

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



1173.9370.02 – 01

This manual applies to the following R&S®FSW models with firmware version 1.51 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)

The following firmware options are described:

- R&S FSW-K100 (LTE FDD DL) (order no. 1313.1545.02)
- R&S FSW-K104 (LTE TDD DL) (order no. 1313.1574.02)

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

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1 Welcome to the LTE Measurement Application

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

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage (<http://www2.rohde-schwarz.com/product/FSW.html>).

Installation

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

1.1 Starting the LTE Measurement Application

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

To activate the application

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

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

2. Select the "LTE" item.



The R&S 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 R&S FSW, the "Mode" dialog box also contains a item for this software. It is labeled "LTE Software" and opens the PC software on the R&S FSW.

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 (see [chapter 4, "Configuration"](#), on page 30).

1.2 Understanding the Display Information

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



- 1 = Toolbar
- 2 = Channel bar
- 3 = Diagram header
- 4 = Result display
- 5 = Softkey bar
- 6 = Status bar



MSRA operating mode

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

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

Channel bar information

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

Table 1-1: 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
Cell ID	Cell identity
Capture Time	Signal length that has been captured

Frame Count	Number of frames that have been captured
Selected Subframe	Subframe considered in the signal analysis

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

Window title bar information

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

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.

2 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 in a graphic way or tables that show the results in a numeric way.

Selecting measurements

- ▶ Press the MEAS key.


The application opens a dialog box that contains several buttons.

Each button represents a set of result displays that thematically belong together and that have a particular display configuration. For example, the "Time Alignment" button starts the "Capture Memory" and "Power Spectrum" result displays to get an idea of the time characteristics of the signal. If these predefined display configuration do not suit your requirements you can add or remove result displays as you like. For more information about selecting result displays see ["Selecting result displays"](#) on page 8.

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

- If you select "EVM", the application processes the I/Q data of the signal. For more information on available I/Q result displays see [chapter 2.1, "I/Q Measurements"](#), on page 10.
When you select one of the result displays available for I/Q measurements, you can combine the result displays available for I/Q measurements in any way.
- If you select "Channel Power ACLR" or "Spectrum Emission Mask", the application performs a frequency sweep. For more information see [chapter 2.2, "Frequency Sweep Measurements"](#), on page 22.
When you select one of the frequency sweep measurements, you can combine the result displays available for the frequency sweep measurements in any way. Note that you can not display the ACLR and SEM at the same time.

Selecting result displays

- ▶ Select the  icon in the toolbar or press the MEAS key.

The application enters the SmartGrid configuration mode.

For more information on the SmartGrid functionality see the R&S FSW Getting Started.

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

- Capture Memory
- EVM vs Carrier

- Power Spectrum
- Result Summary
- Constellation Diagram

From that predefined state, add and remove result display as you like.

Performing measurements

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

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

Selecting the operating mode

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

- ▶ Press the MODE key.
- ▶ Select the "Multi-Standard Radio Analyzer Tab".

The R&S FSW enters MSRA mode.

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

When you are using the MSRA operating mode, only the MSRA master actually captures data. The application receive an extract of the captured data for analysis, referred to as the **application data**. For the LTE application in MSRA moed, the data range of the application is defined by the same settings used to define the signal capture in Spectrum mode. In addition, you can define a capture offset. A capture offset is an offset from the start of the captured data to the start of the LTE analysis interval.

However, the application does not have to analyze the complete data range. The data range that is actually analyzed by the LTE application is referred to as the **analysis interval**.

The analysis interval is automatically determined according to the [Capture Time](#) you have defined. The analysis interval can not be edited directly in the LTE application, but is changed automatically when you change the evaluation range.

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

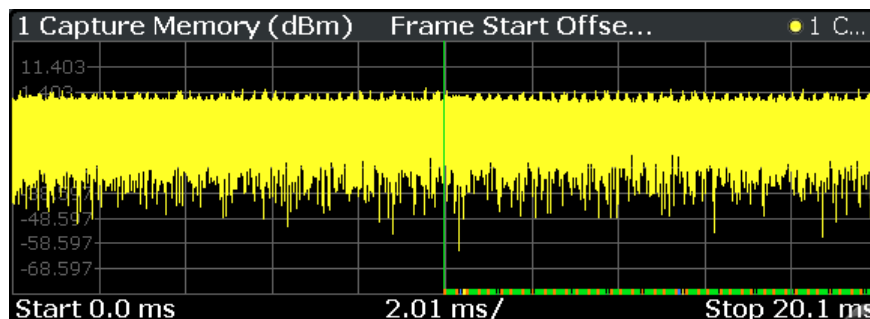
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Capture Buffer




The capture buffer result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).



The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

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

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

-  Indicates the S-SYNC and data.

A blue vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram includes the Subframe Start Offset value (blue text). This value is the time difference between the subframe start and capture buffer start.

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

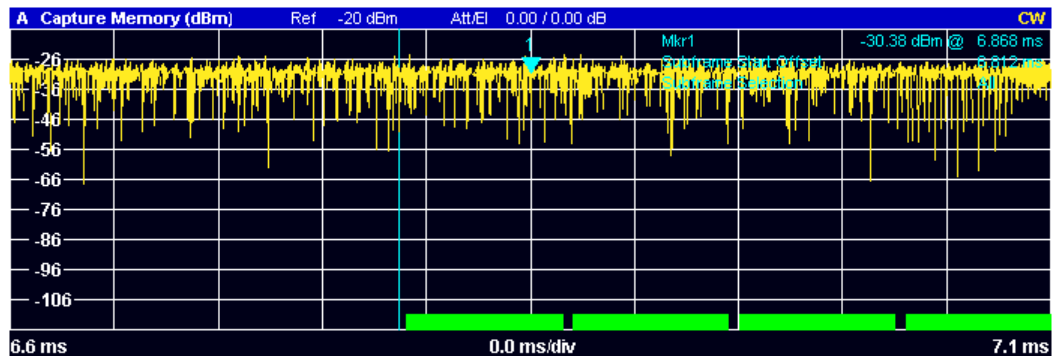


Fig. 2-1: Capture buffer after a zoom has been applied

SCPI command:

`LAY:ADD ? '1',LEFT,CBUF`

`TRACe:DATA?`

EVM vs Carrier

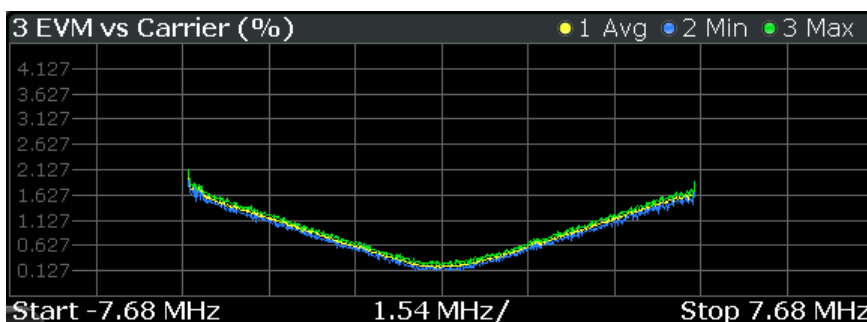
Starts the EVM vs Carrier result display.

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

The displayed result is an average over all available OFDM symbols. By default, three traces are shown. One trace shows the average EVM. The second and the third trace show the minimum and maximum EVM values respectively. You can select to display the EVM for a specific subframe. In that case, the application shows the EVM of that subframe only.

For more information see "[Subframe Selection](#)" on page 61

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



SCPI command:
[LAY:ADD ? '1',LEFT,EVCA](#)
[TRACe:DATA?](#)

EVM vs Symbol

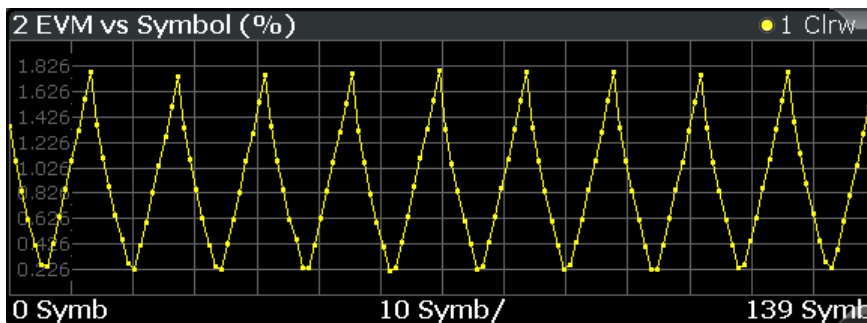
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) on symbol level for all OFDM symbols in all subframes. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The result is an average over all subcarriers.

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

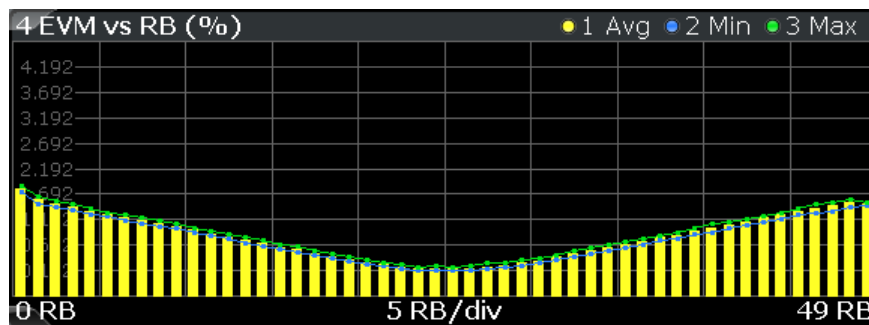
On the y-axis, the EVM is plotted either in % or in dB, depending on the [EVM Unit](#)



SCPI command:
[LAY:ADD ? '1',LEFT,EVSY](#)
[TRACe:DATA?](#)

EVM vs RB

The EVM vs RB shows the EVM of the PDSCH for each resource block it occupies.



SCPI command:

```
LAY:ADD ? '1',LEFT,EVRP
TRACe:DATA?
```

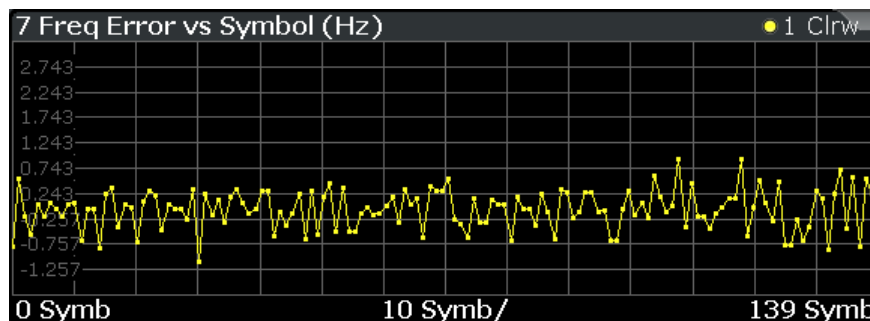
Frequency Error vs Symbol

Starts the Frequency Error vs Symbol result display.

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

The result is an average over all subcarriers.

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



SCPI command:

```
LAY:ADD ? '1',LEFT,FEVS
TRACe:DATA?
```

EVM vs Subframe

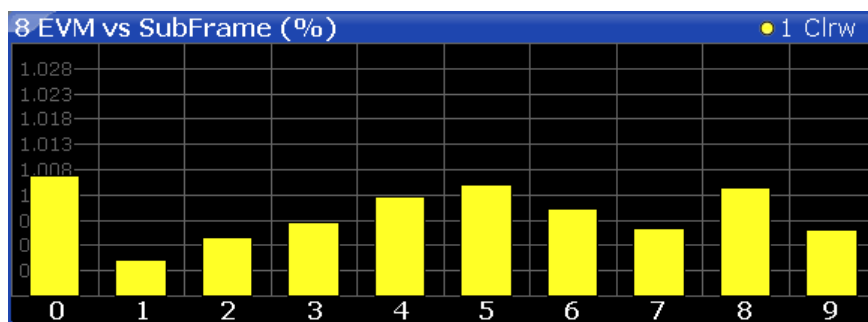
Starts the EVM vs Subframe result display.

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

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

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

On the y-axis, the EVM is plotted either in % or in dB, depending on the [EVM Unit](#).



SCPI command:

```
LAY:ADD ? '1',LEFT,EVSU
TRACe:DATA?
```

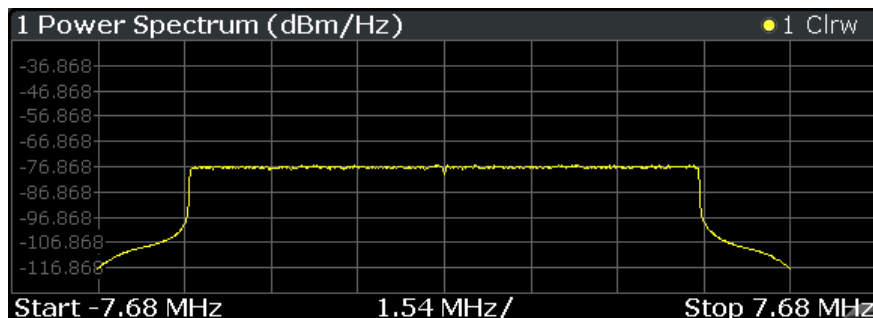
Power Spectrum

Starts the Power Spectrum result display.

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

For more information see "[Channel Bandwidth / Number of Resource Blocks](#)" on page 34.

