffix:

<ant> irrelevant

Parameters:

<State> ON | OFF | 1 | 0
*RST: ON

Example: //Couple attenuation to reference level (auto attenuation)
```
INP:ATT:AUTO ON
```

Manual operation: See "RF Attenuation" on page 118

INPut:COUPling <CouplingType>

Selects the coupling type of the RF input.

If an external frontend is active, the coupling is automatically set to `AC`.

Parameters:

<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 119

INPut:GAIN:STATe <State>

Turns the internal preamplifier on and off. It requires the optional preamplifier hardware.

Note that if an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

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

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

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```
Switches on 15 dB preamplification.

Manual operation: See "Preamplifier" on page 119

INPut:GAIN[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 269).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> For all FSW models except for FSW85, the following settings are available:
15 dB and 30 dB
All other values are rounded to the nearest of these two.
For FSW85 models:
FSW43 or higher:
30 dB

Default unit: DB

Example:
`INP:GAIN:STAT ON`
`INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 119

INPut:IMPedance <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 120

INPut:EATT<ant> <Attenuation>

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.

Is available with the optional electronic attenuator, but not if you are using the optional digital baseband input.

Suffix:

<ant> Connected instrument

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example:
//Define signal attenuation
`INP:EATT 10`

Manual operation: See "Electronic Attenuation" on page 119

INPut:EATT<ant>:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Is available with the optional electronic attenuator, but not if you are using the optional digital baseband Input.

Suffix:

<ant> 1...4
Connected instrument

Parameters:

<State>	ON | OFF | 1 | 0 *RST: OFF
Example:	//Turn on automatic selection of electronic attenuation `INP:EATT:AUTO ON`
Manual operation:	See "Electronic Attenuation" on page 119

INPut:EATT<ant>:STATe <State>

Turns the electronic attenuator on and off.

Is available with the optional electronic attenuator, but not if you are using the optional digital baseband input.

Suffix:

<ant>	1...4 Connected instrument

Parameters:

<State>	ON | OFF *RST: OFF
Example:	//Turn on electronic attenuation `INP:EATT:STAT ON`
Manual operation:	See "Electronic Attenuation" on page 119

7.10.2.5 Data capture

[SENSe:][LTE:]FRAMe:COUNt <Subframes>

Defines the number of frames you want to analyze.

Prerequisites for this command

- Turn on overall frame count (`[SENSe:][LTE:]FRAMe:COUNt:STATe`).
- Turn on manual selection of frames to analyze (`[SENSe:][LTE:]FRAMe:COUNt:AUTO`).

Parameters:

<Subframes>	<numeric value> (integer only) *RST: 1

Example: //Define number of frames to analyze manually
`FRAM:COUN:STAT ON`
`FRAM:COUN:AUTO OFF`
`FRAM:COUN 20`

Manual operation: See "Number of Frames to Analyze" on page 122

[SENSe:][LTE:]FRAMe:COUNt:AUTO <State>

Turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>

ON | 1
Selects the analyzed number of frames according to the LTE standard.

OFF | 0
Turns on manual selection of the number of frames.

Example: //Turn on automatic selection of analyzed frames
`FRAM:COUN:AUTO ON`

Manual operation: See "Auto According to Standard" on page 122

[SENSe:][LTE:]FRAMe:COUNt:STATe <State>

Turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>

ON | 1
You can set the number of frames to analyze.

OFF | 0
The FSW analyzes the frames captured in a single sweep.

*RST: ON

Example: //Turn on manual selection of number of frames
`FRAM:COUN:STAT ON`

Manual operation: See "Overall Frame Count" on page 121

[SENSe:][LTE:]FRAMe:SCOunt <Subframes>

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> (integer only)
Number of subframes that the application analyzes.

Range: 1 to 9

*RST: ALL

Example: //Select number of analyzed subframes
`FRAM:SCO 3`

Manual operation: See "Maximum Number of Subframes per Frame to Analyze" on page 122

[SENSe:]SWAPiq <State>

Turns a swap of the I and Q branches on and off.

