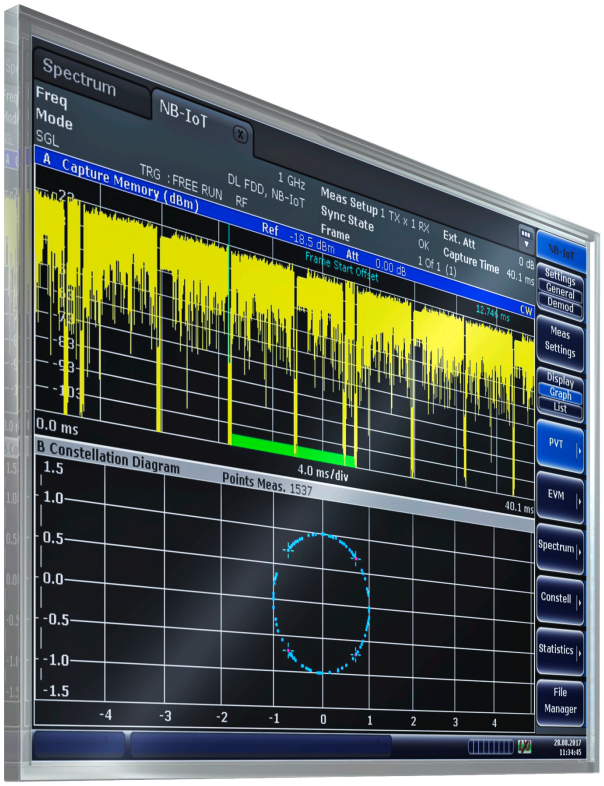
R&S®FSV-K106
LTE NB-IoT Measurement Application (Downlink)
User Manual



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User Manual

ROHDE&SCHWARZ

This manual describes the following firmware applications:

- R&S®FSV-K106 LTE NB-IoT Measurement Application (1309.9797.02)

This manual describes the following R&S FSVA/FSV models with firmware version 3.30 and higher:

- R&S®FSVA4 (1321.3008K05)
- R&S®FSVA7 (1321.3008K08)
- R&S®FSVA13 (1321.3008K14)
- R&S®FSVA30 (1321.3008K31)
- R&S®FSVA40 (1321.3008K41)
- R&S®FSV4 (1321.3008K04)
- R&S®FSV7 (1321.3008K07)
- R&S®FSV13 (1321.3008K13)
- R&S®FSV30 (1321.3008K30)
- R&S®FSV40 (1321.3008K39/1321.3008K40)

It also applies to the following R&S®FSV models. However, note the differences described in Chapter 1.4, "Notes for Users of R&S FSV 1307.9002Kxx Models", on page 9.

- R&S®FSV3 (1307.9002K03)
- R&S®FSV7 (1307.9002K07)
- R&S®FSV13 (1307.9002K13)
- R&S®FSV30 (1307.9002K30)
- R&S®FSV40 (1307.9002K39/1307.9002K40)

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

Contents

1 Preface

1.1 Documentation Overview

This section provides an overview of the R&S FSVA/FSV user documentation. Unless specified otherwise, you find the documents on the R&S FSVA/FSV product page at:

www.rohde-schwarz.com/manual/FSVA

1.1.1 Quick Start Guide

Introduces the R&S FSVA/FSV and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument. A PDF version is available for download on the Internet.

1.1.2 Operating Manuals and Help

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

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

The contents of the operating manuals are available as help in the R&S FSVA/FSV. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

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

1.1.3 Service Manual

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

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS, https://gloris.rohde-schwarz.com).

1.1.4 Instrument Security Procedures

Deals with security issues when working with the R&S FSVA/FSV in secure areas. It is available for download on the Internet.

1.1.5 Basic Safety Instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

1.1.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S FSVA/FSV. It also lists the firmware applications and their order numbers, and optional accessories.

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

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

1.1.7 Release Notes and Open Source Acknowledgment (OSA)

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

The open source acknowledgment document provides verbatim license texts of the used open source software.

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

1.1.8 Application Notes, Application Cards, White Papers, etc.

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

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

1.2 Conventions Used in the Documentation

1.2.1 Typographical Conventions

The following text markers are used throughout this documentation:

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

1.2.2 Conventions for Procedure Descriptions

When operating the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

1.2.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

1.3 How to Use the Help System

Calling context-sensitive and general help

► To display the general help dialog box, press the HELP key on the front panel.

The help dialog box "View" tab is displayed. A topic containing information about the current menu or the currently opened dialog box and its function is displayed.

For standard Windows dialog boxes (e.g. File Properties, Print dialog etc.), no context-sensitive help is available.

► If the help is already displayed, press the softkey for which you want to display help.

A topic containing information about the softkey and its function is displayed.

If a softkey opens a submenu and you press the softkey a second time, the submenu of the softkey is displayed.

Contents of the help dialog box

The help dialog box contains four tabs:

- "Contents" - contains a table of help contents
- "View" - contains a specific help topic
- "Index" - contains index entries to search for help topics
- "Zoom" - contains zoom functions for the help display

To change between these tabs, press the tab on the touchscreen.

Navigating in the table of contents

- To move through the displayed contents entries, use the UP ARROW and DOWN ARROW keys. Entries that contain further entries are marked with a plus sign.
- To display a help topic, press the ENTER key. The "View" tab with the corresponding help topic is displayed.
- To change to the next tab, press the tab on the touchscreen.

Navigating in the help topics

- To scroll through a page, use the rotary knob or the UP ARROW and DOWN ARROW keys.
- To jump to the linked topic, press the link text on the touchscreen.

Searching for a topic

1. Change to the "Index" tab.
2. Enter the first characters of the topic you are interested in. The entries starting with these characters are displayed.
3. Change the focus by pressing the ENTER key.
4. Select the suitable keyword by using the UP ARROW or DOWN ARROW keys or the rotary knob.
5. Press the ENTER key to display the help topic.

   The "View" tab with the corresponding help topic is displayed.

Changing the zoom

1. Change to the "Zoom" tab.
2. Set the zoom using the rotary knob. Four settings are available: 1-4. The smallest size is selected by number 1, the largest size is selected by number 4.

Closing the help window

► Press the ESC key or a function key on the front panel.

1.4 Notes for Users of R&S FSV 1307.9002Kxx Models

Users of R&S FSV 1307.9002Kxx models should consider the following differences to the description of the newer R&S FSVA/FSV 1321.3008Kxx models:

- Functions that are based on the Windows 10 operating system (e.g. printing or setting up networks) may have a slightly different appearance or require different settings on the Windows XP based models. For such functions, refer to the Windows documentation or the documentation originally provided with the R&S FSV instrument.
- The R&S FSV 1307.9002K03 model is restricted to a maximum frequency of 3 GHz, whereas the R&S FSVA/FSV1321.3008K04 model has a maximum frequency of 4 GHz.
- The bandwidth extension option R&S FSV-B160 (1311.2015.xx) is not available for the R&S FSV 1307.9002Kxx models. The maximum usable I/Q analysis bandwidth for these models is 28 MHz, or with option R&S FSV-B70, 40 MHz.

2 Welcome

The NB-IoT measurement application uses the I/Q capture functionality of the following spectrum and signal analyzers to enable NB-IoT TX measurements conforming to the 3GPP specification.

- R&S FSV

This manual contains all information necessary to configure, perform and analyze such measurements.

2.1 Installing the Software

For information on the installation procedure see the release notes of the R&S FSVA/ FSV.

2.2 Application Overview

Starting the application

Access the application via the "Mode" menu.

► Press the MODE key and select "NB-IoT".
Note that you may have to browse through the "Mode" menu with the "More" softkey to find the NB-IoT entry.