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



SCPI command:

```
LAY:ADD ? '1',LEFT,PSPE
TRACe:DATA?
```

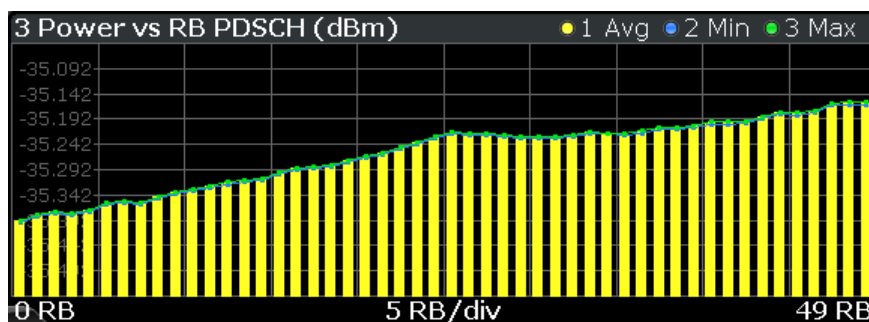
Power vs Resource Block PDSCH

Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

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

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



SCPI command:

```
LAY:ADD ? '1',LEFT,PVRP
TRACe:DATA?
```

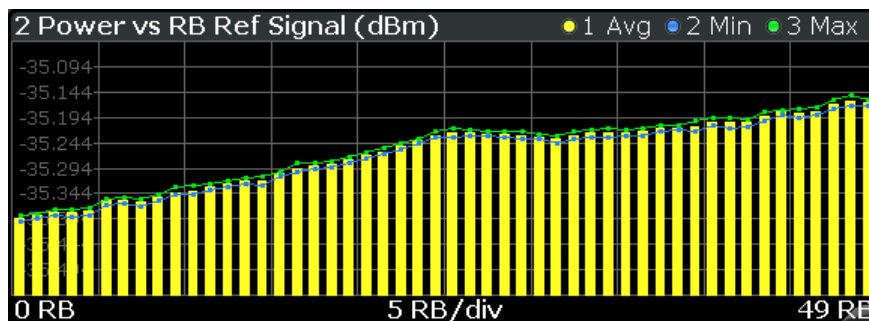
Power vs Resource Block RS

Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

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

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



SCPI command:

```
LAY:ADD ? '1',LEFT,PVRR
TRACe:DATA?
```

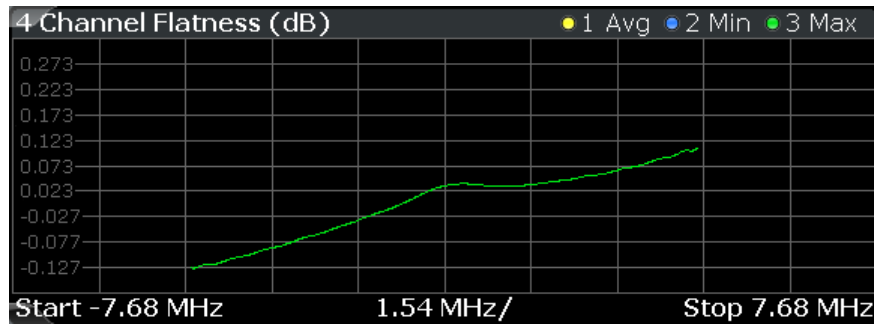
Channel Flatness

Starts the Channel Flatness result display.

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

The currently selected subframe depends on your [selection](#).

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



SCPI command:

```
LAY:ADD ? '1',LEFT,FLAT
TRACe:DATA?
```

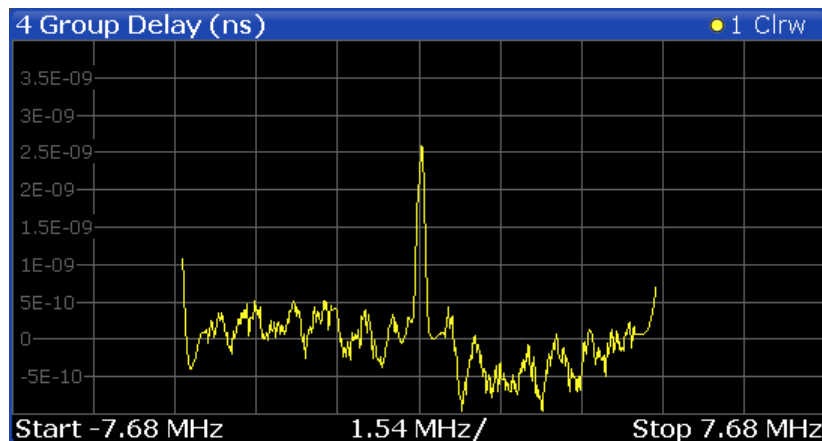
Channel Group Delay

Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your [selection](#).

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



SCPI command:

```
LAY:ADD ? '1',LEFT,GDEL
TRACe:DATA?
```

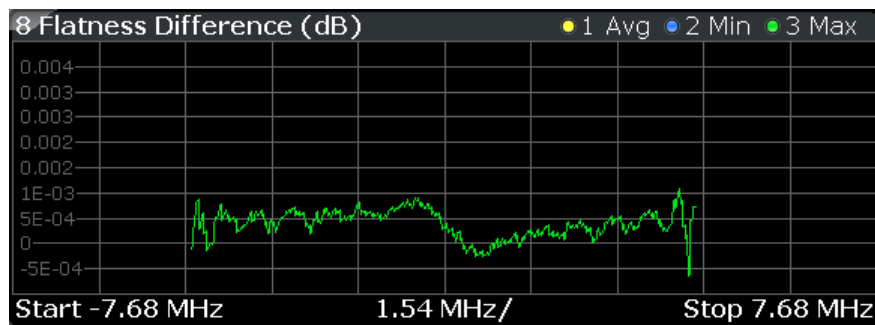
Channel Flatness Difference

Starts the Channel Flatness Difference result display.

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

The currently selected subframe depends on your [selection](#).

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



SCPI command:

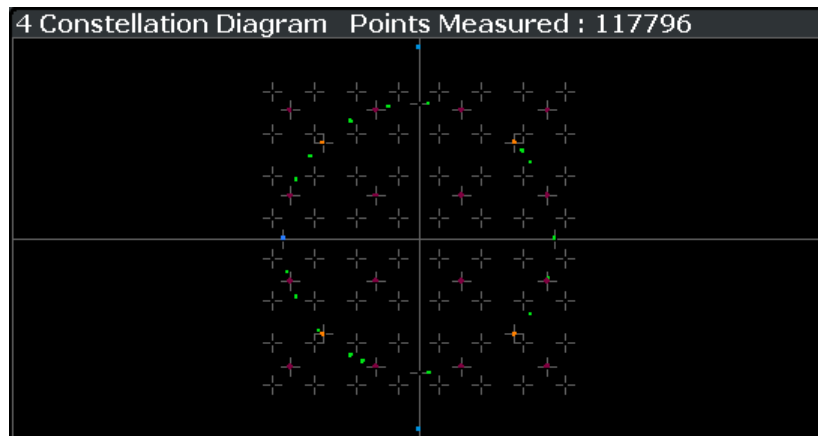
```
LAY:ADD ? '1',LEFT,FDIF
TRACe:DATA?
```

Constellation Diagram

Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.



SCPI command:

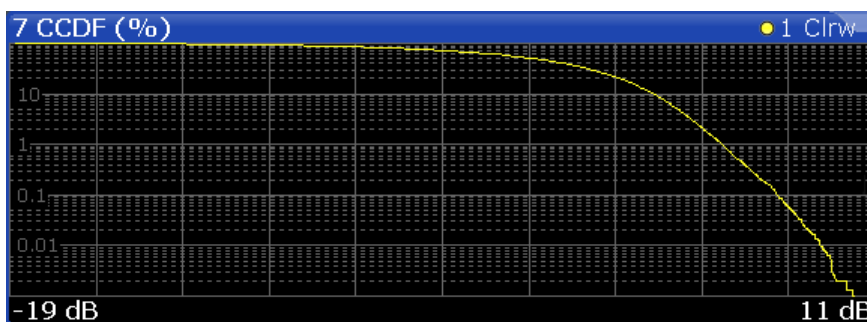
```
LAY:ADD ? '1',LEFT,CONS
TRACe:DATA?
```

CCDF

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

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

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



SCPI command:
 LAY:ADD ? '1',LEFT,CCDF
 TRACe:DATA?

Allocation Summary

Starts the Allocation Summary result display.

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

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

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

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.
- **Number of RB**
Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
Shows the relative power of the allocation.
- **Modulation**
Shows the modulation type.
- **Power per RE [dBm]**
Shows the power of each resource element in dBm.
- **EVM**

Shows the EVM of the allocation. The unit depends on your [selection](#).

SCPI command:

[LAY:ADD ? '1',LEFT,ASUM](#)

[TRACe:DATA?](#)

Bit Stream

Starts the Bit Stream result display.

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

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

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

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

2 Bit Stream					
Sub-Frame	Allocation ID	Code-word	Modulation	Symbol Index	
0	PBCH	1/1	QPSK	0	00 00 02 00 00
0	PBCH	1/1	QPSK	18	00 03 01 01 00
0	PBCH	1/1	QPSK	36	00 00 00 00 01
0	PBCH	1/1	QPSK	54	01 01 00 00 02
0	PBCH	1/1	QPSK	72	00 02 01 01 01
0	PBCH	1/1	QPSK	90	03 01 00 00 02
0	PBCH	1/1	QPSK	108	02 03 03 00 02

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

SCPI command:

[LAY:ADD ? '1',LEFT,BSTR](#)

[TRACe:DATA?](#)

Result Summary

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

SCPI 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:SUMMary:EVM:DSQP\[:AVERage\]?](#) on page 87
- EVM PDSCH 16QAM**
 Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
[FETCh:SUMMary:EVM:DSST\[:AVERage\]?](#) on page 87
- EVM PDSCH 64QAM**
 Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
[FETCh:SUMMary:EVM:DSSF\[:AVERage\]?](#) on page 88

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 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:SUMMary:EVM\[:ALL\]\[:AVERage\]?](#) on page 87
- EVM Phys Channel**
 Shows the EVM for all physical channel resource elements in the analyzed frame.
[FETCh:SUMMary:EVM:PCHannel\[:AVERage\]?](#) on page 88

- **EVM Phys Signal**
Shows the EVM for all physical signal resource elements in the analyzed frame.
[FETCh:SUMMary:EVM:PSIGNal\[:AVERAge\]?](#) on page 88
- **Frequency Error**
Shows the difference in the measured center frequency and the reference center frequency.
[FETCh:SUMMary:FERRor\[:AVERAge\]?](#) on page 89
- **Sampling Error**
Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
[FETCh:SUMMary:SERRor\[:AVERAge\]?](#) on page 91
- **I/Q Offset**
Shows the power at spectral line 0 normalized to the total transmitted power.
[FETCh:SUMMary:IQOFFset\[:AVERAge\]?](#) on page 89
- **I/Q Gain Imbalance**
Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
[FETCh:SUMMary:GIMBalance\[:AVERAge\]?](#) on page 89
- **I/Q Quadrature Error**
Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
[FETCh:SUMMary:QUADerror\[:AVERAge\]?](#) on page 90
- **RSTP**
Shows the reference signal transmit power as defined in 3GPP TS 36.141. 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:SUMMary:RSTP\[:AVERAge\]?](#) on page 91
- **OSTP**
Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141. It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.
[FETCh:SUMMary:OSTP\[:AVERAge\]?](#) on page 90
- **Power**
Shows the average time domain power of the analyzed signal.
[FETCh:SUMMary:POWer\[:AVERAge\]?](#) on page 90
- **Crest Factor**
Shows the peak-to-average power ratio of captured signal.
[FETCh:SUMMary:CRESt\[:AVERAge\]?](#) on page 87

Marker Table

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

2 Marker						
Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.197057
D1	N1	1	-7.942 GHz	-49.41 dB		
D2	N1	2	-3.918 GHz	-21.90 dB		
D3	N1	3	4.024 GHz	-21.99 dB		

SCPI command:

LAY:ADD? '1',RIGH, MTAB, see [LAYout:ADD\[:WINDow\]?](#) on page 121

2.2 Frequency Sweep Measurements

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

Frequency sweep measurements are available if RF input is selected.

ACLR.....22
 Spectrum Mask.....23

ACLR

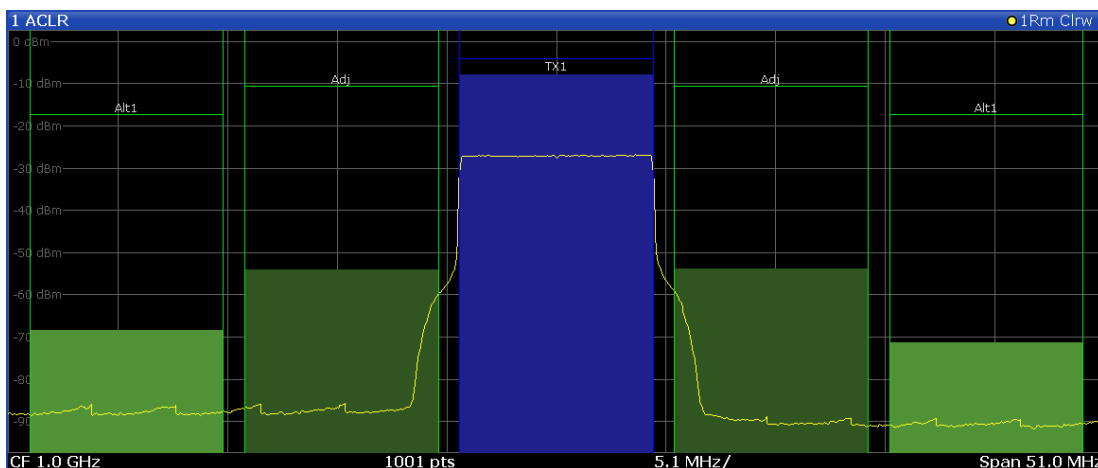
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

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

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



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

- Channel

Shows the channel type (TX, Adjacent or Alternate Channel).

- **Bandwidth**
Shows the bandwidth of the channel.
- **Spacing**
Shows the channel spacing.
- **Lower / Upper**
Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
Shows the limit of that channel, if one is defined.

2 Result Summary		EUTRA/LTE Square		
Channel	Bandwidth	Offset	Power	
TX1 (Ref)	9.015 MHz		-7.82 dBm	
Tx Total			-7.82 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	9.015 MHz	10.000 MHz	-46.34 dB	-46.04 dB
Alt1	9.015 MHz	20.000 MHz	-60.57 dB	-63.57 dB

SCPI command:

Selection:

[CONF:MEAS ACLR](#)

Reading results:

[CALCulate<n>:MARKer<m>:FUNCTION:POWER:RESult\[:CURRENT\]?](#)

on page 85

[TRACe:DATA?](#)

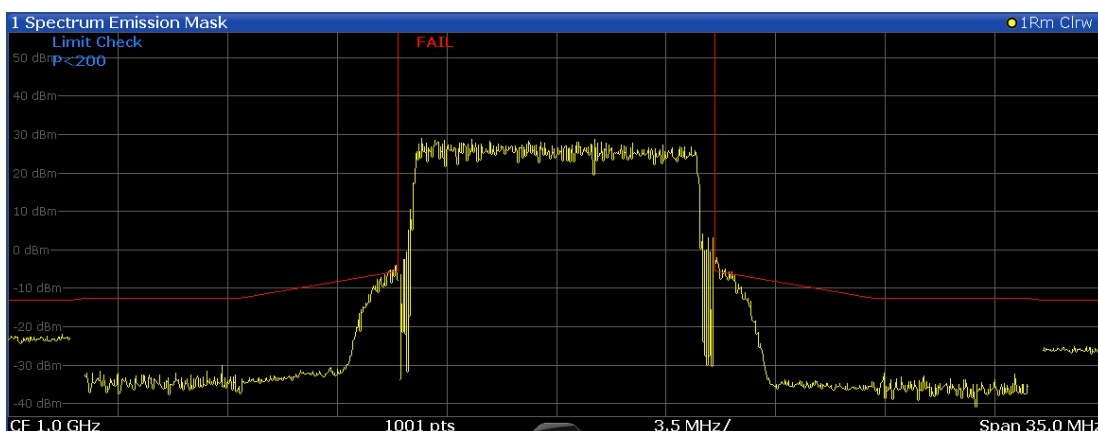
Spectrum Mask

Starts the Spectrum Emission Mask (SEM) result display.

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

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSW puts a label to the limit line to indicate whether the limit check passed or failed.