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Swap I and Q branches
`SWAP ON`

Manual operation: See "Swap I/Q" on page 121

[SENSe:]SWEep:TIME <CaptureLength>

Defines the capture time.

Parameters:
<CaptureLength> <numeric value>
*RST: 20.1 ms / 40.1 ms (DL TDD)
Default unit: s

Example: //Define capture time
`SWE:TIME 40ms`

Manual operation: See "Capture Time" on page 121

7.10.2.6 Trigger

The trigger functionality of the LTE measurement application is the same as that of the FSW.

For a comprehensive description of the available remote control commands for trigger configuration, see the documentation of the FSW.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

For input from the "Analog Baseband" interface using the baseband power trigger (BBP), the default drop out time is set to 100 ns to avoid unintentional trigger events (as no hysteresis can be configured in this case).

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:HOLDoff<ant>[:TIME] <Offset>

Defines the trigger offset.

Suffix:

<ant> Instrument

Parameters:

<Offset> <numeric value>

*RST: 0 s
Default unit: s

Example: //Define trigger offset

```
TRIG:HOLD 5MS
```

Manual operation: See "Trigger Source" on page 123
See "Triggering multiple data streams (MIMO measurements)" on page 124

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example: `TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:
<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: DB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:LEVel<ant>[:EXTernal<tp>] <Level>

Defines the level for an external trigger.

Suffix:
<ant> Instrument

<tp> Trigger port

Parameters:
<Level> Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example: //Define trigger level
`TRIG:LEV 2V`

Manual operation: See "Trigger Source" on page 123
See "Triggering multiple data streams (MIMO measurements)" on page 124

TRIGger[:SEQuence]:LEVel<ant>:BBPower <Level>

Sets the level of the baseband power trigger.

Is available for the optional Digital Baseband Interface and the optional Analog Baseband Interface.

Suffix:
<ant> Instrument

Parameters:

<Level> <numeric value>

Range: -50 dBm to +20 dBm
*RST: -20 dBm
Default unit: dBm

Example: //Define trigger level

```
TRIG:SOUR BBP
TRIG:LEV:BBP -30dBm
```

TRIGger[:SEQuence]:LEVel<ant>:IFPower <Level>

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Suffix:

<ant> Instrument

Parameters:

<Level> <numeric value>

For details on available trigger levels and trigger bandwidths see the specifications document.

*RST: -10 dBm
Default unit: dBm

Example: //Define trigger level

```
TRIG:SOUR IFP
TRIG:LEV:IFP -30dBm
```

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:LEVel<ant>:IQPower <Level>

Defines the magnitude the I/Q data must exceed to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Suffix:

<ant> Instrument

Parameters:

<Level> <numeric value>

Range: -130 dBm to 30 dBm
*RST: -20 dBm
Default unit: dBm

Example: //Define trigger level

```
TRIG:SOUR IQP
TRIG:LEV:IQP -30dBm
```

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:LEVel<ant>:RFPower <Level>

Defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Suffix:
<ant> Instrument

Parameters:
<Level> <numeric value>

For details on available trigger levels and trigger bandwidths see the specifications document.

*RST: -20 dBm
Default unit: dBm

Example: //Define trigger level
```
TRIG:SOUR RFP
TRIG:LEV:RFP -30dBm
```

Manual operation: See "Trigger Source" on page 123

TRIGger[:SEQuence]:PORT<ant> <port>

Selects the trigger port for measurements with devices that have several trigger ports.

Suffix:
<ant> Analyzer

Parameters:
<port> **PORT1**

PORT2

PORT3

Example: //Select trigger port 1
```
TRIG:PORT PORT1
```

Manual operation: See "Triggering multiple data streams (MIMO measurements)" on page 124

TRIGger[:SEQuence]:SLOPe <Type>

Selects the trigger slope.