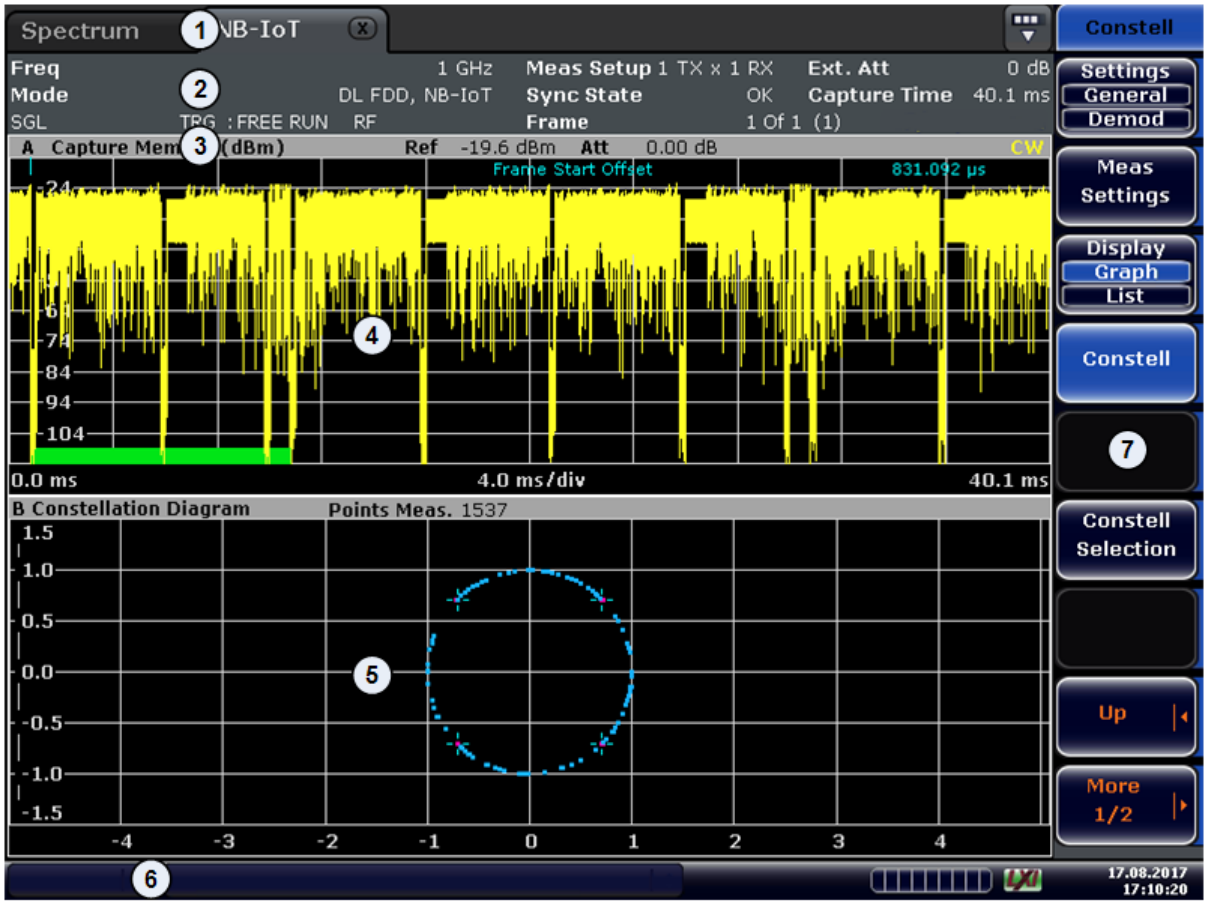
Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

`CONFigure:PRESet` on page 69

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.



1 = Channel Bar: contains all currently active measurement applications
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays

The status bar

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.

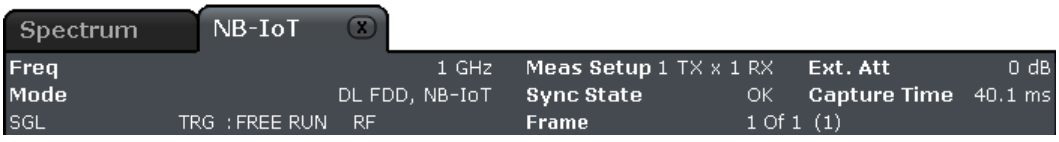


Table 2-1: Information displayed in the channel bar in the NB-IoT measurement application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Offset	Reference level offset
Freq	Frequency
E-UTRA Freq	Center frequency of the LTE channel (in-band deployment only)
Mode	NB-IoT standard
MIMO	Number of Tx and Rx antennas in the measurement setup
Capture Time	Length of the signal that has been captured
Frame Count	Number of frames that have been captured

2.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSVA/FSV stores the information in a number of files that are located in the R&S FSVA/FSV directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde & Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

3 Measurements and Result Displays

The NB-IoT measurement application features several measurements to examine and analyze different aspects of an NB-IoT signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file.

For more information, see:

- "Selecting the Input Source" on page 33
- Chapter 6, "File Management", on page 44

For more information on the functionality to actually perform the measurement, see Chapter 4.1, "Performing Measurements", on page 25.

3.1 Numerical Results

Access: MEAS CONFIG > "Display (Graph List)"

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

Remote command:

`DISPlay[:WINDow<n>]:TABLe` on page 53

Contents of the result summary

Result Summary						
Frame Result 1/1	Min		Mean	Limit	Max	Limit	Unit
Results for Selection	Subframe(s) ALL		Selection Antenna 1		Frame Result 1/1		
EVM All	0.18		0.26		0.40		%
EVM Phys. Channel	0.00		0.26		0.41		%
EVM Phys. Signal	0.13		0.28		0.36		%
Frequency Error	253.66		254.11		254.90		Hz
Sampling Error	- 9.04		- 0.59		12.39		ppm
RSTP	- 41.92		- 41.92		- 41.91		dBm
OSTP	- 31.50		- 31.16		- 31.12		dBm
Power	- 33.04		- 31.51		- 31.12		dBm
Crest Factor			9.05				dB

The table shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also indicates limit values as defined in the NB-IoT standard and 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 () in front of failed results.

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

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

The statistic is always evaluated over the subframes.

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

EVM All

Shows the EVM for all resource elements in the analyzed frame.

`FETCh[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]?` on page 63

EVM Phys Channel

Shows the EVM for all physical channel resource elements in the analyzed frame.

A physical channel corresponds to a set of resource elements carrying information from higher layers. NPDSCH, NPBCH or NPDCCH, for example, are physical channels. For more information, see 3GPP 36.211.

`FETCh[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]?` on page 64

EVM Phys Signal

Shows the EVM for all physical signal resource elements in the analyzed frame.

The reference signal, for example, is a physical signal. For more information, see 3GPP 36.211.

`FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]?` on page 64

Frequency Error

Shows the difference in the measured center frequency and the reference center frequency.

`FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]?` on page 64

Sampling Error

Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.

`FETCh[:CC<cc>]:SUMMary:SERRor[:AVERage]?` on page 66

RSTP

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

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

`FETCh[:CC<cc>]:SUMMary:RSTP[:AVERage]?` on page 66

OSTP

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

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

`FETCh[:CC<cc>]:SUMMary:OSTP[:AVERage]?` on page 65

Power	Shows the average time domain power of the analyzed signal. `FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]?` on page 65
Crest Factor	Shows the peak-to-average power ratio of captured signal. `FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]?` on page 63

3.2 Power vs Time (PVT)

Access: MEAS CONFIG > "PVT"

Capture Buffer

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

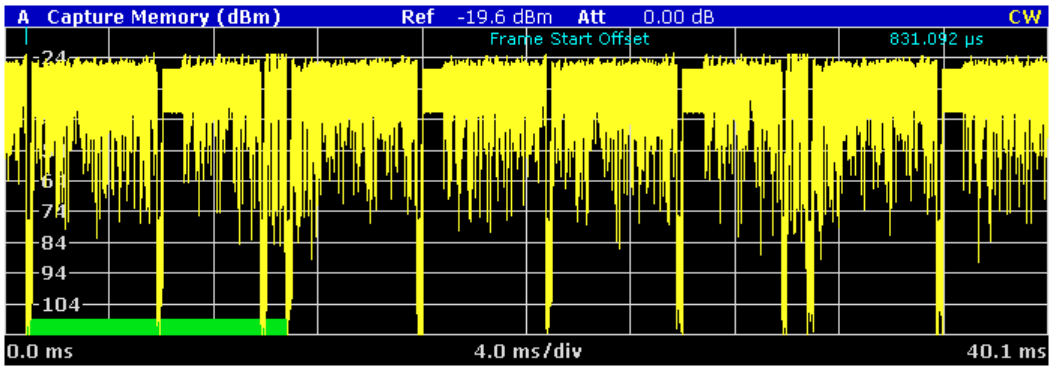


Figure 3-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode. A green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the capture buffer represents the subframe start. The diagram also contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