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



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

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

2 Result Summary			LTE Category A (Freq. > 1GHz) DL			
Tx Power 45.24 dBm		Tx Bandwidth 10.000 MHz		RBW 100.000 kHz		
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	Δ Limit
-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

SCPI command:

CONF:MEAS ESP

TRACe:DATA?

3 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

- [Symbols and Variables](#).....25
- [Overview](#).....26
- [The LTE Downlink Analysis Measurement Application](#).....26

3.1 Symbols and Variables

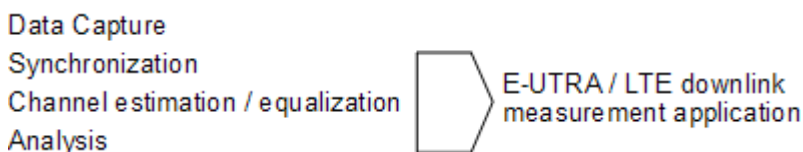
The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{i,k}, \hat{a}_{i,k}$	data symbol (actual, decided)
$b_{i,k}$	boosting factor
$\Delta f, \Delta \hat{f}_{\text{coarse}}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{i,k}, \hat{H}_{i,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{t}_{\text{coarse}}, \hat{t}_{\text{fine}}$	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
$n_{i,k}$	noise sample
Φ_l	common phase error
$r(i)$	received sample in the time domain
$r_{i,k}, r'_{i,k}, r''_{i,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time

T_g	guard time
T_s	symbol time

3.2 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.

3.3 The LTE Downlink Analysis Measurement Application

The block diagram in [figure 3-1](#) shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{i,k}$ of the transmitted data symbols $a_{i,k}$. Depending on the user-defined compensation, the received samples $r_{i,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

3.3.1 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{t}_{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 $\Delta\tilde{c}$, $\Delta\tilde{t}_i$ and $\Delta\tilde{t}_h$. For the reference path, only the signal taken at the timing offset $\Delta\tilde{c}$ is used.

The LTE Downlink Analysis Measurement Application

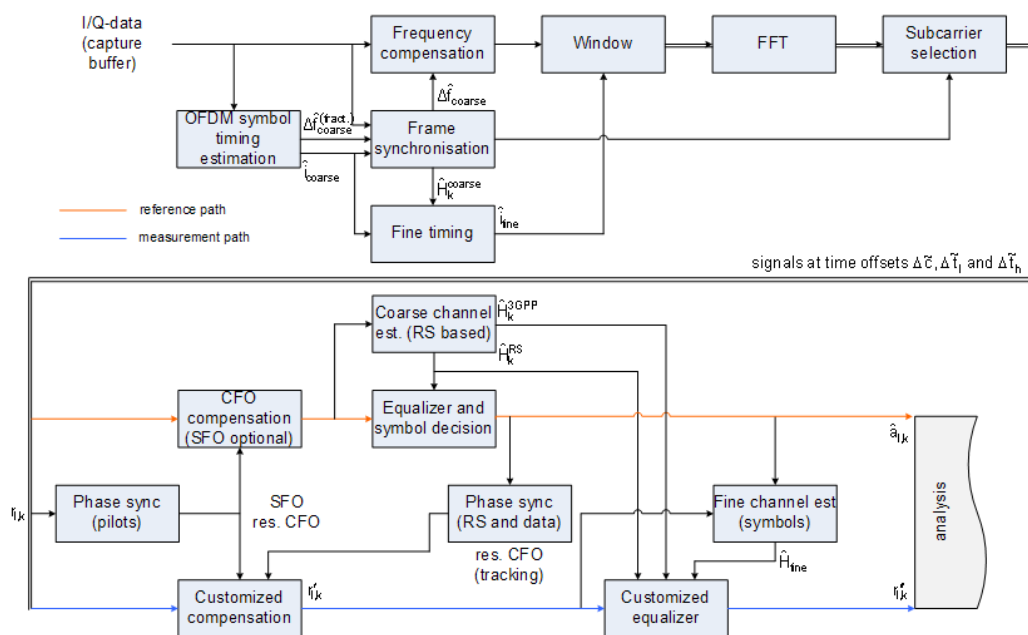


Fig. 3-1: Block diagram for the LTE DL measurement application

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_1 (CPE)

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

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_1}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_s / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_s / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res. CFO} + N_{l,k} \tag{3 - 1}$$

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.

3.3.2 Channel Estimation and Equalization

As shown in [figure 3-1](#), 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.

3.3.3 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

$$EVM_{l,k} = \frac{|r_{l,k}'' - \hat{a}_{l,k}|}{b_{l,k} \sqrt{E \left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}} \quad (3 - 2)$$

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

$$EVM_{n,l} = \frac{|r_{l,k}'' - \hat{a}_{l,k}|}{b_{l,k}} \quad (3 - 3)$$

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_l \sum_{k_{data}} EVM_{l,k_{data}}^2}$$
(3 - 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

$$r(t) = I \Re\{s(t)\} + jQ \Im\{s(t)\}$$
(3 - 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 $Q:=1+\Delta Q$.

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

$$\text{modulator gain balance} = |1 + \Delta Q|$$
(3 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$
(3 - 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 Configuration

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

When you activate a measurement channel in the LTE application, a measurement for the input signal is started automatically with the default configuration. The "LTE" menu is displayed and provides access to the most important configuration functions.



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

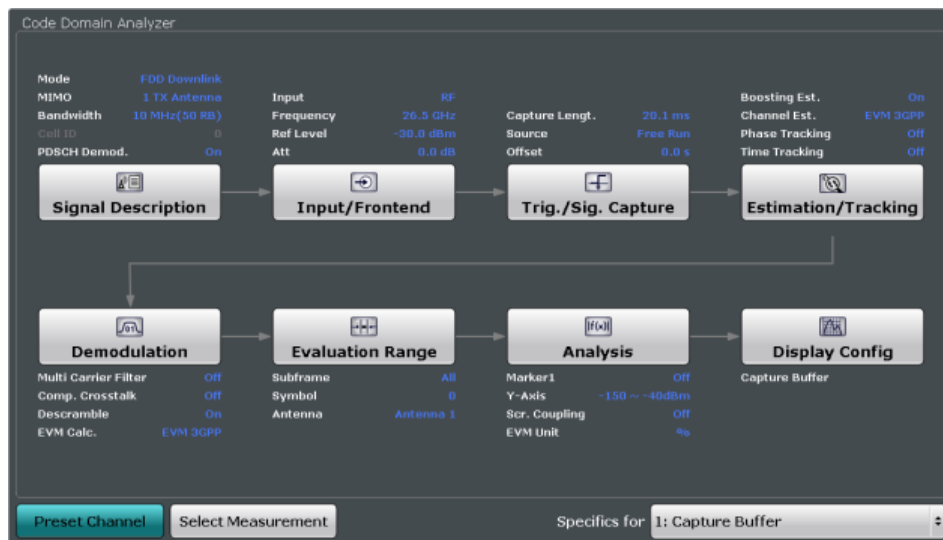
The R&S FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before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

- [Configuration Overview](#).....30
- [Configuring I/Q Measurements](#).....32
- [Configuring Frequency Sweep Measurements](#).....59

4.1 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 4.2.1.1, "Signal Description"](#), on page 32.
2. Input / Frontend
See [chapter 4.2.2, "Input / Frontend"](#), on page 49.
3. Trigger / Signal Capture
See [chapter 4.2.3, "Signal Capture"](#), on page 52.
4. Estimation / Tracking
See [chapter 4.2.4, "Parameter Estimation"](#), on page 55.
5. Demodulation
See [chapter 4.2.5, "Demodulation"](#), on page 56.
6. Evaluation Range
See [chapter 5.1.1, "Evaluation Range"](#), on page 61.
7. Analysis
See [chapter 5, "Analysis"](#), on page 61.
8. Display Configuration
See [chapter 2.1, "I/Q Measurements"](#), on page 10.

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

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

For more information refer to the documentation of the R&S 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 the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key on the front panel restores all measurements **in all measurement channels** on the R&S FSW to their default values!

SCPI command:

[SYSTEM:PRESet:CHANnel\[:EXECute\]](#) on page 92

Specifics for

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

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

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

4.2 Configuring I/Q Measurements

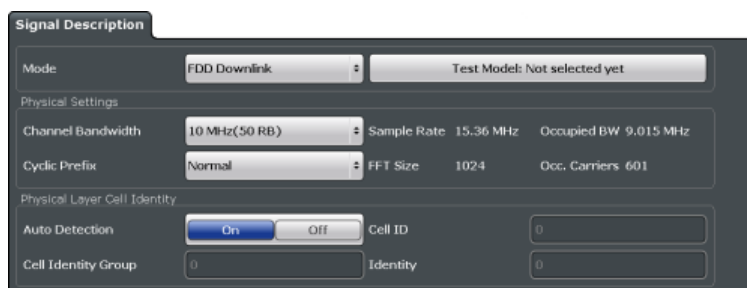
- [Defining the Signal Characteristics](#).....32
- [Input / Frontend](#).....49
- [Signal Capture](#).....52
- [Parameter Estimation](#).....55
- [Demodulation](#).....56

4.2.1 Defining the Signal Characteristics

- [Signal Description](#).....32
- [Configuring MIMO Setups](#).....37
- [PDSCH Settings](#).....37
- [Advanced Downlink Settings](#).....41

4.2.1.1 Signal Description

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



- [Selecting the LTE Mode](#).....33
- [Using Test Models](#).....33
- [Channel Bandwidth / Number of Resource Blocks](#).....34
- [Cyclic Prefix](#).....34
- [Configuring TDD Frames](#).....35
- [Configuring the Physical Layer Cell Identity](#).....36

Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSW.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE 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.

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



SCPI command:

[CONFigure\[:LTE\]:DUPLexing](#) on page 93

Using Test Models

Opens the "Test Models" dialog box to select or manage EUTRA test models.

EUTRA test models (E-TM) are descriptions of LTE signals defined in the 3GPP standard (TS 36.141).

The standard contains and defines three main groups of test models: E-TM1, E-TM2 and E-TM3. All test models use the following parameters:

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

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

The predefined test models are made for specific test scenarios.

E-TM	Test scenario
E-TM1.1	BS output power Unwanted emissions Transmitter intermodulation RS absolute accuracy
E-TM1.2	ACLR Operating band unwanted emissions
E-TM2	Total power dynamic range (lower OFDM symbol power limit at min. power) EVM of single 64QAM PRB allocation (at min. power) Frequency error (at min. power)
E-TM3.1	Output power dynamics Transmitted signal quality (frequency error and EVM for 64QAM modulation at max. power)

E-TM	Test scenario
E-TM3.2	Transmitted signal quality <ul style="list-style-type: none"> • Frequency error • EVM for 16QAM modulation
E-TM3.3	Transmitted signal quality <ul style="list-style-type: none"> • Frequency error • EVM for QPSK modulation

In addition to the predefined test models, you can also make custom test models and save it for later use.

To create a new test model, characterize the signal as required, then save the file in the "User Defined" tab of the "Test Models" dialog box. In addition to saving a signal configuration, you can also restore previously created test models or delete ones you do not need anymore.

Channel Bandwidth / Number of Resource Blocks

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

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSW automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

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	23.04	30.72
FFT Size	128	256	512	1024	2048	2048

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



SCPI command:

[CONFigure\[:LTE\]:DL:BW](#) on page 93

[CONFigure\[:LTE\]:DL:NORB](#) on page 93

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.

SCPI command:

`CONFigure[:LTE]:DL:CYCPrefix` on page 94

Configuring TDD Frames

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

TDD UL/DL Allocations

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

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

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

U = uplink

D = downlink

S = special subframe

Conf. of Special Subframe

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

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

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:

Subframe

[CONFigure\[:LTE\]:DL:TDD:UDConf](#) on page 94

Special Subframe

[CONFigure\[:LTE\]:DL:TDD:SPSC](#) on page 94

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 R&S FSW automatically updates the other two.

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

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

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

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is contained in 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.

The application shows the currently selected cell ID in the channel bar.



SCPI command:

Cell Identity Group:

[CONFigure\[:LTE\]:DL:PLC:CIDGroup](#) on page 95

[FETCh:PLC:CIDGroup?](#) on page 95

Identity

[CONFigure\[:LTE\]:DL:PLC:PLID](#) on page 95

[FETCh:PLC:PLID?](#) on page 96

4.2.1.2 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups.



[MIMO Configuration](#).....37

MIMO Configuration

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

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

In setups with multiple antennas, antenna selection defines the antenna you'd like to test.

SCPI command:

MIMO configuration

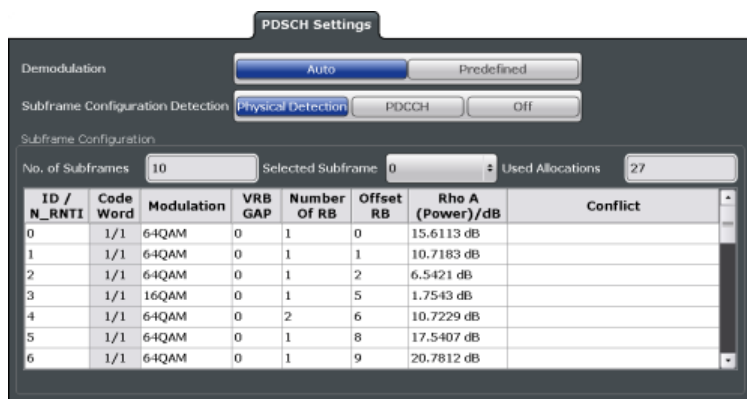
[CONFigure\[:LTE\]:DL:MIMO:CONFig](#) on page 96

Antenna selection:

[CONFigure\[:LTE\]:DL:MIMO:ASElection](#) on page 96

4.2.1.3 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.



- [Demodulating the PDSCH](#).....38
- [Configuring PDSCH Subframes](#).....39

Demodulating the PDSCH

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

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.
- Physical detection
Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.

The "PDSCH Subframe Configuration Detection" is not available if you have turned on [Auto PDSCH Demodulation](#).

SCPI command:

```
[SENSe] [:LTE] :DL:FORMat:PSCD on page 97
```

Auto PDSCH Demodulation

Turns automatic demodulation of the PDSCH on and off.

Turn on automatic PDSCH demodulation for automatic detection of the PDSCH resource allocation. The application is able to detect the PDSCH resource allocation by analyzing the protocol information in the PDCCH or by analyzing the physical signal. It then writes the results into the [PDSCH Configuration Table](#).

You can set the way the R&S FSW identifies the PDSCH resource allocation with "[PDSCH Subframe Configuration Detection](#)" on page 38.

If the automatic demodulation of the PDSCH is off, 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.

SCPI command:

```
[SENSe] [:LTE]:DL:DEMod:AUTO on page 97
```

Configuring PDSCH Subframes

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

If you turn "Auto Demodulation" on, the application automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.

Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The R&S FSW shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	VRB GAP	Number Of RB	Offset RB	Rho A (Power)/dB	Conflict
0	1/1	64QAM	0	1	0	15.6113 dB	
1	1/1	64QAM	0	1	1	10.7183 dB	
2	1/1	64QAM	0	1	2	6.5421 dB	
3	1/1	16QAM	0	1	5	1.7543 dB	
4	1/1	64QAM	0	2	6	10.7229 dB	

Note that the Enhanced Settings are not yet supported.

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	VRB GAP	Number Of RB	Offset RB	Rho A (Power)/dB	Conflict
0	1/1	64QAM	0	2	0	15.6113 dB	Col :1
1	1/1	64QAM	0	1	1	10.7183 dB	Col :0
2	1/1	64QAM	0	1	2	6.5421 dB	
3	1/1	16QAM	0	1	5	1.7543 dB	
4	1/1	64QAM	0	2	6	10.7229 dB	

Error in Subframes: 0

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.

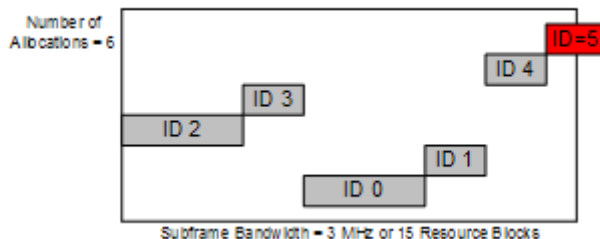
[Configuring PDSCH Allocations](#).....40

Configuring PDSCH Allocations

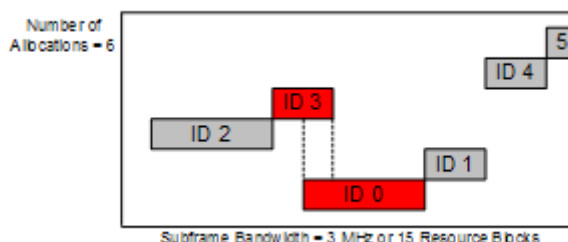
In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The application expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure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

The configuration table contains the settings to configure the allocations.

- **ID/N_RNTI**
Selects the allocation's ID. The ID corresponds to the N_RNTI.
By default, the application assigns consecutive numbers starting with 0.
The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- **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 includes. 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.
- **Modulation**
Selects the modulation scheme for the corresponding allocation.
The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- **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 R&S FSW will show an error message in the "Conflicts" column and the "Error in Subframes" field.
- **Offset RB**
Sets the resource block at which the allocation begins.
A wrong offset for any allocation would lead to an overlap of allocations. In that case the application will show an error message.
- **Power [dB]**
Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- **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.



SCPI command:

Configurable Subframes:

[CONFigure\[:LTE\]:DL:CSUBframes](#) on page 97

Used Allocations:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALCount](#) on page 98

Modulation:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>\[:CW<Cwnum>\]:MODulation](#) on page 99

Number of RB:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount](#) on page 98

Offset RB:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOffset](#) on page 98

Power:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWER](#) on page 98

4.2.1.4 Advanced Downlink Settings

The downlink advanced signal characteristics contain settings that describe the detailed structure of a downlink LTE signal.

- [Configuring the Synchronization Signal](#).....42
- [Configuring the Reference Signal](#).....42
- [Configuring the Positioning Reference Signal](#).....43
- [Defining the PDSCH Resource Block Symbol Offset](#).....44
- [Configuring the PBCH](#).....45

- [Configuring the PCFICH](#).....46
- [Configuring the PHICH](#).....46
- [Configuring the PDCCH](#).....48

Configuring the Synchronization Signal

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

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



- [P-/S-SYNC Tx Antenna](#).....42
- [P-SYNC Relative Power](#).....42
- [S-SYNC Relative Power](#).....42

P-/S-SYNC Tx Antenna

Selects the antenna that transmits the P-SYNC and the 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.

SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:ANTenna](#) on page 99

P-SYNC Relative Power

Defines the power of the P-SYNC signals relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:PPower](#) on page 100

S-SYNC Relative Power

Defines the power of the S-SYNC signals relative to the reference signal.

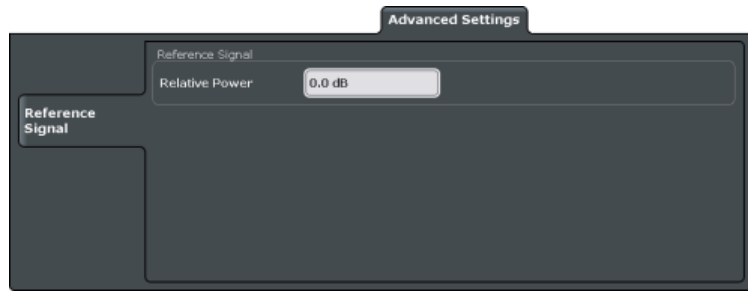
SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:SPOwer](#) on page 100

Configuring the Reference Signal

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

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



Rel Power (Reference Signal).....43

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.

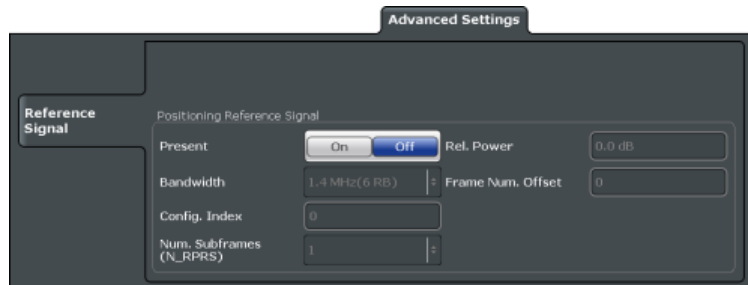
SCPI command:

CONFigure[:LTE]:DL:REFSig:POWer on page 100

Configuring the Positioning Reference Signal

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

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



Present.....43
 Bandwidth.....43
 Configuration Index.....44
 Num. Subframes (N_PRPS).....44
 Relative Power (Positioning Reference Signal).....44
 Frame Number Offset.....44

Present

Turns the positioning reference signal on and off.

SCPI command:

CONFigure[:LTE]:DL:PRSS:STATE on page 101

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.

SCPI command:

`CONFigure[:LTE]:DL:PRSS:BW` on page 100

Configuration Index

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

SCPI command:

`CONFigure[:LTE]:DL:PRSS:CI` on page 101

Num. Subframes (N_PRS)

Defines the number of consecutive DL subframes in that PRS are transmitted.

SCPI command:

`CONFigure[:LTE]:DL:PRSS:NPRS` on page 101

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.

SCPI command:

`CONFigure[:LTE]:DL:PRSS:POWer` on page 101

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.

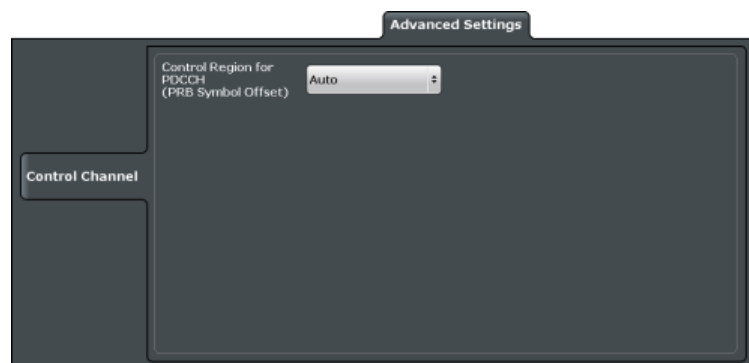
Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

SCPI command:

`CONFigure[:LTE]:DL:SFNO` on page 102

Defining the PDSCH Resource Block Symbol Offset

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



PRB Symbol Offset

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

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

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

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

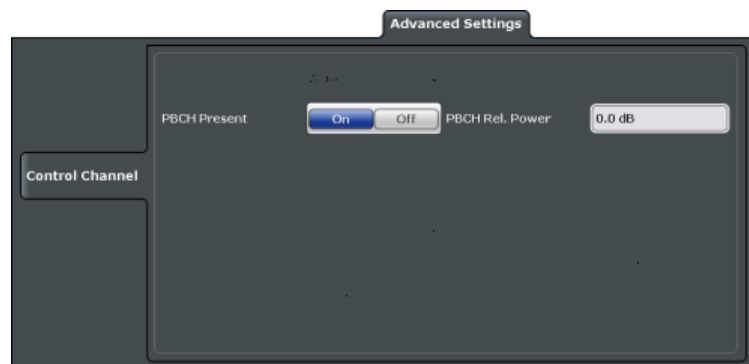
SCPI command:

[CONFigure\[:LTE\]:DL:PSOffset](#) on page 105

Configuring the PBCH

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

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



PBCH Present

Includes or excludes the PBCH from the test setup.

SCPI command:

[CONFigure\[:LTE\]:DL:PBCH:STAT](#) on page 102

PBCH Relative Power

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

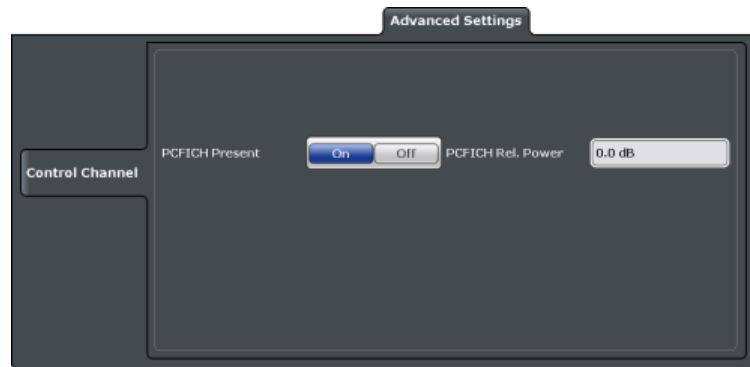
SCPI command:

[CONFigure\[:LTE\]:DL:PBCH:POWer](#) on page 102

Configuring the PCFICH

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

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



PCFICH Present

Includes or excludes the PCFICH from the test setup.

SCPI command:

[CONFigure\[:LTE\]:DL:PCFich:STAT](#) on page 103

PCFICH Relative Power

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

SCPI command:

[CONFigure\[:LTE\]:DL:PCFich:POWer](#) on page 102

Configuring the PHICH

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

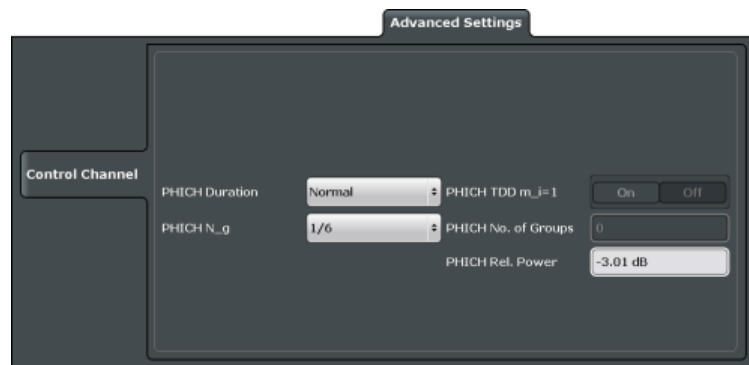
You can set several specific parameters for the PHICH.

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



Turning off the PHICH

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



PHICH Duration

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

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

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

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:DURation](#) on page 104

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.

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:MITM](#) on page 104

PHICH N_g

Sets the variable N_g .

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:NGParameter](#) on page 104

PHICH Number of Groups

Sets the number of PHICH groups contained in a subframe.

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

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:NOGRoups](#) on page 105

PHICH Rel Power

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

SCPI command:

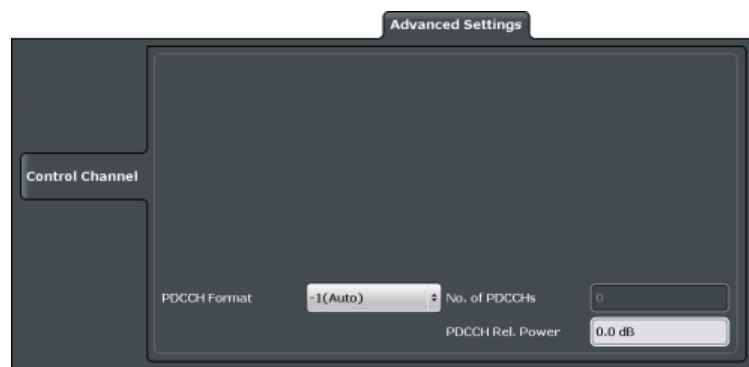
[CONFigure\[:LTE\]:DL:PHICH:POWer](#) on page 105

Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information.

The PDCCH is always present. You can define several specific parameters for the PDCCH.

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

**PDCCH Format**

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:PDCCh:FORMat](#) on page 103

Number of PDCCHs

Sets the number of physical downlink control channels.

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

SCPI command:

[CONFigure\[:LTE\]:DL:PDCCh:NOPD](#) on page 103

PDCCH Rel Power

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

SCPI command:

CONFigure [:LTE] :DL:PDCCh:POWer on page 103

4.2.2 Input / Frontend

- [Selecting the Input and Output Source](#).....49
- [Defining the Frequency](#).....49
- [Configuring the Vertical Axis](#).....50

4.2.2.1 Selecting the Input and Output Source

The application supports several input sources and outputs. These are the same as in Spectrum mode.

For a comprehensive description of the supported input sources (including the Digital Baseband In- and Output), please refer to the documentation of the R&S FSW.

4.2.2.2 Defining the Frequency

Frequency settings define the frequency characteristics of the signal at the RF input.



[Defining the Signal Frequency](#).....49

Defining the Signal Frequency

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

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

The frequency setting is available for the RF input source.

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

- = Center
One frequency step corresponds to the current center frequency.
- Manual

Define a any stepsize you need.

SCPI command:

Center frequency:

[SENSe]:FREQuency:CENTer on page 106

Frequency stepsize:

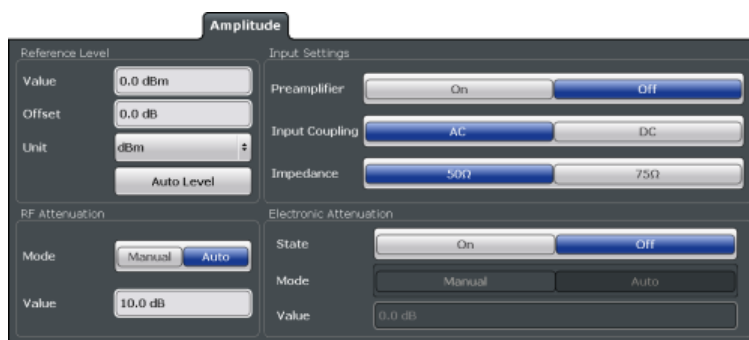
[SENSe:]FREQuency:CENTer:STEP on page 106

Frequency offset:

[SENSe:]FREQuency:OFFSet on page 107

4.2.2.3 Configuring the Vertical Axis

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



Defining a Reference Level.....50

Attenuating the Signal.....51

Preamplifier (option B24).....52

Input Coupling.....52

Impedance.....52

Defining a Reference Level

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

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

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

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

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

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

Automatic level detection also optimizes RF attenuation.