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 "Trigger Source" on page 123
See "Triggering multiple data streams (MIMO measurements)" on page 124

TRIGger[:SEQuence]:SMSetting<ant> <State>

Selects the trigger configuration for secondary analyzers in a MIMO setup.

Suffix:
<ant> Instrument

Parameters:
<State>

ON | 1
Uses the same trigger configuration as the primary analyzer.

OFF | 0
Uses a custom trigger configuration for the selected analyzer.

*RST: ON

Example: //Second analyzer uses same configuration as primary analyzer
`TRIG:SMS2 ON`

Manual operation: See "Triggering multiple data streams (MIMO measurements)" on page 124

TRIGger[:SEQuence]:SOURce<ant> <Source>

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.

Suffix:
<ant> Analyzer

Parameters:
<Source>

IMMediate
Free run (no trigger event to start a measurement).

EXTernal
Measurement starts when the external trigger signal exceeds a certain level.
Trigger signal from the "Trigger In" connector.

EXT2
Trigger signal from the "Trigger Input / Output" connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the "Trigger 3 Input / Output" connector.
Note: Connector must be configured for "Input".

RFPower
Measurement starts when the first intermediate frequency exceeds a certain level.
(Frequency and time domain measurements only.)
Not available for input from the optional Digital Baseband Interface or the optional analog baseband Interface.

IFPower
Measurement starts when the second intermediate frequency exceeds a certain level.
Not available for input from the optional digital baseband interface. For input from the optional analog baseband interface, this parameter is interpreted as `BBPower` for compatibility reasons.

IQPower
Measurement starts when the sampled I/Q data exceeds a certain magnitude.
For applications that process I/Q data, such as the I/Q analyzer or optional applications.

BBPower
Measurement starts when the baseband power exceeds a certain level.
For digital input via the optional digital baseband interface or the optional analog baseband interface.

PSEN
External power sensor

GP0 | GP1 | GP2 | GP3 | GP4 | GP5
For applications that process I/Q data, such as the I/Q analyzer or optional applications, and only if the optional digital baseband interface is available.
Defines triggering of the measurement directly via the LVDS connector. The parameter specifies which general purpose bit (0 to 5) will provide the trigger data.

TUNit
If activated, the measurement is triggered by a connected R&S FS-Z11 trigger unit, simultaneously for all connected analyzers.

*RST: IMMediate

Manual operation: See "Trigger Source" on page 123
See "Triggering multiple data streams (MIMO measurements)" on page 124

7.10.2.7 Demodulation

CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CROSstalk <State>

Turns MIMO crosstalk compensation on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on crosstalk compensation
`CONF:DL:MIMO:CROS ON`

Manual operation: See "Compensate Crosstalk" on page 128

[SENSe:][LTE:]DL:DEMod:MCFilter <State>

Turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on interference suppression
`DL:DEM:MCF ON`

Manual operation: See "Multicarrier Filter" on page 127

[SENSe:][LTE:]DL:DEMod:CBSCrambling <State>

Turns scrambling of coded bits on and off.

Parameters:
<State> ON | OFF | 1 | 0
*RST: ON

Example: //Descramble coded bits
`DL:DEM:CBSC ON`

Manual operation: See "Scrambling of Coded Bits" on page 128

[SENSe:][LTE:]DL:DEMod:DACHannels <State>

Turns the decoding of all control channels on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on decoding of all control channels
`DL:DEM:DACH ON`

Manual operation: See "Decode All Channels" on page 128

[SENSe:][LTE:]DL:DEMod:EVMCalc <Calculation>

Selects the EVM calculation method.