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

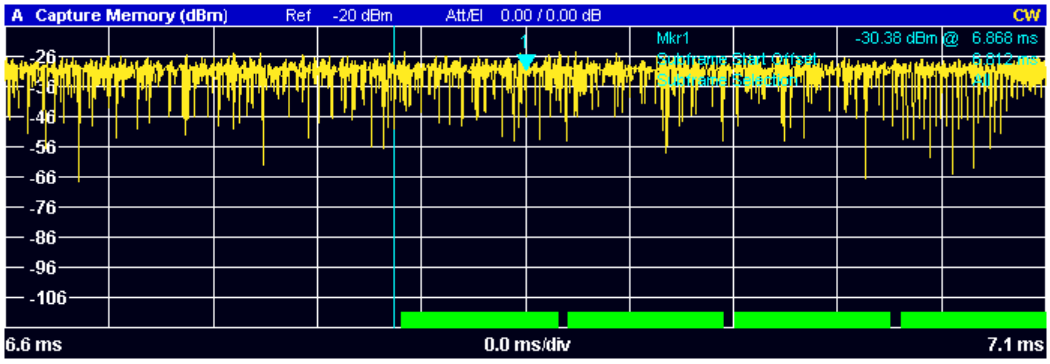


Figure 3-2: Capture buffer after a zoom has been applied

Remote command:
Selecting the result display: CALCulate<n>:FEED 'PVT:CBUF'
Querying results:
TRACe:DATA?
Querying the subframe start offset: `FETCh[:CC<cc>]:SUMMary:TFRame?`
on page 66

3.3 Error Vector Magnitude (EVM)

Access: MEAS CONFIG > "EVM"

EVM vs Carrier
Starts the EVM vs Carrier result display.

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

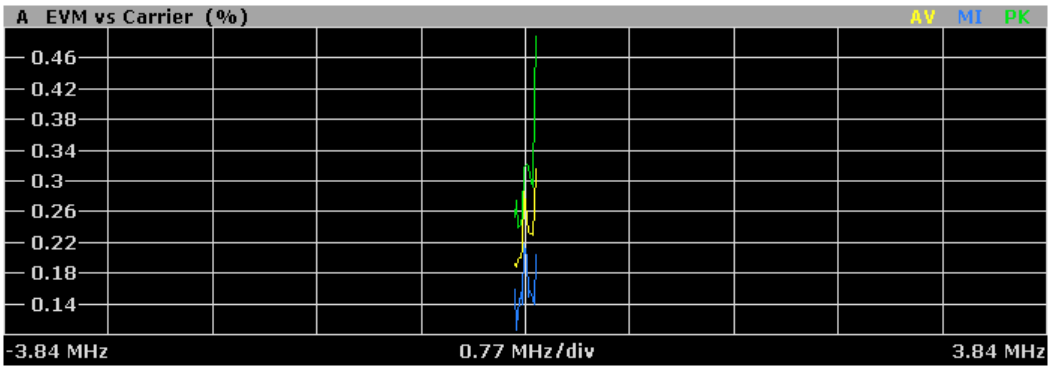
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed subframe in the capture buffer.

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

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

If you select and analyze one subframe only, the result display contains one trace that shows the subcarrier EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information, see "Subframe Selection" on page 39.

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVCA'
Querying results:
TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

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

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

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

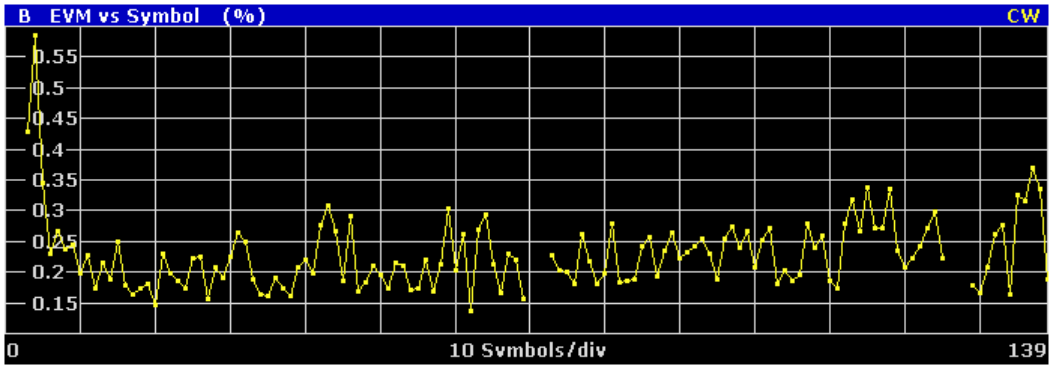
- Average EVM
  This trace shows the OFDM symbol EVM, averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the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

If you select and analyze one subframe only, the result display contains one trace that shows the OFDM symbol EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information, see "Subframe Selection" on page 39.

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

The number of displayed symbols depends on the subframe selection.

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVSY'
Querying results:
TRACe:DATA?

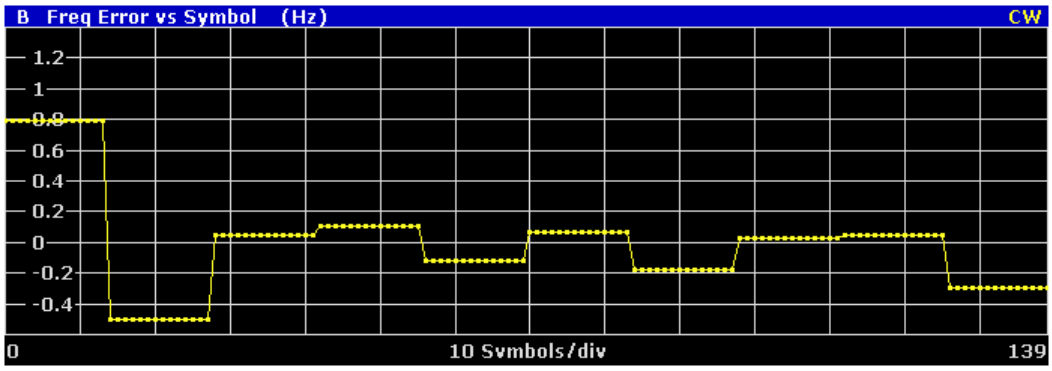
Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

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

The result is an average over all subcarriers.

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

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:FEVS'
Querying results:
TRACe:DATA?

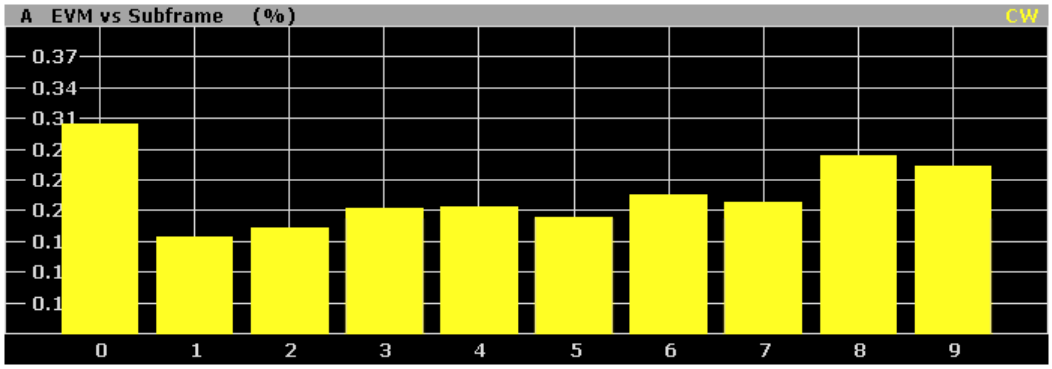
EVM vs Subframe
Starts the EVM vs Subframe result display.

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

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

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

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVSU'
Querying results:
TRACe:DATA?