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



SCPI command:

Manual:

[DISPlay\[:WINDow<n>\]:TRACe:Y\[:SCALe\]:RLEVel](#) on page 108

Automatic:

[\[SENSe:\]ADJust:LEVel](#) on page 111

Offset:

[DISPlay\[:WINDow<n>\]:TRACe:Y\[:SCALe\]:RLEVel:OFFSet](#) on page 108

Unit:

[CALCulate<n>:UNIT:POWer](#) on page 107

Attenuating the Signal

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

The LTE application provides several attenuation modes.

- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
- If you have equipped your R&S FSW with option R&S FSW-B25, it also provides **electronic** attenuation. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.

For both methods, the application provides **automatic** detection of the ideal attenuation level. Alternatively, you can define the attenuation level **manually**. The range is from 0 dB to 79 dB (RF attenuation) or 30 dB (electronic attenuation) in 1 dB steps.

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

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



SCPI command:

RF attenuation:

[INPut:ATTenuation](#) on page 108

[INPut:ATTenuation:AUTO](#) on page 108

Electronic attenuation:

[INPut<n>:EATT:STATe](#) on page 111

[INPut<n>:EATT:AUTO](#) on page 110

[INPut<n>:EATT](#) on page 110

Preamplifier (option B24)

If option R&S FSW-B24 is installed, a preamplifier can be activated for the RF input signal. For R&S FSW 26 models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW 8 or 13 models, 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.

SCPI command:

[INPut:GAIN:STATe](#) on page 109

[INPut:GAIN\[:VALue\]](#) on page 109

Input Coupling

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

This function is not available for input from the Digital Baseband Interface (R&S FSW-B17).

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

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

SCPI command:

[INPut:COUPling](#) on page 109

Impedance

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

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

This value also affects the unit conversion.

This function is not available for input from the Digital Baseband Interface (R&S FSW-B17).

SCPI command:

[INPut:IMPedance](#) on page 110

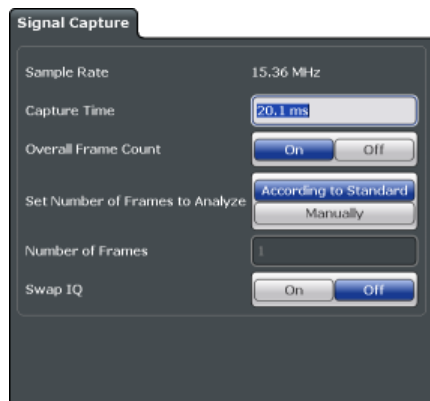
4.2.3 Signal Capture

- [Configuring the Data Capture](#).....53
- [Triggering Measurements](#).....54

4.2.3.1 Configuring the Data Capture

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

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



Capture Time

Defines the capture time.

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

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

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



Note that if you are using the multi-standard radio analyzer, only the MSRA master channel actually captures the data. The capture time only defines the LTE analysis interval. For more information see ["Selecting the operating mode"](#) on page 9.

SCPI command:

[\[SENSe\]](#) : [SWEep](#) : [TIME](#) on page 112

Overall Frame Count

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

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

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

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



SCPI command:

[\[SENSe\]](#) [: [LTE](#)] : [FRAMe](#) : [COUNT](#) : [STATe](#) on page 112

Auto According to Standard

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

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

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

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

SCPI command:

[\[SENSe\] \[:LTE\] :FRAMe:COUNT:AUTO](#) on page 112

Number of Frames to Analyze

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

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

The parameter is read only if

- the overall frame count is inactive,
- the data is captured [according to the standard](#).

SCPI command:

[\[SENSe\] \[:LTE\] :FRAMe:COUNT](#) on page 111

Swap I/Q

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

SCPI command:

[\[SENSe\] :SWAPiq](#) on page 112

4.2.3.2 Triggering Measurements

The trigger functionality of the LTE measurement application is the same as that of the R&S FSW. For a comprehensive description of the available trigger settings see the documentation of the R&S FSW.

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

**Gated frequency sweep measurements**

The application automatically selects the correct gate settings (delay and length) according to the [TDD configuration](#).

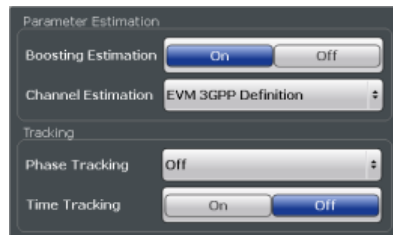
The trigger settings are part of the "Trigger" tab of the "Trigger/Signal Capture" dialog box.



For more information on triggering measurements see the documentation of the R&S FSW.

4.2.4 Parameter Estimation

Estimation and tracking processes are done during the measurement to increase the quality of measurement results.



- [Estimating Parameters](#).....55
- [Compensating Measurement Errors](#).....56

4.2.4.1 Estimating Parameters

The parameter estimation settings contain settings that estimate various parameters during the measurement.

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

Boosting Estimation

Turns boosting estimation on and off.

If active, the R&S FSW automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

SCPI command:

[\[:SENSe\] \[:LTE\] :DL:DEMod:BEStimation](#) on page 114

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.

SCPI command:

[\[SENSe\] \[:LTE\] :DL:DEMod:CESTimation](#) on page 115

4.2.4.2 Compensating Measurement Errors

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

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

Phase

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

- | | |
|---------------------|---|
| "Off" | Phase tracking is not applied. |
| "Pilot Only" | Only the reference signal is used for the estimation of the phase error. |
| "Pilot and Payload" | Both reference signal and payload resource elements are used for the estimation of the phase error. |

SCPI command:

[\[SENSe\] \[:LTE\] :DL:TRACking:PHASe](#) on page 115

Timing

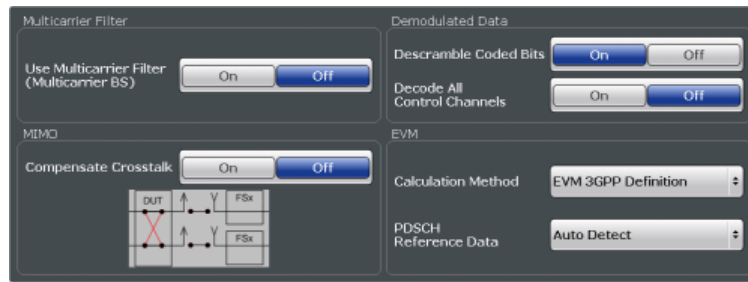
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

SCPI command:

[\[SENSe\] \[:LTE\] :DL:TRACking:TIME](#) on page 115

4.2.5 Demodulation

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



Multicarrier Filter.....57
 Compensate Crosstalk.....57
 Scrambling of Coded Bits.....57
 Decode All Control Channels.....58
 EVM Calculation Method.....58
 PDSCH Reference Data.....58

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).

SCPI command:

[\[SENSe\]\[:LTE\]:DL:DEMod:MCFilter](#) on page 113

Compensate Crosstalk

Specifies if crosstalk produced by the device under test or over-the-air measurements will be compensated or not.

Note that this function is not yet supported.

SCPI command:

[CONFigure\[:LTE\]:DL:MIMO:CROSstalk](#) on page 113

Scrambling of Coded Bits

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

The scrambling of coded bits affects the bitstream results.

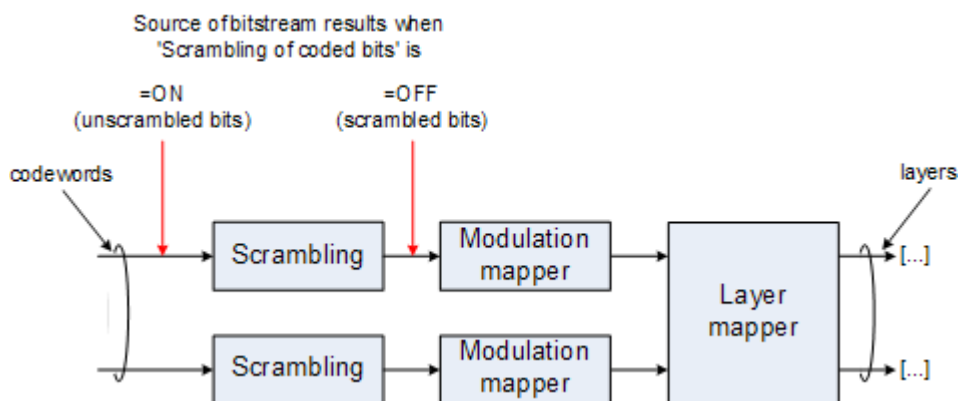


Fig. 4-1: Source for bitstream results if scrambling for coded bits is on and off

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:CBScrambling](#) on page 113

Decode All Control Channels

Turns the decoding of all control channels on and off.

If on, the software shows the decoding results in the "Channel Decoder Results" result display.

If off,

- the PBCH is decoded only if the [PHICH Duration](#) or the [PHICH N_g](#) are automatically determined
- the PDCCH is decoded only if the [PDSCH Subframe Configuration Detection](#) is set to PDCCH protocol.

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

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:DACHannels](#) on page 114

EVM Calculation Method

Selects the method to calculate the EVM.

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

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:EVMCalc](#) on page 114

PDSCH Reference Data

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

- Auto detect
Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.

To get valid results, you have to use a DUT that transmits an all-zero data vector. This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

SCPI command:

[\[SENSe\] \[:LTE\] :DL:DEMod:PRData](#) on page 114

4.3 Configuring Frequency Sweep Measurements

After starting one of the frequency sweep measurements, the application automatically loads the configuration required by measurements according to the 3GPP standard: the spectral mask as defined in the 3GPP standard for SEM measurements and the channel configuration defined in the standard for the ACLR measurement.

If you need a different measurement configuration, you can change all parameters as required. Except for the dialog box described below, the measurement configuration menus for the frequency sweep measurements are the same as in the Spectrum application.

Please refer to the User Manual of the R&S FSW for a detailed description on how to configure ACLR and SEM measurements.

4.3.1 ACLR Signal Description

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

- ▶ Press the MEAS CONFIG key.
- ▶ Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model and Channel Bandwidth see "[Selecting the LTE Mode](#)" on page 33, "[Using Test Models](#)" on page 33 and "[Channel Bandwidth / Number of Resource Blocks](#)" on page 34.

Assumed Adjacent Channel Carrier

Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

SCPI command:

[\[SENSe\] :POWER:ACHannel:AACHannel](#) on page 116

4.3.2 SEM Signal Description

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

▶ Press the MEAS CONFIG key.

▶ Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see ["Selecting the LTE Mode"](#) on page 33, ["Using Test Models"](#) on page 33, ["Channel Bandwidth / Number of Resource Blocks"](#) on page 34 and ["Cyclic Prefix"](#) on page 34.

Category

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

The software supports limit definitions for the following types of base stations:

- Wide Area base stations
- Local Area base stations
- Home base stations

For Wide Area base stations, several limit definitions are provided.

Category A and B are defined in ITU-R recommendation SM.329. For Category B operating band unwanted emissions, there are two options for the limits that may be applied regionally (Opt1 and Opt2).

The type and category you should use for the measurement depends on the category and option that the base station you are testing supports.

SCPI command:

[\[SENSe\] : POWer : SEM : CATegory](#) on page 116

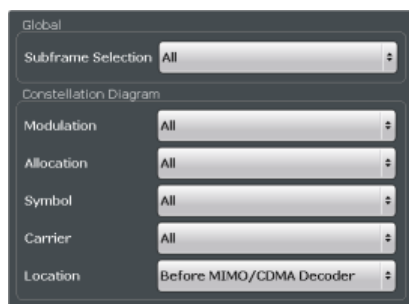
5 Analysis

5.1 Analyzing I/Q Measurements

- [Evaluation Range](#).....61
- [Scale](#).....63
- [Result Settings](#).....63
- [Markers](#).....64

5.1.1 Evaluation Range

The evaluation range defines the signal parts that are considered during signal analysis.



- [Subframe Selection](#).....61
- [Constellation Selection](#).....62

Subframe Selection

Selects a particular subframe whose results the software displays.

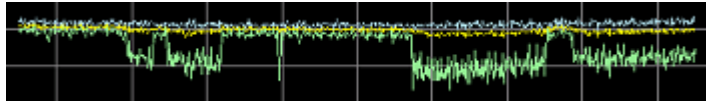
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, Allocation Summary and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

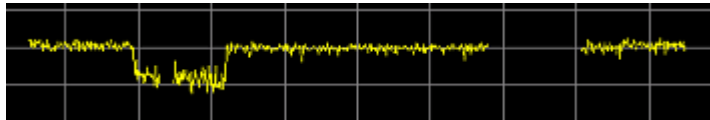
If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



● 1 Avg ● 2 Min ● 3 Max

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



SCPI command:

[SENSe] [:LTE]:SUBFrame:SElect on page 118

Constellation Selection

Filters the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

You can filter the results by the following parameters:

- **Modulation**
Filter by modulation scheme.
- **Allocation**
Filter by allocation ID.
- **Symbol**
Filter by OFDM symbol.
- **Carrier**
Filter by subcarrier.
- **Location**
Selects whether the R&S FSW generates the constellation diagram before or after the MIMO decoder.
If you use Spatial Multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. Filter these symbols in the field "Modulation" with the value "MIXTURE". You get the mixed symbols only if "Location" is set to "Before MIMO decoder".

If the location is "After MIMO Decoder", filters "Symbol" and "Carrier" are not available.

SCPI command:

Location:

[CONFigure\[:LTE\]:DL:CONS:LOCation](#) on page 117

5.1.2 Scale

[Y-Axis Scale](#).....63

Y-Axis Scale

The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis by defining the **minimum** and **maximum** values displayed on the vertical axis. Possible values and units depend on the result display you want to adjust the scale of.

Tip:

Alternatively, you can scale the windows in the "Auto Set" menu. In addition to scaling the window currently in focus ("Auto Scale Window"), there you can scale **all windows** at the same time ("Auto Scale All").

SCPI command:

[DISPlay\[:WINDow<n>\]:TRACe:Y\[:SCALe\]:AUTO ONCE](#) on page 117

[DISPlay\[:WINDow<n>\]:TRACe:Y\[:SCALe\]:MAXimum](#) on page 118

[DISPlay\[:WINDow<n>\]:TRACe:Y\[:SCALe\]:MINimum](#) on page 118

5.1.3 Result Settings

Result settings define the way certain measurement results are displayed.



[EVM Unit](#).....63

[Bit Stream Format](#).....64

EVM Unit

Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

SCPI command:

[UNIT:EVM](#) on page 119

Bit Stream Format

Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

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

Fig. 5-1: 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	0010010110111111001001101010011001100000000110001
0	PBCH	1/1	QPSK	144	100101000110100101111111010001011000111010110010

Fig. 5-2: Bit stream display in downlink application if the bit stream format is set to "bits"

SCPI command:
[UNIT:BSTR](#) on page 118

5.1.4 Markers

Markers are available for most of the I/Q measurement result displays and for the frequency sweep measurements. The functionality (setting and positioning) is the same as in Spectrum mode.