Parameters:

<Calculation> **TGPP**
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: //Select EVM calculation method
`DL:DEM:EVMC TGPP`

Manual operation: See "EVM Calculation Method" on page 129

[SENSe:][LTE:]DL:DEMod:PRData <Reference>

Selects 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: //Select reference data for PDSCH demodulation
`DL:DEM:PRD ALL0`

Manual operation: See "PDSCH Reference Data" on page 129

[SENSe:][LTE:]DL:DEMod:SISYnc <State>

Turns suppression of 5G resources with a 30 kHz subcarrier spacing (dynamic spectrum sharing) on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on suppression
`DL:DEM:SISY ON`

Manual operation: See "Suppress Interferer for Synchronization" on page 129

7.10.2.8 Estimation & compensation

Parameter estimation

[SENSe:][LTE:]DL:DEMod:BESTimation <State>

Turns boosting estimation on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: ON

Example: //Turn on boosting estimation
`DL:DEM:BEST ON`

Manual operation: See "Boosting Estimation" on page 125

[SENSe:][LTE:]DL:DEMod:CESTimation <Type>

Selects the channel estimation type.

Parameters:

<Type>

OFF
Turns off channel estimation.

PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

TGPP
3GPP EVM definition

*RST: TGPP

Example: //Select channel estimation type
`DL:DEM:CEST TGPP`

Manual operation: See "Channel Estimation" on page 125

Error compensation

[SENSe:][LTE:]DL:TRACking:PHASe <Type>

Selects the phase tracking type.

Parameters:

<Type>

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example: //Select phase tracking type
`DL:TRAC:PHAS PILPAY`

Manual operation: See "Phase" on page 126

[SENSe:][LTE:]DL:TRACking:TIME <State>

Turns timing tracking on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on timing tracking
`DL:TRAC:TIME ON`

Manual operation: See "Time Tracking" on page 126

7.10.2.9 Automatic configuration

Commands to configure the application automatically described elsewhere.

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO`

[SENSe:]ADJust:CONFigure:LEVel:DURation <Duration>

To determine the ideal reference level, the FSW performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example:
`ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Auto Level" on page 117

[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the FSW performs a measurement on the current input data. This command selects the way the FSW determines the length of the measurement .

Parameters:

<Mode>

AUTO
The FSW determines the measurement length automatically according to the current input data.

MANual
The FSW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:LEVel:DURation` on page 283.

*RST: AUTO

Manual operation: See "Auto Level" on page 117

[SENSe:]ADJust:CONFigure:LTE

Automatically detects several signal characteristics and selects the appropriate parameters in the application.

The following signal characteristics are automatically detected.

- Carrier bandwidth
- MIMO configuration

Example:
//Determine signal characteristics based on the measurement signal
`ADJ:CONF:LTE`

Usage: Event

Manual operation: See "Auto LTE" on page 130

[SENSe:]ADJust:LEVel<ant>

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 FSW or limiting the dynamic range by an S/N ratio that is too small.

Suffix:
<ant> 1...4
Connected instrument

Example: //Auto level on one instrument
`ADJ:LEV2`

Usage: Event

Manual operation: See "Auto Level" on page 117
See "Auto leveling" on page 130

7.10.3 Time alignment error measurements

All commands specific to the time alignment error measurement are listed below.

Commands to configure the time alignment error measurement described elsewhere:

- `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 265
- Commands in "Signal characteristics" on page 222
- Commands in "Synchronization signal" on page 239

CONFigure[:LTE]:CAGGregation:STATe <State>

Turns carrier aggregation for time alignment error measurements on and off.

You can select the number of component carriers with `CONFigure[:LTE]:NOCC`.

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Select 2 component carrier
```
CONF:CAGG:STAT ON
CONF:NOCC 2
```

CONFigure[:LTE]:NOCC <Carrier>

Selects the number of component carriers analyzed in the measurement.

Parameters:

<Carrier> 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 74.