3.4 Spectrum Measurement

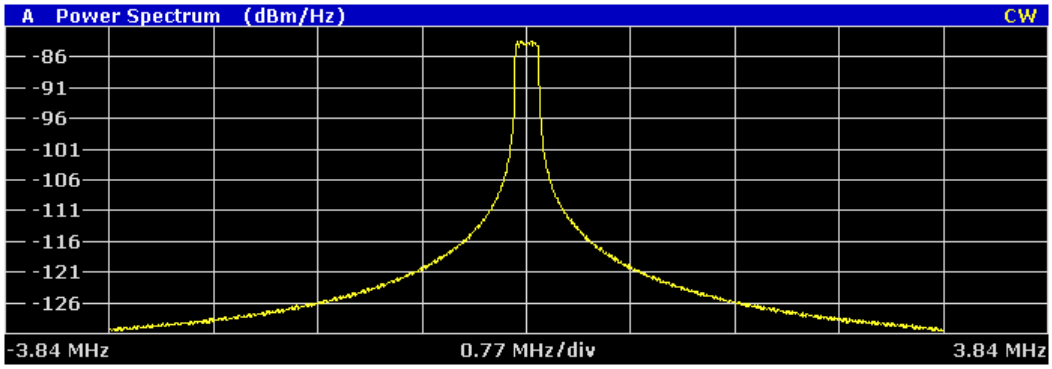
Access: MEAS CONFIG > "Spectrum"

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 is always 7.68 MHz.

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



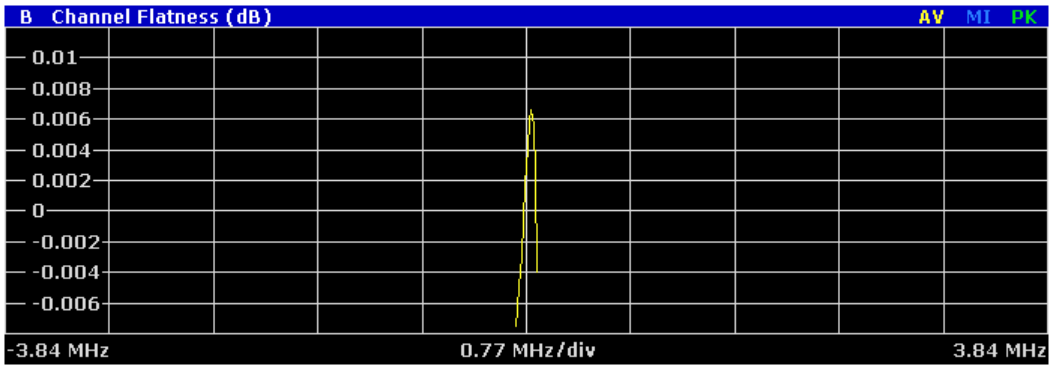
Remote command:
Selecting the result display: CALCulate<screenid>:FEED 'SPEC:PSPE'
Querying results:
TRACe:DATA?

Channel Flatness
Starts the Channel Flatness result display.

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

The currently selected subframe depends on your selection.

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:FLAT'
Querying results:
TRACe:DATA?

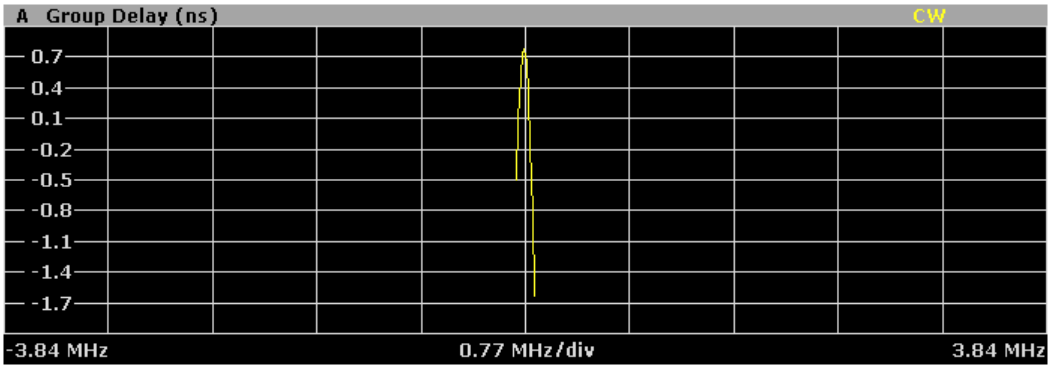
Group Delay
Starts the Group Delay result display.

This result display shows the group delay of each subcarrier.

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

The currently selected subframe depends on your selection.

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



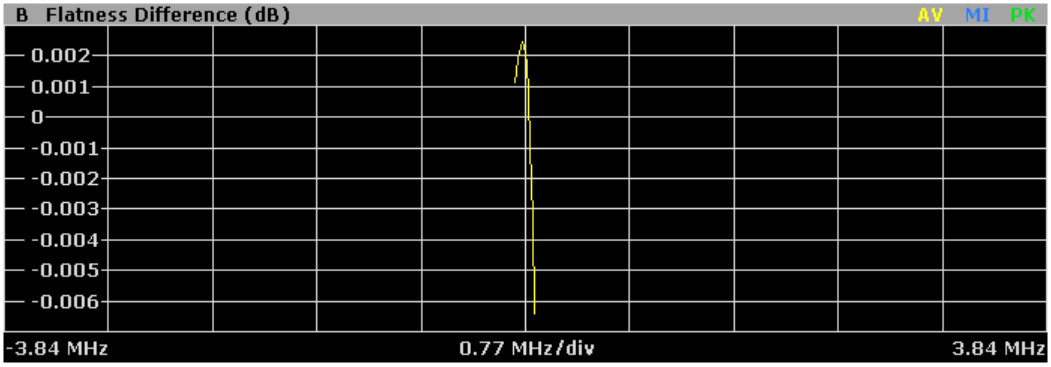
Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:GDEL'
Querying results:
TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

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

The currently selected subframe depends on your selection.

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:FDIF'
Querying results:
TRACe:DATA?

3.5 Constellation

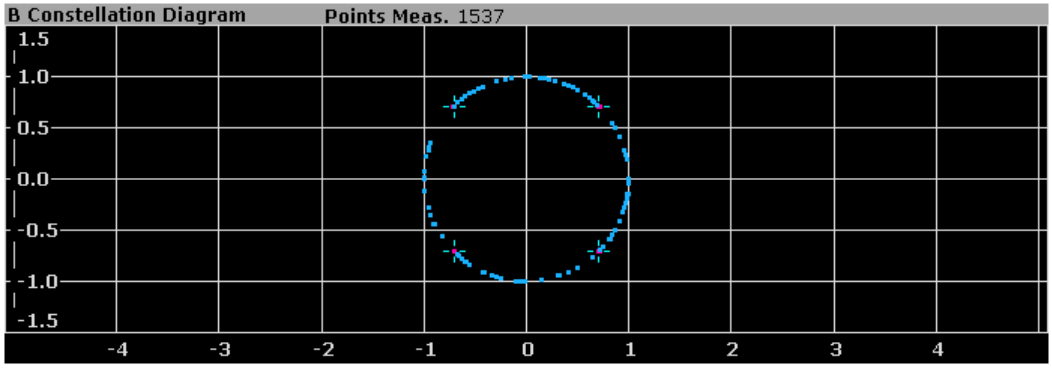
Access: MEAS CONFIG > "Constell"

Constellation Diagram
Starts the Constellation Diagram result display.

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

In the default state, the result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

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



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

Remote command:
Selecting the result display: CALCulate<n>:FEED 'CONS:CONS'
Querying results: TRACe:DATA?

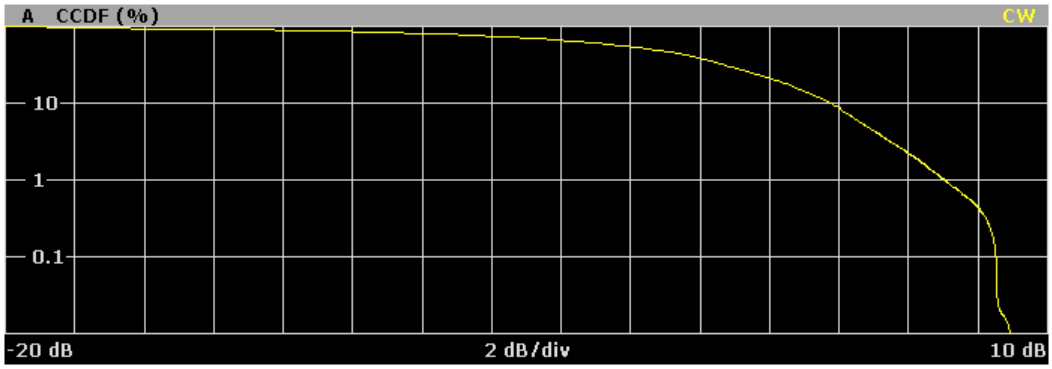
3.6 Statistics

Access: MEAS CONFIG > "Statistics"

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

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

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



Remote command:
Selecting the result display: CALCulate<n>:FEED 'STAT:CCDF'
Querying results: TRACe:DATA?