For a comprehensive description of the marker functionality see the corresponding chapters in the documentation of the R&S FSW.

5.2 Analyzing Frequency Sweep Measurements

The LTE application supports the same functionality to analyze the results of frequency sweep measurements (Spectrum Emission mask and Adjacent Channel Leakage Ratio) as the R&S FSW base unit does for those measurements.

Please refer to the User Manual of the R&S FSW for a detailed description on how to analyze ACLR and SEM measurements.

6 Remote Control

6.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

6.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSW.



Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

6.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

6.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

6.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

```
[SENSe:]FREQuency:CENTer is the same as FREQuency:CENTer
```

With a numeric suffix in the optional keyword:

```
DISPlay[:WINDow<1...4>]:ZOOM:STATe
```

DISPlay:ZOOM:STATe ON enables the zoom in window 1 (no suffix).

DISPlay:WINDow4:ZOOM:STATe ON enables the zoom in window 4.

6.2.4 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.

6.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

```
LAYout:ADD:WINDow Spectrum,LEFT,MTABLE
```

Parameters may have different forms of values.

- [Numeric Values](#).....67
- [Boolean](#).....68
- [Character Data](#).....69
- [Character Strings](#).....69
- [Block Data](#).....69

6.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: SENSe:FREQuency:CENTer 1GHZ

without unit: SENSe:FREQuency:CENTer 1E9 would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- **MIN/MAX**
Defines the minimum or maximum numeric value that is supported.
- **DEF**
Defines the default value.
- **UP/DOWN**
Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- **INF/NINF**
Infinity or negative infinity. Represents the numeric values `9.9E37` or `-9.9E37`.
- **NAN**
Not a number. Represents the numeric value `9.91E37`. NAN is returned in case of errors.

6.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

6.2.5.3 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 6.2.1, "Long and Short Form"](#), on page 66.

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`

6.2.5.4 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'`

6.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

6.3 Remote Commands to Select the LTE Application

<code>INSTRument:CREate[NEW]</code>	70
<code>INSTRument:CREate:REPLace</code>	70
<code>INSTRument:DELeTe</code>	70
<code>INSTRument:LIST?</code>	71
<code>INSTRument:REName</code>	72
<code>INSTRument[:SELeCt]</code>	72

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel. The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

- <ChannelType> Channel type of the new channel.
For a list of available channel types see [table 6-1](#).
- <ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see [table 6-1](#)).

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds an additional spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Parameters:

- <ChannelName1> String containing the name of the measurement channel you want to replace.
- <ChannelType> Channel type of the new channel.
For a list of available channel types see [table 6-1](#).
- <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 [table 6-1](#)).

Example: `INST:CRE:REPL 'Spectrum2', IQ, 'IQAnalyzer'`
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

INSTrument:DELeTe <ChannelName>

This command deletes a measurement channel. If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

- <ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'Spectrum4'`
Deletes the spectrum channel with the name 'Spectrum4'.

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>,
<ChannelName>

For each channel, the command returns the channel type and channel name (see [table 6-1](#)).

Tip: to change the channel name, use the [INSTrument:REName](#) command.

Example:

```
INST:LIST?
```

Result for 3 measurement channels:

```
'ADEM', 'Analog Demod', 'IQ', 'IQ  
Analyzer', 'SANALYZER', 'Spectrum'
```

Usage:

Query only

Table 6-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS

Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.

Application	<ChannelType> Parameter	Default Channel Name*)
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE

Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
 Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'Spectrum2', 'Spectrum3'`
 Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

INSTrument[:SElect] <ChannelType>

This command selects a new measurement channel with the defined channel type.

Parameters:

<ChannelType> **LTE**
 LTE measurement channel (R&S FSW-K10x)

Example: `INST LTE`
 Selects the LTE application.

6.4 Remote Commands to Read Trace Data

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6.4.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC: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] ?`).

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6.4.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
Returns one value for each trace point.
- LIST
Returns the contents of the ACLR table.

6.4.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...

The unit for <absolute power> is always dBm. The unit for <relative power> is always dB. The unit for <EVM> depends on [UNIT:EVM](#). All other values have no unit.

The <allocation ID> and <modulation> are encoded. For the code assignment see [chapter 6.4.1.21, "Return Value Codes"](#), on page 81.

Note that the data format of the return values is always ASCII.

Example:

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, 0.00000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

6.4.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>, ...

All values have no unit. The format of the bitstream depends on [Bit Stream Format](#).

The <allocation ID>, <codeword> and <modulation> are encoded. For the code assignment see [chapter 6.4.1.21, "Return Value Codes"](#), on page 81.

For symbols or bits that are not transmitted, the command returns

- "FF" 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

- "FE" 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:

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, 01, 03, 00, 03, ...
```

6.4.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

```
<absolute power>, ...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1

6.4.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
Returns the probability values (y-axis).
<# of values>, <probability>, ...
The unit is always %.
The first value that is returned is the number of the following values.
- TRACE2
Returns the corresponding power levels (x-axis).
<# of values>, <relative power>, ...
The unit is always dB.
The first value that is returned is the number of the following values.

6.4.1.6 Channel Decoder Results

For the Channel Decoder Results, the number and type of return values depend on the parameter.

- PBCH
Returns the results for the PBCH if PBCH decoding (or CRC check) was successful.
The results are made up out of six values.

<subframe>, <# of antennas>, <system bandwidth>, <frame>, <PHICH duration>, <PHICH resource>

The unit for <system bandwidth> is Hz. All other values have no unit.

The <PHICH duration> and <PHICH resource> are encoded. For the code assignment see [chapter 6.4.1.21, "Return Value Codes"](#), on page 81.

If PBCH decoding was not successful, the command returns NAN.

- PCFICH
Returns the results for the PCFICH. The results are made up out of two parameters.
<subframe>, <number of symbols for PDCCH>
The values have no unit.
- PHICH
Returns the results for the PHICH. The results are made up out of three values for each line of the table.
<subframe>, <ACK/NACK>, <relative power>
The unit for <relative power> is dB. All other values have no unit.
The <ACK/NACK> is encoded. For the code assignment see [chapter 6.4.1.21, "Return Value Codes"](#), on page 81.
- 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 6.4.1.21, "Return Value Codes"](#), on page 81.

6.4.1.7 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

<relative power>, ...

The unit is always dB.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.8 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

<relative power>, ...

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.9 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

<group delay>, ...

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
Returns the group delay.

6.4.1.10 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

```
<I[SF0][Symb0][Carrier1], <Q[SF0][Symb0][Carrier1], ..., <I[SF0][Symb0][Carrier(n)], <Q[SF0][Symb0][Carrier(n)],
<I[SF0][Symb1][Carrier1], <Q[SF0][Symb1][Carrier1], ..., <I[SF0][Symb1][Carrier(n)], <Q[SF0][Symb1][Carrier(n)],
<I[SF0][Symb(n)][Carrier1], <Q[SF0][Symb(n)][Carrier1], ..., <I[SF0][Symb(n)][Carrier(n)], <Q[SF0][Symb(n)][Carrier(n)],
<I[SF1][Symb0][Carrier1], <Q[SF1][Symb0][Carrier1], ..., <I[SF1][Symb0][Carrier(n)], <Q[SF1][Symb0][Carrier(n)],
<I[SF1][Symb1][Carrier1], <Q[SF1][Symb1][Carrier1], ..., <I[SF1][Symb1][Carrier(n)], <Q[SF1][Symb1][Carrier(n)],
<I[SF(n)][Symb(n)][Carrier1], <Q[SF(n)][Symb(n)][Carrier1], ..., <I[SF(n)][Symb(n)][Carrier(n)], <Q[SF(n)][Symb(n)][Carrier(n)]>
```

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
Returns all constellation points included in the selection.

6.4.1.11 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

<EVM>, ...

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1
Returns the average EVM over all subframes
- TRACE2
Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.12 EVM vs RB

For the EVM vs RB result display, the command returns one value for each resource block that has been analyzed.

<EVM>, ...

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1
Returns the average power for each resource block over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.13 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

<EVM>, ...

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.4.1.14 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

<EVM>, ...

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.4.1.15 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

<frequency error>, ...

The unit is always Hz.

The following parameters are supported.

- TRACE1

6.4.1.16 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
Returns the power for the Off power regions.
<absolute power>, ...
The unit is always dBm.
- TRACE2
Returns the power for the transient regions.
<absolute power>, ...
The unit is always dBm.

- **LIST**
Returns the contents of the On/Off Power table. For each line, it returns seven values. <off period start limit>, <off period stop limit>, <time at delta to limit>, <absolute off power>, <distance to limit>, <falling transient period>, <rising transient period>, ...
The unit for the <absolute off power> is dBm. The unit for the <distance to limit> is dB. The unit for the <transient periods> is μ s. All other values have the unit s.

6.4.1.17 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

<power>, ...

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

6.4.1.18 Power vs RB RS

For the Power vs RB RS, the command returns one value for each resource block of the reference signal that has been analyzed.

<absolute power>, ...

The unit is always dBm.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.19 Power vs RB PDSCH

For the Power vs RB PDSCH, the command returns one value for each resource block of the PDSCH that has been analyzed.

<absolute power>, ...

The unit is always dBm.

The following parameters are supported.

- TRACE1

Returns the average power over all subframes

- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.4.1.20 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
Returns one value for each trace point.
<absolute power>, ...
The unit is always dBm.
- LIST
Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine 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>, ...
The <limit check result> is either a 0 (for PASS) or a 1 (for FAIL).

6.4.1.21 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- 1 = ACK
- 0 = NACK
- -1 = DTX

<allocation ID>

Represents the allocation ID. The range is {-1...-13}.

- -1 = Invalid
- -2 = All
- -3 = P-SYNC
- -4 = S-SYNC
- -5 = PILOTS_ANT1
- -6 = PILOTS_ANT2
- -7 = PILOTS_ANT3

- **-8** = PILOTS_ANT4
- **-9** = PCFICH
- **-10** = PHICH
- **-11** = PDCCH
- **-12** = PBCH
- **-13** = PMCH

<codeword>

Represents the codeword of an allocation. The range is {0...2}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2

<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
- **30** = DCI format 3
- **31** = DCI format A
- **103** = DCI format 0/3/3A

<modulation>

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- 1 = normal
- 2 = extended

<PHICH resource>

Represents the parameter N_g . The range is {1...4}.

- 1 = N_g 1/6
- 2 = N_g 1/2
- 3 = N_g 1
- 4 = N_g 2

TRACe<n>[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see [chapter 6.4.1, "Using the TRACe\[:DATA\] Command"](#), on page 72.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Usage: Query only

6.4.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?	83
CALCulate<n>:LIMit<k>:ACPower:ALternate:RESult?	84
CALCulate<n>:MARKer<m>:FUNction:POWER:RESult[:CURRent]?.....	85
FORMat[:DATA].....	85

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>

ALL

Queries the overall limit check results.

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.

1

Limit check has passed.

0

Limit check has failed.

Example:`CALC:LIM:ACP:ACH:RES? ALL`

Queries the results of the adjacent channel limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:ACP:ALternate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>

ALL

Queries the overall limit check results.

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.

1

Limit check has passed.

0

Limit check has failed.

Example:`CALC:LIM:ACP:ALT:RES? ALL`

Queries the results of the alternate channel limit check.

Usage:

Query only

CALCulate<n>:MARKer<m>:FUNction:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m> 1

Query parameters:

CPOW This parameter queries the signal power of the SEM measurement.

Return values:

<Result>

SEMResults

Power level in dBm.

ACLRResults

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?

Returns the current ACLR measurement results.

Usage:

Query only

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCII | REAL
*RST: ASCII

Example: FORM REAL
The software will send binary data in Real32 data format.

6.5 Remote Commands to Read Numeric Results

FETCh:SUMMary:CRESt[:AVERage]?	87
FETCh:SUMMary:EVM[:ALL]:MAXimum?	87
FETCh:SUMMary:EVM[:ALL]:MINimum?	87
FETCh:SUMMary:EVM[:ALL][:AVERage]?	87
FETCh:SUMMary:EVM:DSQP:MAXimum?	87
FETCh:SUMMary:EVM:DSQP:MINimum?	87
FETCh:SUMMary:EVM:DSQP[:AVERage]?	87
FETCh:SUMMary:EVM:DSST:MAXimum?	87
FETCh:SUMMary:EVM:DSST:MINimum?	87
FETCh:SUMMary:EVM:DSST[:AVERage]?	87
FETCh:SUMMary:EVM:DSSF:MAXimum?	88
FETCh:SUMMary:EVM:DSSF:MINimum?	88
FETCh:SUMMary:EVM:DSSF[:AVERage]?	88
FETCh:SUMMary:EVM:PCHannel:MAXimum?	88
FETCh:SUMMary:EVM:PCHannel:MINimum?	88
FETCh:SUMMary:EVM:PCHannel[:AVERage]?	88
FETCh:SUMMary:EVM:PSIGnal:MAXimum?	88
FETCh:SUMMary:EVM:PSIGnal:MINimum?	88
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?	88
FETCh:SUMMary:FERRor:MAXimum?	89
FETCh:SUMMary:FERRor:MINimum?	89
FETCh:SUMMary:FERRor[:AVERage]?	89
FETCh:SUMMary:GIMBalance:MAXimum?	89
FETCh:SUMMary:GIMBalance:MINimum?	89
FETCh:SUMMary:GIMBalance[:AVERage]?	89
FETCh:SUMMary:IQOFset:MAXimum?	89
FETCh:SUMMary:IQOFset:MINimum?	89
FETCh:SUMMary:IQOFset[:AVERage]?	89
FETCh:SUMMary:OSTP:MAXimum?	90
FETCh:SUMMary:OSTP:MINimum?	90
FETCh:SUMMary:OSTP[:AVERage]?	90
FETCh:SUMMary:POWer:MAXimum?	90
FETCh:SUMMary:POWer:MINimum?	90
FETCh:SUMMary:POWer[:AVERage]?	90
FETCh:SUMMary:QUADerror:MAXimum?	90
FETCh:SUMMary:QUADerror:MINimum?	90
FETCh:SUMMary:QUADerror[:AVERage]?	90
FETCh:SUMMary:RSTP:MAXimum?	91
FETCh:SUMMary:RSTP:MINimum?	91
FETCh:SUMMary:RSTP[:AVERage]?	91
FETCh:SUMMary:SERRor:MAXimum?	91
FETCh:SUMMary:SERRor:MINimum?	91
FETCh:SUMMary:SERRor[:AVERage]?	91

FETCh:SUMMary:CRESt[:AVERAge]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor> <numeric value>
Crest Factor in dB.

Example:

FETC : SUMM : CRES ?
Returns the current crest factor in dB.

Usage:

Query only

FETCh:SUMMary:EVM[:ALL]:MAXimum?**FETCh:SUMMary:EVM[:ALL]:MINimum?****FETCh:SUMMary:EVM[:ALL][:AVERAge]?**

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example:

FETC : SUMM : EVM ?
Returns the mean value.