*RST: 1

Example: //Select number of component carriers
```
CONF:NOCC 2
```

Manual operation: See "Remote commands to configure carrier aggregation" on page 77

7.10.4 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<cc>]:BW
- CONFigure[:LTE]:DL[:CC<cc>]:CYCPrefix
- CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection
- CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CONFig
- CONFigure[:LTE]:DL[:CC<cc>]:PLC:CID
- CONFigure[:LTE]:DL[:CC<cc>]:PLC:CIDGroup
- CONFigure[:LTE]:DL[:CC<cc>]:PLC:PLID
- CONFigure[:LTE]:DL[:CC<cc>]:SYNC:ANTenna
- CONFigure[:LTE]:DL[:CC<cc>]:SYNC:PPOWer
- CONFigure[:LTE]:DL[:CC<cc>]:SYNC:SPOWer
- CONFigure[:LTE]:DL[:CC<cc>]:TDD:SPSC
- CONFigure[:LTE]:DL[:CC<cc>]:TDD:UDConf
- CONFigure[:LTE]:DUPLexing
- CONFigure[:LTE]:LDIRection
- FETCh[:CC<cc>]:PLC:CIDGroup?
- FETCh[:CC<cc>]:PLC:PLID?
- MMEMory:LOAD[:CC<cc>]:TMOD:DL
- [SENSe:]FREQuency:CENTer[:CC<cc>]
- [SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet
- [SENSe:]SWAPiq
- Commands in Chapter 7.10.2.4, "Amplitude configuration", on page 267

CONFigure[:LTE]:OOPower:NFRames <Frames>

Defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:
<Frames> <numeric value>

Example: //Select frames to be analyzed
`CONF:OOP:NFR 10`

Manual operation: See "Number of Frames" on page 131

[SENSe:][LTE:]OOPower:NCORrection <State>

Turns noise correction for on/off power measurements on and off.

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on noise correction
`OOP:NCOR ON`

Manual operation: See "Noise Cancellation" on page 45
See "Noise Correction" on page 131

UNIT:OPOWer <Unit>

Selects the unit the off power (transmit on / off power measurements) is displayed in.

Parameters:
<Unit> **DBM**
Displays the power as an absolute value in dBm.
DMHZ
Displays the power as a relative value in dBm/MHz.
*RST: DBM

Example: //Select the unit dBm.
`UNIT:OPOW DBM`

Manual operation: See "Transmit On / Off Power" on page 42

7.10.5 Frequency sweep measurements

Please refer to the documentation of the FSW 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.

Commands to configure frequency sweep measurements described elsewhere:

- `[SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet`

CONFigure[:LTE]:NDEVices <Devices>

Selects the number of FSW used in a time alignment error measurement with carrier aggregation.

Parameters:

<Devices>

1
Performs a broadband measurement over all component carriers on a single FSW.

2
Performs a measurement on two FSW, each one analyzing a single component carrier.

*RST: 1

Example: //Select broadband measurement over all CCs
`CONF:NDEV 1`

Manual operation: See "Remote commands to configure carrier aggregation" on page 77

[SENSe:]POWer:ACHannel:AACHannel <Channel>

Selects the bandwidth of the adjacent channel for ACLR measurements.

For 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: //Select assumed adjacent channel
`POW:ACH:AACH UTRA384`

Manual operation: See "Remote commands to configure carrier aggregation" on page 77
See "Assumed Adjacent Channel Carrier" on page 132

[SENSe:]POWer:ACHannel:UAAChannel <Bandwidth>

For MC ACLR measurements, the command selects the bandwidth of the upper adjacent channel.

Parameters:

<Bandwidth>

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: //Select bandwidth of assumed adjacent channel carrier.
`POW:ACH:UAAC UTRA384`

Manual operation: See "Remote commands to configure carrier aggregation" on page 77

[SENSe:]POWer:SEM:CATegory <Category>

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: //Select base station category
`POW:SEM:CAT MED`

Manual operation: See "Category" on page 134

[SENSe:]POWer:SEM:CHBS:AMPower <Power>

Defines the aggregated maximum power for home base stations or the Tx power for medium range base stations.

Prerequisites for this command

- Select medium range base stations ([SENSe:]POWer:SEM:CATegory).
- Turn off automatic power determination ([SENSe:]POWer:SEM:CHBS:AMPower:AUTO).