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in a table.

B Allocation Summary

Sub-frame	Allocation ID	Number of RB	Rel. Power/dB	Modulation	Power per RE [dBm]	EVM [%]
0	RS Ant1		0.000	QPSK	-41.921	0.128
	NPBCH		0.001	QPSK	-41.915	0.315
	ALL	0				0.305
1	RS Ant1		0.000	QPSK	-41.915	0.157
	NPDSCH/NPDCCH (	1	0.001	QPSK	-41.916	0.195
	ALL	1				0.193
2	RS Ant1		0.000	QPSK	-41.916	0.184
	NPDSCH/NPDCCH (	1	-0.001	QPSK	-41.918	0.204
	ALL	1				0.203

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

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the corresponding NPDSCH 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.

Remote command:
Selecting the result display: CALCulate<n>:FEED 'STAT:ASUM'
Querying results: TRACe:DATA?

4 Configuration

Before you can start a measurement, you have to configure the R&S FSVA/FSV in order to get valid measurement results. This chapter contains detailed information on all settings available in the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns orange to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns orange.

In the "General Settings" dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of several tabs. By default, the "General" tab is the active one.

In the "Demod Settings" dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of several tabs. By default, the "DL Demod" tab is the active one.

You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

4.1 Performing Measurements

Access: SWEEP

The sweep menu contains functions that control the way the R&S FSVA/FSV performs a measurement.

Single Sweep and Continuous Sweep
In continuous sweep mode, the R&S FSVA/FSV continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSVA/FSV captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSVA/FSV interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

Remote command:
INITiate:CONTinuous on page 53

Auto Level
The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

For more information, see "Defining a Reference Level" on page 29.

Remote command:
[SENSe:]POWer:AUTO<instrument>[:STATe] on page 78

Refresh
Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSVA/FSV updates the current measurement results regarding the new settings. It does not capture I/Q data again but uses the data captured last.

Remote command:
INITiate:REFResh on page 54

4.2 General Settings

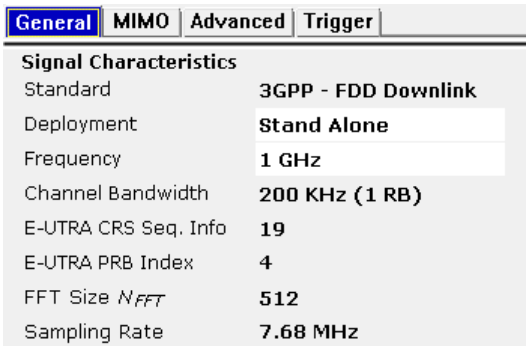
Access: MEAS CONFIG > "Settings General"

The general settings contain settings to describe the basic measurement configuration.

4.2.1 Signal Characteristics

Access: MEAS CONFIG > "Settings General" > "General"

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



Selecting the NB-IoT mode
The "Mode" selects the NB-IoT link direction you are testing.

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.
  Note that the NB-IoT standard only supports FDD mode.

Downlink (DL) and Uplink (UL) describe the **transmission path**.
- Downlink is the transmission path from the base station to the user equipment.
  The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station.

Remote command:
not supported

Deployment
The 3GPP standard specifies several operating modes, or deployment. The deployment specifies where the NB-IoT signal is located in the frequency spectrum.

You can select the deployment of the signal you are testing from the "Deployment" dropdown menu.

The application supports the following deployments.
- "Stand Alone"
  The NB-IoT signal uses its own band outside of an LTE band, for example a frequency band currently used by GSM. With a carrier bandwidth of 200 kHz in GSM, there is enough room for an NB-IoT carrier (180 kHz), including a guard interval of 10 kHz on both sides of the carrier.
- "In Band"
  The NB-IoT signal uses resource blocks within an LTE carrier.

Remote command:
`CONFigure[:LTE]:DEPLoyment` on page 71

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.

Note that the center frequency for the in-band deployment is the center frequency of the used LTE channel (E-UTRA frequency).

Remote command:
Center frequency: `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 74

Defining physical settings for NB-IoT stand alone deployment
The physical properties of the NB-IoT signal depend on the channel bandwidth.

Currently, the 3GPP standard specifies a 200 kHz bandwidth for an NB-IoT carrier. This bandwidth corresponds to one LTE resource block (RB).

The application derives various other physical properties of the measured signal from the bandwidth.

- "Number of Resource Blocks" (NB_1RB)
- "FFT Size"
- "Sample Rate"

All values are read only.

Remote command:
not supported

Defining physical settings for NB-IoT in band deployment
When you use the in band deployment, you have to specify the characteristics of the LTE (E-UTRA) channel that the NB-IoT channel is located in.

Define the following E-UTRA properties:

- "E-UTRA Center Frequency"
  Center frequency of the LTE channel.
- "E-UTRA Channel Bandwidth"
  Channel bandwidth of the LTE channel (3 MHz, 5 MHz, 10 MHz, 15 MHz or 20 MHz).
  Note that the 1.4 MHz bandwidth is not supported for in band transmission of NB-IoT signals.
- "E-UTRA CRS Sequence Info"
  Cell-specific reference signal sequence. The sequence defines the assignment of resources between LTE and NB-IoT. These sequences are defined in 3GPP 36.213, chapter 16.8.
- "E-UTRA PRB Index"
  The PRB index depends on the CRS sequence you have selected. The PRB index is also used to assign resources between LTE and NB-IoT.
  It is automatically calculated by the application.

In addition, the application shows various physical properties of the NB-IoT signal.

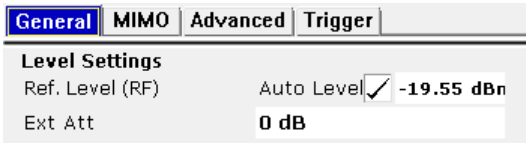
- "NB-IoT Channel Bandwidth", which is currently always 200 kHz.
- "NB-IoT Center Frequency", which is calculated from the E-UTRA channel characteristics.
- "FFT Size"
- "Sample Rate"

Remote command:
E-UTRA center frequency: `CONFigure[:LTE]:EUTRa:FREQuency` on page 71
E-UTRA channel bandwidth: `CONFigure[:LTE]:DL[:CC<cc>]:BW` on page 72
E-UTRA CRS sequence: `CONFigure[:LTE]:DL:SINFo` on page 72
E-UTRA PRB index: `CONFigure[:LTE]:DL:PINDex` on page 72

4.2.2 Level Settings

Access: MEAS CONFIG > "Settings General" > "General"

The level settings contain settings that control the input level of the analyzer.



Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power for signals with a high crest factor like NB-IoT.

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

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

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

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 before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time** (→ "Advanced" tab).

Automatic level detection also optimizes RF attenuation.

Remote command:
Manual (RF): `CONFigure:POWer:EXPected:RF<instrument>` on page 77
Manual (BB): `CONFigure:POWer:EXPected:IQ<instrument>` on page 76
Automatic: `[SENSe:]POWer:AUTO<instrument>[:STATe]` on page 78
Auto Level Track Time: `[SENSe:]POWer:AUTO<instrument>:TIME` on page 79

Attenuating the Signal

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

The NB-IoT measurement application provides several attenuation modes.

- **External** attenuation is always available. It controls an external attenuator if you are using one.
- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
  Mechanical attenuation is available in the "Advanced" tab of the "General Settings" dialog box.

Positive values correspond to an attenuation and negative values correspond to an amplification.