Usage:

Query only

FETCh:SUMMary:EVM:DSQP:MAXimum?**FETCh:SUMMary:EVM:DSQP:MINimum?****FETCh:SUMMary:EVM:DSQP[:AVERAge]?**

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example:

FETC : SUMM : EVM : DSQP ?
Returns the PDSCH QSPK EVM.

Usage:

Query only

FETCh:SUMMary:EVM:DSST:MAXimum?**FETCh:SUMMary:EVM:DSST:MINimum?****FETCh:SUMMary:EVM:DSST[:AVERAge]?**

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example:

FETC : SUMM : EVM : DSST ?
Returns the PDSCH 16QAM EVM.

Usage:

Query only

FETCh:SUMMary:EVM:DSSF:MAXimum?**FETCh:SUMMary:EVM:DSSF:MINimum?****FETCh:SUMMary:EVM:DSSF[:AVERage]?**

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example:

FETC : SUMM : EVM : DSSF ?
Returns the PDSCH 64QAM EVM.

Usage:

Query only

FETCh:SUMMary:EVM:PCHannel:MAXimum?**FETCh:SUMMary:EVM:PCHannel:MINimum?****FETCh:SUMMary:EVM:PCHannel[:AVERage]?**

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example:

FETC : SUMM : EVM : PCH ?
Returns the mean value.

Usage:

Query only

FETCh:SUMMary:EVM:PSIGnal:MAXimum?**FETCh:SUMMary:EVM:PSIGnal:MINimum?****FETCh:SUMMary:EVM:PSIGnal[:AVERage]?**

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>
Minimum, maximum or average frequency error, depending on the last command syntax element.
Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>
Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.
Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

FETCh:SUMMary:IQOffset:MAXimum?
FETCh:SUMMary:IQOffset:MINimum?
FETCh:SUMMary:IQOffset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>
Minimum, maximum or average I/Q offset, depending on the last command syntax element.
Default unit: dB

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP:MAXimum?
FETCh:SUMMary:OSTP:MINimum?
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP> <numeric value>
Minimum, maximum or average OSTP, depending on the last command syntax element.
Default unit: dBm

Example: `FETC:SUMM:OSTP?`
Returns the current average OSTP value.

Usage: Query only

FETCh:SUMMary:POWER:MAXimum?
FETCh:SUMMary:POWER:MINimum?
FETCh:SUMMary:POWER[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>
Minimum, maximum or average power, depending on the last command syntax element.
Default unit: dBm

Example: `FETC:SUMM:POW?`
Returns the total power in dBm

Usage: Query only

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>
Minimum, maximum or average quadrature error, depending on the last command syntax element.
Default unit: deg

Example: `FETC:SUMM:QUAD?`
Returns the current mean quadrature error in degrees.

Usage: Query only

FETCh:SUMMary:RSTP:MAXimum?

FETCh:SUMMary:RSTP:MINimum?

FETCh:SUMMary:RSTP[:AVERage]?

This command queries the RSTP as shown in the result summary.

Return values:

<RSTP> RSTP in dBm.

Example: `FETC:SUMM:RSTP?`

Queries the RSTP.

Usage: Query only

FETCh:SUMMary:SERRor:MAXimum?

FETCh:SUMMary:SERRor:MINimum?

FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`

Returns the current mean sampling error in ppm.

Usage: Query only

6.6 Remote Commands to Configure the Application

6.6.1 General Configuration

The following remote control command control general configuration of the application.

The remote control commands to select the result displays for I/Q measurements are described in [chapter 6.9, "Working with Windows in the Display"](#), on page 120.

[CONFigure\[:LTE\]:MEASurement](#).....92
[SYSTem:PRESet:CHANnel\[:EXECute\]](#).....92

CONFigure[:LTE]:MEASurement <Measurement>

This command selects the measurement.

Parameters:

<Measurement>	ACLR Selects the Adjacent Channel Leakage Ratio measurement.
	ESpectrum Selects the Spectrum Emission Mask measurement.
	EVM Selects I/Q measurements with the "EVM" display configuration.

Example:

```
CONF:MEAS ACLR
Selects the ACLR measurement.
```

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example:

```
INST 'Spectrum2'
Selects the channel for "Spectrum2".
SYST:PRESet:CHAN:EXEC
Restores the factory default settings to the "Spectrum2" channel.
```

Usage: Event

6.6.2 Configuring I/Q Measurements

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6.6.2.1 Signal Description

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Signal Characteristics

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CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>	TDD Time division duplex
	FDD Frequency division duplex
	*RST: FDD

Example:

```
CONF:DUPL TDD
Activates time division duplex.
```

CONFigure[:LTE]:DL:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth>	BW1_40 BW3_00 BW5_00 BW10_00 BW15_00 BW20_00
	*RST: BW10_00

Example:

```
CONF:DL:BW BW1_40
Sets a signal bandwidth of 1.4 MHz in downlink.
```

CONFigure[:LTE]:DL:NORB <ResourceBlocks>

This command selects the number of resource blocks for downlink signals.

Parameters:

<ResourceBlocks>	<numeric value>
	*RST: 50

Example:

```
CONF:DL:NORB 25
Sets the number of resource blocks to 25.
```

CONFigure[:LTE]:DL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength> **NORM**
 Normal cyclic prefix length

EXT
 Extended cyclic prefix length

AUTO
 Automatic cyclic prefix length detection

*RST: AUTO

Example:

```
CONF:DL:CYCP EXT
Sets cyclic prefix type to extended.
```

CONFigure[:LTE]:DL:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>
 Numeric value that defines the subframe configuration.
 Subframe configurations 7 and 8 are only available if the cyclic
 prefix is normal.

Range: 0 to 8

*RST: 0

Example:

```
CONF:DL:CYCP NORM
Selects normal cyclic prefix.
CONF:DL:TDD:SPSC 7
Selects subframe configuration 7, available only with a normal
cyclic prefix.
```

CONFigure[:LTE]:DL:TDD:UDConf <Configuration>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<Configuration> Range: 0 to 6

*RST: 0

Example:

```
CONF:DL:TDD:UDC 2
Selects allocation configuration number 2.
```

CONFigure[:LTE]:DL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId> **AUTO**
Automatically defines the cell ID.

<numeric value>
Number of the cell ID.

 Range: 0 to 503

Example:

CONF:DL:PLC:CID 12
Defines the cell ID 12.

CONFigure[:LTE]:DL:PLC:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber> **AUTO**
Automatic selection

0...167
Manual selection

 *RST: AUTO

Example:

CONF:DL:PLC:CIDG 134
Cell identity group number 134 is selected

CONF:DL:PLC:CIDG AUTO
Automatic cell identity group detection is selected

CONFigure[:LTE]:DL:PLC:PLID <Identity>

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity> **AUTO**
Automatic selection

0...2
Manual selection

 *RST: AUTO

Example:

CONF:DL:PLC:PLID 1
Selects physical layer cell ID 2.

FETCH:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.

 Range: 0 to 167

Example:

FETCH:PLC:CIDG?
Returns the current cell identity group.

Usage: Query only

FETCH:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity> The command returns -1 if no valid result has been detected yet.
 Range: 0 to 2

Example: `FETCH:PLC:PLID?`
 Returns the current cell identity.

Usage: Query only

MIMO Setup

[CONFigure\[:LTE\]:DL:MIMO:ASElection.....](#)96
[CONFigure\[:LTE\]:DL:MIMO:CONFig.....](#)96

CONFigure[:LTE]:DL:MIMO:ASElection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<Antenna> **ANT1 | ANT2 | ANT3 | ANT4**
 Select a single antenna to be analyzed
 *RST: ANT1

Example: `CONF:DL:MIMO:ASEL ANT3`
 Selects antenna 3 to be analyzed.

CONFigure[:LTE]:DL:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas> **TX1**
 Use one Tx-antenna
TX2
 Use two Tx-antennas
TX4
 Use four Tx-antennas
 *RST: TX1

Example: `CONF:DL:MIMO:CONF TX2`
 TX configuration with two antennas is selected.

PDSCH Settings

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 CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:
 MODulation.....99

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

- <Format> **OFF**
 Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.
- PDCCH**
 Identifies the configuration according to the data in the PDCCH DCIs.
- PHYDET**
 Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
 Automatic PDSCH configuration: physical detection of the configuration.
- *RST: PHYD

Example: DL:FORM:PSCD OFF
 Applies the user configuration and does not check the received signal

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:

- <State> ON | OFF
 *RST: ON

Example: DL:DEM:AUTO ON
 Activates the auto-demodulation for DL.

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes> Range: 0 to 39
 *RST: 1

Example:

CONF:DL:CSUB 5
 Sets the number of configurable subframes to 5.

CONFigure[LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>
 *RST: 1

Example:

CONF:DL:SUBF2:ALC 5
 Defines 5 allocations for subframe 2.

CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWER <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example:

CONF:DL:SUBF2:ALL5:POW -1.3
 Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCCount
<ResourceBlocks>**

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:

<ResourceBlocks> <numeric value>
 *RST: 6

Example:

CONF:DL:SUBF2:ALL5:RBC 25
 Defines 25 resource block for allocation 5 in subframe 2.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOffset
<Offset>**

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<Offset> <numeric value>
 *RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`
 Defines a resource block offset of 3 for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID <ID>

This command defines the ID or N_RNTI.

Parameters:

<ID> ID of the user equipment.

Example: `CONF:DL:SUBF2:ALL5:UEID 5`
 Assigns the ID 5 to allocation 5 in subframe 2.

**CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:
 MODulation <Modulation>**

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum> 1..n
 Selects the codeword.

Parameters:

<Modulation> **QPSK**
 QPSK modulation
QAM16
 16QAM modulation
QAM64
 64QAM modulation
 *RST: QPSK

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
 Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

Synchronization Signal

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[CONFigure\[:LTE\]:DL:SYNC:PPOWer.....](#)100
[CONFigure\[:LTE\]:DL:SYNC:SPOWer.....](#)100

CONFigure[:LTE]:DL:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE
 *RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
 All antennas are used to transmit the P-SYNC and S-SYNC.

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example:

CONF:DL:SYNC:PPOW 0.5
 Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example:

CONF:DL:SYNC:SPOW 0.5
 Sets a relative power of 0.5 dB.

Reference Signal

CONFigure[:LTE]:DL:REFSig:POWer.....100

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example:

CONF:DL:REFS:POW -1.2
 Sets a relative power of -1.2 dB.

Positioning Reference Signal

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 CONFigure[:LTE]:DL:PRSS:CI.....101
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 CONFigure[:LTE]:DL:PRSS:STATe.....101
 CONFigure[:LTE]:DL:SFNO.....102

CONFigure[:LTE]:DL:PRSS:BW <Bandwidth>

This command defines the bandwidth of the positioning reference signal.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 |
BW20_00

*RST: BW1_40

Default unit: MHz

Example:

CONF:DL:PRSS:BW BW5_00

Defines a 5 MHz bandwidth for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:CI <PRSSConfiguration>

This command selects the configuration index of the Positioning Reference Signal.

Parameters:

<PRSSConfiguration> Number of the configuration index.

Example:

CONF:DL:PRSS:CI 2

Selects configuration index 2 for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:NPRS <NofDLSubframes>

This command defines the number of subframes the Positioning Reference Signal occupies.

Parameters:

<NofDLSubframes> 1 | 2 | 4 | 6

Example:

CONF:DL:PRSS:NPRS 1

Defines 1 subframe for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:POWER <Power>

This command defines the relative power of the Positioning Reference Signal.

Parameters:

<Power> Default unit: dB

Example:

CONF:DL:PRSS:POW 1

Defines a relative power of 1 dB for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:STATE <State>

This command turns the positioning reference signal on and off.

Parameters:

<State> ON | OFF

Example:

CONF:DL:PRSS:STAT ON

Turns the positioning reference signal on.

CONFigure[:LTE]:DL:SFNO <Offset>

This command defines the frame number offset for the positioning reference signal.

Parameters:

<Offset> <numeric value>

Example:

CONF:DL:SFNO 4
Defines a frame number offset of 4.

Control Channel

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CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example:

CONF:DL:PBCH:POW -1.1
Sets the relative power to -1.1 dB.

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:

<State> ON | OFF
*RST: ON

Example:

CONF:DL:PBCH:STAT ON
Activates the PBCH.

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example:

CONF:DL:PCF:POW 0
 Sets the relative power to 0 dB.

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

CONF:DL:PCF:STAT ON
 Activates the PCFICH.

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:

<Format> -1 | 0 | 1 | 2 | 3
 *RST: -1

Example:

CONF:DL:PDCCH:FORM 0
 Sets the PDDCH format to 0.

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH> <numeric value>
 *RST: 0

Example:

CONF:DL:PDCCH:NOPD 3
 Sets the number of DPCCHs to 3.

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>
 *RST: 0 dB
 Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`
Sets the relative power to -1.2 dB.

CONFigure[:LTE]:DL:PHICH:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration> **NORM**
Normal
EXT
Extended
***RST:** **NORM**

Example: `CONF:DL:PHICH:DUR NORM`
Selects normal PHICH duration.

CONFigure[:LTE]:DL:PHICH:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State> **ON | OFF**
***RST:** **OFF**

Example: `CONF:DL:PHICH:MITM ON`
Activates PHICH TDD $m_i=1$ (E-TM)

CONFigure[:LTE]:DL:PHICH:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng> **NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM**
Select NG_CUSTOM to customize N_g . You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICH:NOGRoups`.
***RST:** **NG1_6**

Example: `CONF:DL:PHICH:NGP NG1_6`
Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.
`CONF:DL:PHICH:NGP NG_CUSTOM`
Define a customized value for N_g .
`CONF:DL:PHICH:NOGR 5`
Directly sets the number of PHICH groups in the subframe to 5.

CONFigure[:LTE]:DL:PHICH:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>
*RST: 0

Example:

CONF:DL:PHICH:NOGR 5
Sets number of PHICH groups to 5.

CONFigure[:LTE]:DL:PHICH:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>
*RST: -3.01 dB
Default unit: DB

Example:

CONF:DL:PHICH:POW -1.3
Sets the relative power to -1.3 dB.

CONFigure[:LTE]:DL:PSOOffset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<Offset> **AUTO**
Automatically determines the symbol offset.
<numeric value>
Manual selection of the symbol offset.
Range: 0 to 4
*RST: AUTO

Example:

CONF:DL:PSOF 2
Sets an offset of 2 symbols.

6.6.2.2 Input / Frontend**Defining the Frequency**

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[SENSe]:FREQuency:CENTer:STEP:LINK:FACTor.....	107
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[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency> <numeric value>
 Range: fmin to fmax
 *RST: 1 GHz
 Default unit: Hz

Example:

FREQ:CENT 2GHZ
 Set the center frequency to 2 GHz.

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` and `SENS:FREQ DOWN` commands, see [\[SENSe\]:FREQuency:CENTer](#) on page 106.

Parameters:

<StepSize> f_{\max} is specified in the data sheet.
 Range: 1 to fMAX
 *RST: 0.1 x span
 Default unit: Hz

Example:

FREQ:CENT 100 MHz
 FREQ:CENT:STEP 10 MHz
 FREQ:CENT UP
 Sets the center frequency to 110 MHz.