Parameters:
<Power> <numeric value>

Default unit: dBm

Example: //Define base station power
```
POW:SEM:CAT MED
POW:SEM:CHBS:AMP:AUTO OFF
POW:SEM:CHBS:AMP 0
```

Manual operation: See "Category" on page 134
See "Aggregated Maximum Power Of All TX Ports (P)" on page 135
See "Tx Power" on page 135

[SENSe:]POWer:SEM:CHBS:AMPower:AUTO <State>

Turn automatic detection of the TX channel power on and off.

Prerequisites for this command

- Select medium range base stations ([SENSe:]POWer:SEM:CATegory).

When you turn off automatic detection, you can define the TX channel power manually with [SENSe:]POWer:SEM:CHBS:AMPower.

Parameters:
<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on automatic detection of the TX channel power
```
POW:SEM:CAT MED
POW:SEM:CHBS:AMP:AUTO ON
```

Manual operation: See "Category" on page 134
See "Tx Power" on page 135

[SENSe:]POWer:SEM:OBANd <OperatingBand>

Selects the SEM for a specific operating band.

Prerequisites for this command

- Turn on selection of operating band related SEM limits ([SENSe:]POWer:SEM:OBANd:STATe).

Parameters:

<OperatingBand> <numeric value> (integer only)

Example: //Select SEM for operating band
```
POW:SEM:OBAN:STAT ON
POW:SEM:OBAN 2
```

Manual operation: See "Category" on page 134

[SENSe:]POWer:SEM:OBANd:STATe <State>

Turns SEM limits defined for specific operating bands on and off.

Effects of this command

- Selecting a base station category to test against becomes unavailable ([SENSe:]POWer:SEM:CATegory).

Parameters:

<State> ON | OFF | 1 | 0

You can select an operating band with [SENSe:]POWer:SEM:OBANd.

*RST: OFF

Example: //Turn on operating band related SEM limits
```
POW:SEM:OBAN:STAT ON
```

Manual operation: See "Category" on page 134

CALCulate<n>:LIMit<li>:ACPower:PMODe <Mode>

Selects the limit evaluation mode for ACLR measurements.

Supported for ACLR measurements in the LTE and 5G applications.

Suffix:

<n> irrelevant

 irrelevant

Parameters:

<Mode> **AND**

Overall limit check passes if both absolute and relative limit checks pass.

OR
Overall limit check passes if either absolute or relative limit checks pass.
*RST: AND

Example: //Select evaluation mode
`CALC:LIM:ACP:PMOD AND`

Manual operation: See "Total Limit Pass Mode" on page 133

7.11 Analysis

7.11.1 Trace export

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:
<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see MMEMory:STORe<n>:TRACe on page 293).

Parameters:

<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the MMEMory:STORe<n>:TRACe command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the MMEMory:STORe<n>:TRACe command is ignored.

*RST: SINGle

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports trace data from the specified window to an ASCII file.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "memory limit reached" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Suffix:

<n> Window

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

7.11.2 Microservice export

MMEMory:STORe<n>:MSERvice <FileName>

Exports the signal configuration to the microservice.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the file.
The file extension is `.m5g`.

Example: //Export to microservice
`MMEM:STOR:MSER 'signal.xxx'`

7.11.3 Evaluation range

CONFigure[:LTE]:DL[:CC<cc>]:BF:AP:CELL <Port>

Selects the antenna port for which beamforming measurement results are displayed.

The availabilty of ports depends on the number of transmit antennas and number of beamforming layers.

Suffix:

<cc> Component Carrier

Parameters:

<Port> Antenna port used by the cell reference signal.

ALL
Shows the results for all antenna ports.

AP_0 | AP_1 | AP_2 | AP_3
Shows the results for antenna port 0, 1, 2 or 3 only.

*RST: ALL

Example: //Display results for all antenna ports
`CONF:DL:BF:AP:CELL ALL`

Manual operation: See "Beamforming Selection" on page 144

CONFigure[:LTE]:DL[:CC<cc>]:BF:AP:CSI <Port>

Selects the antenna port for which beamforming measurement results are displayed.