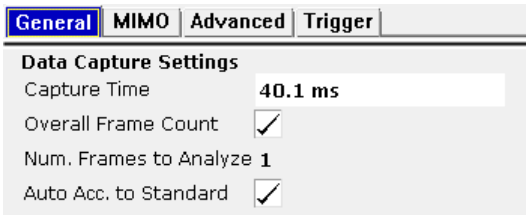
RF attenuation is independent of the reference level. It is available if automatic reference level detection is inactive. The range is from 0 dB to 75 dB.

Remote command:
RF attenuation: `INPut<n>:ATTenuation<instrument>` on page 77
External attenuation: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 77

4.2.3 Configuring the Data Capture

Access: MEAS CONFIG > "Settings General" > "General"

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.



Capture Time
Defines the capture time.

The capture time corresponds to the time of one measurement. Hence, it defines the amount of data the application captures during a single measurement (or sweep).

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

Remote command:
`[SENSe:]SWEep:TIME` on page 81

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 application analyzes all complete NB-IoT frames currently in the capture buffer.

Remote command:
[SENSe:][LTE:]FRAMe:COUNt:STATe on page 80

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 measurement, the application continues the measurement until all frames have been captured.

The parameter is read only in the following cases:
- The overall frame count is inactive,
- The data is captured according to the standard.

Remote command:
[SENSe:][LTE:]FRAMe:COUNt on page 79

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

If active, the application evaluates the number of frames as defined for EVM tests in the NB-IoT standard.

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

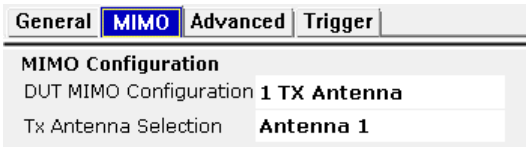
This parameter is not available if the overall frame count is inactive.

Remote command:
[SENSe:][LTE:]FRAMe:COUNt:AUTO on page 80

4.3 Configuring MIMO Setups

Access: MEAS CONFIG > "Settings General" > "MIMO"

The MIMO Configuration contains settings to configure MIMO test setups.



MIMO Configuration 31

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- and 2-antenna configurations are supported.

In setups with multiple antennas, **antenna selection** defines the antenna(s) you would like to test.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.

Remote command:
MIMO configuration: `CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CONFig` on page 75
Antenna selection: `CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection` on page 75

4.4 Advanced Settings

Access: MEAS CONFIG > "Settings General" > "Advanced"

The advanced settings contain parameters to configure more complex measurement setups.

4.4.1 I/Q Settings

Access: MEAS CONFIG > "Settings General" > "Advanced"

The I/Q settings contain settings that control the I/Q data flow.

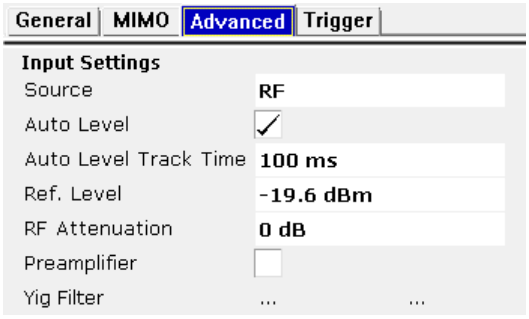
Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
`[SENSe:]SWAPiq` on page 80

4.4.2 Input Settings

Access: MEAS CONFIG > "Settings General" > "Advanced"

The input settings contain settings that control the input source.



Functions to configure the input described elsewhere:

- Reference level: "Defining a Reference Level" on page 29
- Attenuation: "Attenuating the Signal" on page 29

Selecting the Input Source

The input source selects the source of the data you would like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
  Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
  Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
- Digital I/Q
  Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
  The digital baseband input is available with option R&S FSVA/FSV-B17.

For more information on using hardware option R&S FSVA/FSV-B17, see the manual of the R&S FSVA/FSV.

Remote command:
`INPut:SELect` on page 82

Yig Filter
R&S FSVA only

Configures the YIG filter.

If you want to measure broadband signals, you can configure the YIG filter for a greater bandwidth.

The process of configuring the YIG filter consists of two steps.

- **Selecting the mode**
  You can select either manual or automatic control of the YIG filter.
- **Selecting the state**
  Turns the YIG filter on and off.

If inactive, you can use the maximum bandwidth. However, image frequency rejection is no longer ensured.

If you have selected automatic YIG filter control, the R&S FSVA/FSV automatically resolves whether to use the YIG filter or not. Manual selection of the YIG filter state is not available in that case.

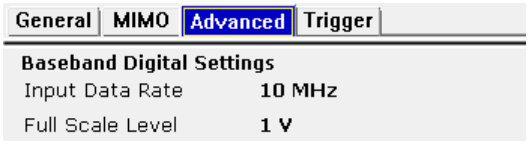
Note that the R&S FSVA/FSV uses the YIG filter only for frequencies greater than 3.6 GHz. If the frequency is smaller, these settings have no effect.

Remote command:
`INPut<n>:FILTer:YIG[:STATe]` on page 82
`INPut<n>:FILTer:YIG:AUTO` on page 82

4.4.3 Digital I/Q Input

Access: MEAS CONFIG > "Settings General" > "Advanced"

The digital I/Q settings contain settings that configure the digital I/Q input.



Sampling Rate (Input Data Rate)
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

Remote command:
`INPut<n>:DIQ:SRATe` on page 83

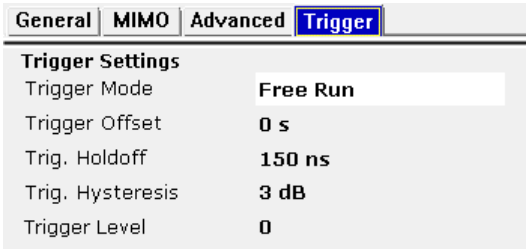
Full Scale Level
Defines the voltage corresponding to the maximum input value of the digital baseband input.

Remote command:
`INPut<n>:DIQ:RANGe[:UPPer]` on page 83

4.5 Trigger Configuration

Access: MEAS CONFIG > "Settings General" > "Trigger"

The trigger settings contain settings to configure triggered measurements.



Configuring the Trigger

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

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

The application supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/ Gate" input.
- IF Power
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.
- RF Power
  The trigger event is the RF power level. The measurement starts when a signal outside of the measured channel meets or exceeds a certain level at the first intermediate frequency.
  The level range is from -50 dBm to -10 dBm. The corresponding trigger level at the RF input is:
  The RF Power trigger is available with detector board 1307.9554.02 Rev. 05.00 or higher. It is not available for measurements with the digital I/Q interface (R&S FSVA/FSV-B17).
- Power Sensor
  The trigger event is a specified level measured by a power sensor. The measurement starts when a power sensor measurement meets certain conditions.
  The power sensor as a trigger source is available with option R&S FSV-K9 and a connected power sensor.

You can define a **power level** for an external, IF power, RF power or power sensor trigger.

The name and contents of the Power Level field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

The measurement starts as soon as the trigger event happens. It can become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

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

The trigger offset is available for all trigger modes, except free run.

A trigger event usually is a certain level value. The **trigger hysteresis** defines a distance to the trigger level that the input signal must stay below in order to fulfill the trigger condition.

If you want to have a minimum time between individual measurements, set a **trigger holdoff**. A trigger holdoff defines a waiting period that must at least pass between one trigger event and the next.

Remote command:
For a comprehensive list of commands to define trigger characteristics see Chapter 7.8.2.5, "Trigger Configuration", on page 83.

4.6 Signal Demodulation

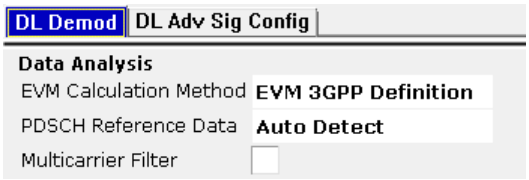
Access: MEAS CONFIG > "Settings Demod"

The downlink demodulation settings contain settings that describe the signal processing and the way the signal is demodulated.

4.6.1 Data Analysis

Access: MEAS CONFIG > "Settings Demod" > "DL Demod"

The data analysis settings contain settings that determine the way the captured signal is analyzed.



EVM Calculation Method
Selects the method to calculate the EVM.

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

Remote command:
[SENSe:][LTE:]DL:DEMod:EVMCalc on page 85

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

- Auto detect
  Automatically identifies the reference data for the NPDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the NPDSCH 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 is not reliable in that case.