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType> **SPAN**
 Couples the step size to the span. Available for measurements in the frequency domain.
OFF
 Decouples the step size.
 *RST: SPAN

Example:

FREQ:CENT:STEP:LINK SPAN

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>**Parameters:**

<Factor> 1 to 100 PCT
 *RST: 10

Example: FREQ:CENT:STEP:LINK:FACT 20PCT

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset> Range: -100 GHz to 100 GHz
 *RST: 0 Hz

Example: FREQ:OFFS 1GHZ

Usage: SCPI confirmed

Configuring the Vertical Axis

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DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel.....	108
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INPut:ATTenuation.....	108
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CALCulate<n>:UNIT:POWER <Unit>

This command selects the unit of the y-axis.

The unit applies to all measurement windows.

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA |
 AMPere
 *RST: dBm

Example: CALC:UNIT:POW DBM
 Sets the power unit to dBm.

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level.

With a reference level offset $\neq 0$, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.
 Range: see datasheet
 *RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset.

Parameters:

<Offset> Range: -200 dB to 200 dB
 *RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
 Increment: 5 dB
 *RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
 Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

INP:ATT:AUTO ON
 Couples the attenuation to the reference level.

Usage:

SCPI confirmed

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
 AC coupling
DC
 DC coupling
 *RST: AC

Example:

INP:COUP:DC

Usage:

SCPI confirmed

INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level if the preamplifier is activated (INP:GAIN:STAT ON, see [INPut:GAIN:STATe](#) on page 109).

The command requires option R&S FSW-B24.

Parameters:

<Gain> 15 dB | 30 dB
 The availability of preamplification levels depends on the R&S FSW model.

- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.
 *RST: OFF

Example:

INP:GAIN:VAL 30
 Switches on 30 dB preamplification.

Usage:

SCPI confirmed

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

INP:GAIN:STAT ON
 Switches on 30 dB preamplification.

Usage:

SCPI confirmed

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input.

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

Parameters:

<Impedance> 50 | 75
 *RST: 50 Ω

Example:

INP:IMP 75

Usage:

SCPI confirmed

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<Attenuation> Attenuation level in dB.
 Default unit: dB

Example:

INP:EATT 10
 Defines an attenuation level of 10 dB.

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<State> ON | OFF
 *RST: OFF

Example: `INP:EATT:AUTO ON`
 Turns automatic selection of electronic attenuation level on.

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:
 <State> ON | OFF
 *RST: OFF

Example: `INP:EATT:STAT ON`
 Turns the electronic attenuator on.

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

6.6.2.3 Signal Capture

Data Capture

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[SENSe][:LTE]:FRAMe:COUNT:AUTO	112
[SENSe]:SWAPiq	112
[SENSe]:SWEp:TIME	112

[SENSe][:LTE]:FRAMe:COUNT <Subframes>

This command sets the number of frames you want to analyze.

Parameters:
 <Subframes> <numeric value>
 *RST: 1

Example: `FRAM:COUN:STAT ON`
 Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
 Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNT:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State> **ON**
 You can set the number of frames to analyze.

OFF
 The R&S FSW analyzes a single sweep.

***RST:** **ON**

Example:

`FRAM:COUNT:STAT ON`
 Turns manual setting of number of frames to analyze on.

[SENSe][:LTE]:FRAMe:COUNT:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State> **ON**
 Selects the number of frames to analyze according to the LTE standard.

OFF
 Turns manual selection of the frame number on.

Example:

`FRAM:COUNT:AUTO ON`
 Turns automatic selection of the analyzed frames on.

[SENSe]:SWAPiQ <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State> **ON | OFF**

***RST:** **OFF**

Example:

`SWAP ON`
 Turns a swap of the I and Q branches on.

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.
 Default unit: s

Example:

`SWE:TIME 40`
 Defines a capture time of 40 seconds.

Trigger

The trigger functionality of the LTE measurement application is the same as that of the R&S FSW.

For a comprehensive description of the available remote control commands for trigger configuration see the documentation of the R&S FSW.

6.6.2.4 Demodulation

[SENSe][:LTE]:DL:DEMod:MCFilter.....	113
[SENSe][:LTE]:DL:DEMod:CBSCrambling.....	113
CONFigure[:LTE]:DL:MIMO:CROStalk.....	113
[SENSe][:LTE]:DL:DEMod:DACHannels.....	114
[SENSe][:LTE]:DL:DEMod:EVMCalc.....	114
[SENSe][:LTE]:DL:DEMod:PRData.....	114

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

DL:DEM:MCF ON
 Turns suppression on of neighboring carriers on.

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

DL:DEM:CBSC ON
 Activate scrambling of coded bits.

CONFigure[:LTE]:DL:MIMO:CROStalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CONF:DL:MIMO:CROS ON
 Turns crosstalk compensation on.

[SENSe][:LTE]:DL:DEMod:DACHannels <State>

This command turns the decoding of all control channels on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

DL:DEM:DACH ON
 Turns decoding of all control channels on.

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation> **TGPP**
 3GPP definition
 OTP
 Optimal timing position
 *RST: TGPP

Example:

DL:DEM:EVMC TGPP
 Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference> **AUTO**
 Automatic identification of reference data.
 ALL0
 Reference data is 0, according to the test model definition.

Example:

DL:DEM:PRD ALL0
 Sets the reference data of the PDSCH to 0.

6.6.2.5 Parameter Estimation**Estimating Parameters**

[SENSe][:LTE]:DL:DEMod:BEStimation.....	114
[SENSe][:LTE]:DL:DEMod:CEStimation.....	115

[SENSe][:LTE]:DL:DEMod:BEStimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

DL:DEM:BST ON
 Turns boosting estimation on.

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type> **TGPP**
 3GPP EVM definition
PIL
 Optimal, pilot only
PILP
 Optimal, pilot and payload
 *RST: TGPP

Example:

DL:DEM:CEST TGPP
 Use 3GPP EVM definition for channel estimation.

Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe.....115
 [SENSe][:LTE]:DL:TRACking:TIME.....115

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type> **OFF**
 Deactivate phase tracking
PIL
 Pilot only
PILP
 Pilot and payload
 *RST: OFF

Example:

DL:TRAC:PHAS PILPAY
 Use pilots and payload for phase tracking.

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

DL:TRAC:TIME ON
 Activates timing tracking.

6.6.3 Configuring Frequency Sweep Measurements

Please refer to the documentation of the R&S 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.

[SENSe]:POWer:ACHannel:AACHannel.....	116
[SENSe]:POWer:SEM:CATegory.....	116

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel> **EUTRA**
 Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
 Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
 Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
 Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example:

POW:ACH:AACH UTRA384
 Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category> A | B | B1 | B2 | LARE | HOME

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

*RST: A

Example:

POW:SEM:CAT B
Selects SEM category B.

6.7 Analysis

CONFigure[:LTE]:DL:CONS:LOCation.....	117
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE.....	117
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum.....	118
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum.....	118
[SENSe][:LTE]:SUBFrame:SElect.....	118
UNIT:BSTR.....	118
UNIT:EVM.....	119

CONFigure[:LTE]:DL:CONS:LOCation <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location> **AMD**
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example:

CONF:DL:CONS:LOC AMD
Use data from after the MIMO decoder.

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again.

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for the selected result display.

Parameters:

<Value> <numeric value>
 *RST: depends on the result display
 The unit and range depend on the result display.

Example:

```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```

Defines the y-axis with a minimum value of -60 and maximum value of 0.

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for the selected result display.

Parameters:

<Value> <numeric value>
 *RST: depends on the result display
 The unit and range depend on the result display.

Example:

```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```

Defines the y-axis with a minimum value of -60 and maximum value of 0.

[SENSe][:LTE]:SUBFrame:SElect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>
ALL
 Select all subframes
0...39
 Select a single subframe
 *RST: ALL

Example:

```
SUBF:SEL ALL
```

Select all subframes for analysis.

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMBOLS

Displays the bit stream using symbols

BITS

Displays the bit stream using bits

*RST: SYMBOLS

Example:

UNIT:BSTR BIT

Bit stream gets displayed using Bits.

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>

DB

EVM results returned in dB

PCT

EVM results returned in %

*RST: PCT

Example:

UNIT:EVM PCT

EVM results to be returned in %.

6.8 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat.....	119
DISPlay[:WINDow<n>]:SIZE.....	120
DISPlay[:WINDow<n>]:SElect.....	120

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit

Displays the MultiView tab with an overview of all active channels

SINGle

Displays the measurement channel that was previously focused.

*RST: SPL

Example:

DISP:FORM SING

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 123).

Parameters:

<Size>

LARGE

Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALL

Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALL

Example:

DISP:WIND2:LARG

DISPlay[:WINDow<n>]:SElect

This command sets the focus on the selected result display window.

This window is then the active window.

Example:

DISP:WIND1:SEL

Sets the window 1 active.

Usage:

Setting only

6.9 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

<code>LAYout:ADD[:WINDow]?</code>	121
<code>LAYout:CATalog[:WINDow]?</code>	122
<code>LAYout:IDENtify[:WINDow]?</code>	122
<code>LAYout:REMove[:WINDow]</code>	122
<code>LAYout:REPLace[:WINDow]</code>	123
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<code>LAYout:WINDow<n>:IDENtify?</code>	125
<code>LAYout:WINDow<n>:REMove</code>	125
<code>LAYout:WINDow<n>:REPLace</code>	126

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

- <WindowName>** String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.
- <Direction>** LEFT | RIGHT | ABOVE | BELOW
Direction the new window is added relative to the existing window.
- <WindowType>** text value
Type of result display (evaluation method) you want to add. See the table below for available parameter values.

Return values:

- <NewWindowName>** When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:ADD? '1', LEFT, MTAB
```

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Table 6-2: <WindowType> parameter values for LTE Downlink Measurement application

Parameter value	Window type
ASUM	Allocation Summary
BSTR	Bitstream
CBUF	Capture Buffer
CCDF	CCDF
FLAT	Channel Flatness
CONS	Constellation Diagram
EVCA	EVM vs Carrier
EVRP	EVM vs RB
EVSU	EVM vs Subframe
FEVS	Frequency Error vs Symbol
GDEL	Group Delay

Parameter value	Window type
PSPE	Power Spectrum
PVRP	Power vs RB PDSCH
PVRR	Power vs RB RS
RSUM	Result Summary

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<Index_1>..<WindowName_n>,<Index_n>

Return values:

<WindowName> string
 Name of the window.
 In the default state, the name of the window is its index.

<Index> **numeric value**
 Index of the window.

Example:

LAY:CAT?

Result:

'2',2,'1',1

Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENTify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window.

Note: to query the **name** of a particular window, use the [LAYout:WINDow<n>:IDENTify?](#) query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMOve[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

<WindowName> String containing the name of the window.
 In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

To add a new window, use the [LAYout:ADD\[:WINDow\]?](#) command.

Parameters:

- <WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, 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 121 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

As opposed to the [DISPlay\[:WINDow<n>\]:SIZE](#) on page 120 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

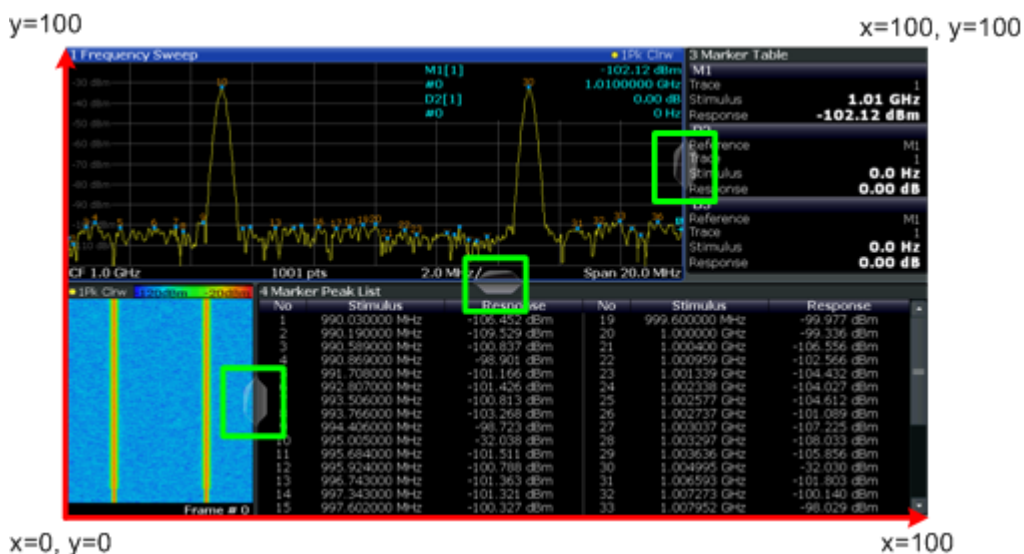


Fig. 6-1: SmartGrid coordinates for remote control of the splitters

Parameters:

- <Index1> The index of one window the splitter controls.
- <Index2> The index of a window on the other side of the splitter.
- <Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 6-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example:

LAY:SPL 1, 3, 50
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example:

LAY:SPL 1, 4, 70
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen. The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
 LAY:SPL 3, 2, 70
 LAY:SPL 4, 1, 70
 LAY:SPL 2, 1, 70

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, as opposed to [LAYout:ADD\[:WINDow\]?](#), the suffix <n> determines the existing window next to which the new window is added.

To replace an existing window, use the [LAYout:WINDow<n>:REPLace](#) command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHT | ABOVE | BELOW

<WindowType> Type of measurement window you want to add.
See [LAYout:ADD\[:WINDow\]?](#) on page 121 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:WIND1:ADD? LEFT,MTAB
```

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage:

Query only

LAYout:WINDow<n>:IDENTify?

This command queries the **name** of a particular display window (indicated by the <n> suffix).

Note: to query the **index** of a particular window, use the [LAYout:IDENTify\[:WINDow\]?](#) command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage:

Query only

LAYout:WINDow<n>:REMOve

This command removes the window specified by the suffix <n> from the display.

The result of this command is identical to the [LAYout:REMOve\[:WINDow\]](#) command.

Usage:

Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

The result of this command is identical to the [LAYout:REPLace \[:WINDow\]](#) command.

To add a new window, use the [LAYout:WINDow<n>:ADD?](#) command.

Parameters:

<WindowType>

Type of measurement window you want to replace another one with.

See [LAYout:ADD \[:WINDow\] ?](#) on page 121 for a list of available window types.

List of Commands

CALCulate<n>:LIMit<k>:ACPoweR:ACHannel:RESult?	83
CALCulate<n>:LIMit<k>:ACPoweR:ALTErnate:RESult?	84
CALCulate<n>:MARKer<m>:FUNctioN:POWeR:RESult[:CURRent]?	85
CALCulate<n>:UNIT:POWeR	107
CONFigure[:LTE]:DL:BW	93
CONFigure[:LTE]:DL:CONS:LOCation	117
CONFigure[:LTE]:DL:CSUBframes	97
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