The availabilty of ports depends on the number of transmit antennas and number of beamforming layers.

Suffix:
<cc> Component Carrier

Parameters:
<Port> Antenna port used by the CSI reference signal.

ALL
Shows the results for all antenna ports.

AP_15 | AP_16 | AP_17 | AP_18 | AP_19 | AP20 | AP21 | AP22
Shows the results for antenna port 15 to antenna port 22 only.

*RST: ALL

Example: //Display results for all antenna ports
`CONF:DL:BF:AP:CSI ALL`

Manual operation: See "Beamforming Selection" on page 144

CONFigure[:LTE]:DL[:CC<cc>]:BF:AP[:UERS] <Port>

Selects the antenna port for which beamforming measurement results are displayed.

The availabilty of ports depends on the number of transmit antennas and number of beamforming layers.

Suffix:
<cc> Component Carrier

Parameters:
<Port> Antenna port used by the UE reference signal.

ALL
Shows the results for all antenna ports.

AP_5_7 | AP_8 | AP_9 | AP_10 | AP_11 | AP_12 | AP_13 | AP_14
Shows the results for antenna port 5/7, 8, 9, 10, 11, 12, 13 or 14 only.

*RST: ALL

Example: //Display results for all antenna ports
`CONF:DL:BF:AP:UERS ALL`

Manual operation: See "Beamforming Selection" on page 144

[SENSe:][LTE:][CC<cc>:]ALLocation:SELect <Allocation>

Filters the displayed results in the constellation diagram by a certain type of allocation.

Suffix:
<cc> Component Carrier

Parameters:
<Allocation>

ALL
Shows the results for all allocations.

<numeric_value> (integer only)
Shows the results for a single allocation type.
Allocation types are mapped to numeric values. For the code assignment, see Chapter 7.7.1.31, "Return value codes", on page 186.

*RST: ALL

Example:
//Display results for PDCCH
`ALL:SEL -11`

Manual operation: See "Evaluation range for the constellation diagram" on page 143

[SENSe:][LTE:][CC<cc>:]CARRier:SELect <Carrier>

Filters the results in the constellation diagram by a certain subcarrier.

Suffix:
<cc> Component Carrier

Parameters:
<Carrier>

ALL
Shows the results for all subcarriers.

<numeric_value> (integer only)
Shows the results for a single subcarrier.

*RST: ALL

Example:
//Display results for subcarrier 1
`CARR:SEL 1`

Manual operation: See "Evaluation range for the constellation diagram" on page 143

[SENSe:][LTE:][CC<cc>:]LOCation:SELect <Location>

Selects the data source of the constellation diagram.

Suffix:
<cc> Component Carrier

Parameters:
<Location>

AMD
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example: //Use data from after the MIMO decoder
`LOC:SEL AMD`

Manual operation: See "Evaluation range for the constellation diagram" on page 143

[SENSe:][LTE:][CC<cc>:]MODulation:SELect <Modulation>

Filters the results in the constellation diagram by a certain type of modulation.

Suffix:
<cc> Component Carrier

Parameters:
<Modulation>

ALL
Shows the results for all modulation types.

<numeric_value> (integer only)
Shows the results for a single modulation type.
Modulation types are mapped to numeric values. For the code assignment, see Chapter 7.7.1.31, "Return value codes", on page 186.

*RST: ALL

Example: //Display results for all elements with a QPSK modulation
`MOD:SEL 2`

Manual operation: See "Evaluation range for the constellation diagram" on page 143

[SENSe:][LTE:][CC<cc>:]SUBFrame:SELect <Subframe>

Selects the subframe to be analyzed.

Suffix:
<cc> Component Carrier

Parameters:
<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: //Display results for all subframes
`SUBF:SEL ALL`

Manual operation: See "Subframe Selection" on page 142

[SENSe:][LTE:][CC<cc>:]SYMBol:SELect <Symbol>

Filters the results in the constellation diagram by a certain OFDM symbol.