Remote command:
[SENSe:][LTE:]DL:DEMod:PRData on page 86

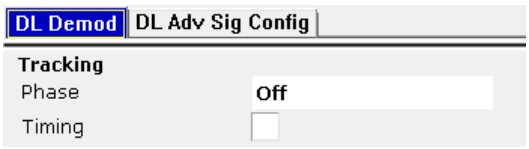
Multicarrier Filter
Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc.).

Remote command:
[SENSe:][LTE:]DL:DEMod:MCFilter on page 85

4.6.2 Tracking

Access: MEAS CONFIG > "Settings Demod" > "DL Demod"

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



Phase
Turns phase tracking on and off.

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

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

Remote command:
[SENSe:][LTE:]DL:TRACking:PHASe on page 87

Timing
Turns timing tracking on and off.

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

Remote command:
[SENSe:][LTE:]DL:TRACking:TIME on page 87

Channel Estimation
Selects the method of channel estimation.

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

Remote command:
[SENSe:][LTE:]DL:DEMod:CESTimation on page 86

4.7 Advanced Signal Characteristics

Access: MEAS CONFIG > "Settings Demod" > "DL Adv Sig Config"

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

PRB Symbol Offset..... 38

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

Only available for the in band deployment.

Remote command:
CONFigure[:LTE]:DL[:CC<cc>]:PSOFfset on page 76

5 Analysis

The NB-IoT application provides several tools to analyze the measurement results in more detail.

5.1 Signal Part Selection

Access: MEAS CONFIG > "Meas Settings" > "Selection"

You can select specific parts of the signal you want to analyze.

Subframe Selection
Selects a particular subframe whose results the application displays.

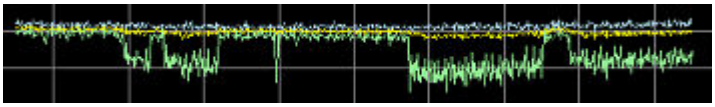
You can select a particular subframe for the following measurements.

- Result Summary
- EVM vs Carrier / EVM vs Symbol / EVM vs Symbol X Carrier
- Group Delay
- Power vs Symbol X Carrier
- Constellation Diagram
- Allocation Summary
- Time Alignment Error

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

Example: Subframe selection

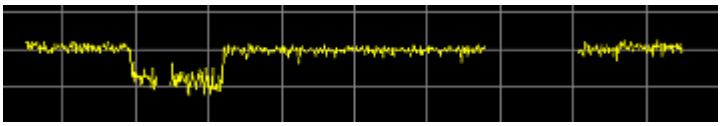
If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



with AV MI PK

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

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



Remote command:
`[SENSe:][LTE:][CC<cc>:]SUBFrame:SELect` on page 89

5.2 Measurement Units

Access: MEAS CONFIG > "Meas Settings" > "Units"

You can select the unit for various measurements and result displays.

EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 90

5.3 Constellation Diagram Filter

Access: MEAS CONFIG > "Constell" > "Constell Filter"

The evaluation filter selects the contents of the constellation diagram.

Evaluation range for the constellation diagram
The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the "Constellation Diagram".

By default the application displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.

- Modulation
  Filters the results to include only the selected type of modulation.
- Allocation
  Filters the results to include only a certain type of allocation.
- Symbol (OFDM)
  Filters the results to include only a certain OFDM symbol.
- Carrier
  Filters the results to include only a certain subcarrier.

The result display is updated when you make the changes.

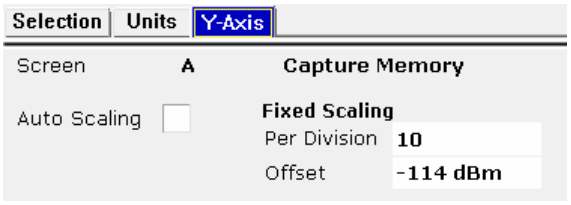
Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Modulation: `[SENSe:][LTE:][CC<cc>:]MODulation:SELect` on page 88
Allocation: `[SENSe:][LTE:][CC<cc>:]ALLocation:SELect` on page 88
Symbol: `[SENSe:][LTE:][CC<cc>:]SYMBol:SELect` on page 89
Carrier: `[SENSe:][LTE:][CC<cc>:]CARRier:SELect` on page 88

5.4 Y-Axis Scale

Access: MEAS CONFIG > "Meas Settings" > "Y-Axis"

You can define the scale of the y-axis in most result displays.



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 and display the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it can become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis. **Fixed scaling** becomes available when you turn off automatic scaling. For a fixed scaling, define the distance between two grid lines (scaling **per division**) and the point of origin of the y-axis (the **offset**).

Remote command:
Automatic scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO` on page 95
Manual scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet` on page 95
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv` on page 95

5.5 Markers

Access: MKR

Access: MKR ➞

The firmware application provides marker functionality to work with. You can use a marker to mark specific points on traces or to read out measurement results.

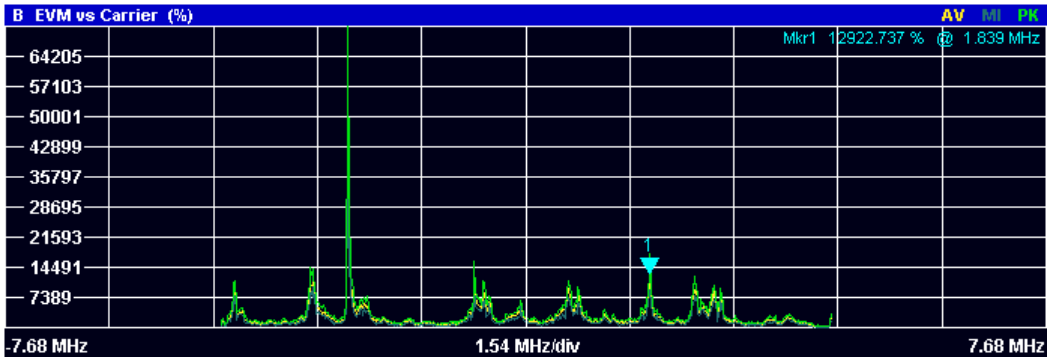


Figure 5-1: Example: Marker

The MKR key opens the corresponding submenu. You can activate up to four markers with the "Marker <x>" softkeys. The first marker is always a normal marker. Markers 2 to 4 are delta marker by default. The reference marker for the delta marker is marker 1. You can turn all delta markers into normal markers with the "Marker (Norm Delta)" softkey.

After pressing the "Marker <x>" softkey, you can set the position of the marker in several ways.

- Enter a frequency value in the marker input field.
- Move the marker with the rotary knob.
- Position the marker to the trace minimum or trace maximum with the "Marker Max" or "Marker Min" softkeys.

The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

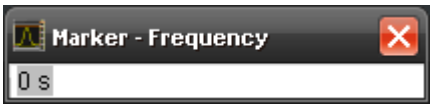
The "Marker <x>" softkey have three possible states:

- If the "Marker <x>" softkey is black, the marker is off.

- After pressing the "Marker <x>" softkey it turns orange to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

- After closing the dialog box, the "Marker <x>" softkey turns blue. The marker stays active.

  Pressing the "Marker <x>" softkey again deactivates the marker. You can also turn off the marker by pressing the "All Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker → Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

SCPI commands:

See Chapter 7.9.4, "Using Delta Markers", on page 92.

6 File Management

6.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0"
RessourceBlocks="50" CP="auto" RefSigSubcarrierOffset="Auto" PSYNCBoostingdB="0"
SSYNCBoostingdB="0" ReferenceSignalBoostingdB="0" PBCHSymbolOffset="7" PBCHLength="4"
PCFICHIsPresent="false" PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="0"
PDCCHIsPresent="false" PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="2"
MIMOConfiguration="1 Tx Antenna" MIMOAntennaSelection="Antenna 1" PhysLayCellIDGrp="Auto"
PhysLayID="Auto" RefSignal3GPPVersion="2" N_c_fastforward="0">
 <Frame>
  <Subframe>
   <PRBs>
    <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK"/>
   </PRBs>
  </Subframe>
 </Frame>
 <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1"
  EVMCCalculationMethod="1" EnableScrambling="1" AutoDemodulation="1"/>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

Note that at least one PRB must exist.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Settings" button.