Suffix:
<cc> Component Carrier

Parameters:
<Symbol> **ALL**
Shows the results for all subcarriers.

<numeric_value> (integer only)
Shows the results for a single OFDM symbol.

*RST: ALL

Example: //Display result for OFDM symbol 2
`SYMB:SEL 2`

Manual operation: See "Evaluation range for the constellation diagram" on page 143

7.11.4 Y-axis scale

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO <ONCE>

Automatically scales the y-axis of a diagram based on the displayed results.

Suffix:
<n> Window

<w> Subwindow

<t> irrelevant

Setting parameters:
<ONCE> **ALL**
Scales the y-axis in all windows for an ideal viewing experience.

DEFault
Restores the default scale of the y-axis.

ONCE
Scales the y-axis in a specific window for an ideal viewing experience.

Example: //Automatically scale the y-axis in subwindow 2 of window 2
`DISP:WIND2:SUBW2:TRAC:Y:AUTO ONCE`

Usage: Setting only

Manual operation: See "Auto Scaling" on page 130
See "Automatic scaling of the y-axis" on page 140

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

Defines the maximum value displayed on the y-axis of a diagram.

Suffix:

<n>	Window
<w>	Subwindow
<t>	irrelevant

Parameters:

<Value>	Maximum displayed value. The unit and value range depend on the selected diagram.
Example:	//Define maximum value on y-axis in subwindow 2 of window 2 `DISP:WIND2:SUBW2:TRAC:Y:MAX 0`
Manual operation:	See "Manual scaling of the y-axis" on page 139

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

Defines the minimum value displayed on the vertical diagram axis.

Suffix:

<n>	Window
<w>	Subwindow
<t>	irrelevant

Parameters:

<Value>	Minimum displayed value. The unit and value range depend on the selected diagram.
Example:	//Define minimum value on y-axis in subwindow 2 of window 2 `DISP:WIND2:SUBW2:TRAC:Y:MIN -50`
Manual operation:	See "Manual scaling of the y-axis" on page 139

7.11.5 Result settings

CALCulate<n>:MARKer<m>:COUPling <State>

Couples or decouples markers in different result displays to each other.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Couple markers to each other.
`CALC:MARK:COUP ON`

Manual operation: See "Marker Coupling" on page 146

DISPlay[:WINDow<n>][:SUBWindow<w>]:COUPling <State>

Couples or decouples result display tabs (subwindows).

Subwindow coupling is available for measurements with multiple data streams (like carrier aggregation).

Suffix:
<n> Window

<w> Subwindow

Parameters:
<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on subwindow coupling
`DISP:COUP ON`

Manual operation: See "Subwindow Coupling" on page 146

UNIT:BSTR <Unit>

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: //Display bit stream as bits
`UNIT:BSTR BIT`

Manual operation: See "Bit Stream Format" on page 145

UNIT:CAXes <Unit>

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:
//Display frequency on the x-axis
```
UNIT:CAX HZ
```

Manual operation: See "Carrier Axes" on page 145

UNIT:EVM <Unit>

Selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example:
//Display EVM results in %
```
UNIT:EVM PCT
```

Manual operation: See "EVM Unit" on page 145

7.12 Reading out status register

The following commands are required to read out the `STATus:QUEStionable:SYNC` status register.

For a full list of commands required to read out the status register, refer to the FSW user manual.

STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

Reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:QUEStionable:SYNC:CONDition? <ChannelName>

Reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:QUEStionable:SYNC:ENABle <BitDefinition>, <ChannelName>

Controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:QUEStionable:SYNC:NTRansition <BitDefinition>[,<ChannelName>]

Controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:QUEStionable:SYNC:PTRansition <BitDefinition>[,<ChannelName>]

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition>	Range: 0 to 65535
<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.

List of commands (LTE downlink)

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