Loading an I/Q File

The R&S FSVA/FSV is able to process I/Q data that has been captured with a R&S FSVA/FSV directly as well as data stored in a file. You can store I/Q data in vari-

ous file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

6.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSVA/FSV. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSVA/FSV.

7 Remote Control

The following remote control commands are required to configure and perform LTE NB-IoT measurements in a remote environment. The R&S FSVA/FSV must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSVA/FSV user manual. In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data.
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation.
- Using the common status registers (specific status registers for Pulse measurements are not used).

7.1 Common Suffixes

In the LTE NB-IoT measurement application, the following common suffixes are used in remote commands:

Table 7-1: Common suffixes used in remote commands in the LTE NB-IoT measurement application

Suffix	Value range	Description
<m>	1..4	Marker
<n>	1..16	Window (**in the currently selected channel**)
<t>	1..6	Trace
<ant>	1..2	Selects an antenna for MIMO measurements.
<cc>	1..5	Selects a component carrier. Irrelevant for the NB-IoT application.

Suffix	Value range	Description
<k>	---	Selects a limit line. Irrelevant for the NB-IoT application.
<np>	0...20	Selects a NPUSCH (NB-IoT uplink only)

7.2 Introduction

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

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

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

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

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

7.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSVA/FSV follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

7.2.2 Long and Short Form

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

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

Example:

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

7.2.3 Numeric Suffixes

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

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

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

Example:

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

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

7.2.4 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

7.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

7.2.6 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

7.2.6.1 Numeric Values

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

Example:

With unit: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

7.2.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

7.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see Chapter 7.2.2, "Long and Short Form", on page 48.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

7.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

7.2.6.5 Block Data

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

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

7.3 Remote Commands to Select the NB-IoT Application

INSTrument[:SELect] <ChannelType>

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

Parameters:

<ChannelType> **NIOT**
LTE NB-IoT measurement channel

Example: //Select LTE NB-IoT application
`INST NIOT`

7.4 Measurement Selection

CALCulate<n>:FEED <Result>

This command selects the measurement and result display.

Parameters:

<Result> String containing the short form of the result display. See table below for details.

Example: `CALC2:FEED 'PVT:CBUF'`
Select Capture Buffer to be displayed on screen B.

Manual operation: See "Capture Buffer" on page 15
See "EVM vs Carrier" on page 16
See "EVM vs Symbol" on page 17
See "Frequency Error vs Symbol" on page 18
See "EVM vs Subframe" on page 19
See "Power Spectrum" on page 19
See "Channel Flatness" on page 20
See "Group Delay" on page 20
See "Channel Flatness Difference" on page 21
See "Constellation Diagram" on page 21
See "CCDF" on page 22
See "Allocation Summary" on page 23

Result display	Parameter
Allocation Summary	'STAT:ASUM'
Capture Buffer	'PVT:CBUF'
CCDF	'STAT:CCDF'

Result display	Parameter
Constellation Diagram	'CONS:CONS'
EVM vs Carrier	'EVM:EVCA'
EVM vs Subframe	'EVM:EVSU'
EVM vs Symbol	'EVM:EVSY'
Flatness Difference	'SPEC:FLAT'
Group Delay	'SPEC:GDEL'
Frequency Error vs Symbol	'EVM:FEVS'
Power Spectrum	'SPEC:PSPE'
Spectrum Flatness	'SPEC:FLAT'

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>

ON
Turns the result summary on and removes all graphical results from the screen.

OFF
Turns the result summary off and restores the graphical results that were previously set.

Example: `DISP:TABL OFF`
Turns the result summary off.

Manual operation: See "Result Summary" on page 13

7.5 Measurement Execution

INITiate:CONTinuous <State>

This command controls the sweep mode.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: OFF

Example: `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

Manual operation: See "Single Sweep and Continuous Sweep" on page 25

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: `INIT`
Initiates a new measurement.

Usage: Event

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example: `INIT:REFR`
The application updates the IQ results

Usage: Event

Manual operation: See "Refresh" on page 26

[SENSe:]SYNC[:CC<cc>][:STATe]?

This command queries the current synchronization state.

Suffix:

<cc> Component Carrier

Return values:

<State> The string contains the following information:
A zero represents a failure and a one represents a successful synchronization.

Example: //Query synchronization state
`SYNC:STAT?`
Would return, e.g. '1' for successful synchronization.

Usage: Query only

7.6 Measurement Result Query

7.6.1 Using the TRACe[:DATA] Command

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

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

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

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

Example:

```
TRAC2:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).

Selecting a measurement window

Before you can query measurement results, you have to select the measurement window that contain the result you would like to query with the command `DISPlay[:WINDow<n>]:SELect`.

7.6.1.1 Allocation Summary

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

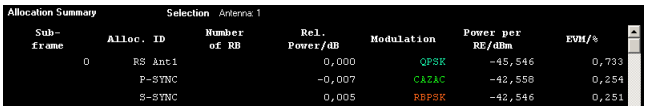
`<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...`

The unit for `<absolute power>` is always dBm. The unit for `<relative power>` is always dB. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see Chapter 7.6.1.13, "Return Value Codes", on page 61.

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

Example:



`TRAC:DATA? TRACE1` would return:

```
0, -5, 0, 0.0000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

Additional information "ALL"

The allocation summary contains additional lines "ALL" that summarize the number of RB analyzed in each subframe and the average EVM measured in that subframe. This information is added to the return values after all allocations of the subframe have been returned. The "ALL" information has the allocation ID code "-2".

In addition, there is a line at the end of the allocation summary that shows the average EVM over all analyzed subframes. This information is also added as the last return values. The "ALL" information has the subframe ID and allocation ID code "-2".

A query result would thus look like this, for example:

```
//For subframe 0:
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
(...)
//ALL for subframe 0:
0,-2,20,,,,2.45581475911678E-06
//For subframe 1:
1, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
1, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
(...)
//ALL for subframe 1:
1,-2,20,,,,2.45581475911678E-06
(...)
//ALL for all subframes
-2,-2,,,,,2.13196434228374E-06
```

7.6.1.2 Capture Buffer

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

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

7.6.1.3 CCDF

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

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

7.6.1.4 Channel and Spectrum Flatness

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

<relative power>, ...

The unit is always dB.

The following parameters are supported.

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

7.6.1.5 Channel and Spectrum Flatness Difference

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

<relative power>, ...

The unit is always dB. The number of values depends on the selected NB-IoT bandwidth.

The following parameters are supported.

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

7.6.1.6 Group Delay

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

<group delay>, ...

The unit is always ns. The number of values depends on the selected NB-IoT bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

7.6.1.7 Constellation Diagram

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

<I[SF0][Sym0][Carrier1]>, <Q[SF0][Sym0][Carrier1]>, ..., <I[SF0][Sym0][Carrier(n)]>, <Q[SF0][Sym0][Carrier(n)]>,

<I[SF0][Sym1][Carrier1]>, <Q[SF0][Sym1][Carrier1]>, ..., <I[SF0][Sym1][Carrier(n)]>, <Q[SF0][Sym1][Carrier(n)]>,

<I[SF0][Sym(n)][Carrier1]>, <Q[SF0][Sym(n)][Carrier1]>, ..., <I[SF0][Sym(n)][Carrier(n)]>, <Q[SF0][Sym(n)][Carrier(n)]>,

<I[SF1][Sym0][Carrier1]>, <Q[SF1][Sym0][Carrier1]>, ..., <I[SF1][Sym0][Carrier(n)]>, <Q[SF1][Sym0][Carrier(n)]>,

<I[SF1][Sym1][Carrier1]>, <Q[SF1][Sym1][Carrier1]>, ..., <I[SF1][Sym1][Carrier(n)]>, <Q[SF1][Sym1][Carrier(n)]>,

<I[SF(n)][Sym(n)][Carrier1]>, <Q[SF(n)][Sym(n)][Carrier1]>, ..., <I[SF(n)][Sym(n)][Carrier(n)]>, <Q[SF(n)][Sym(n)][Carrier(n)]>

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

The I and Q values have no unit.

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

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

7.6.1.8 EVM vs Carrier

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

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

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

7.6.1.9 EVM vs Subframe

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

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

7.6.1.10 EVM vs Symbol

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

```
<EVM>, ...
```

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

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

7.6.1.11 Frequency Error vs Symbol

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

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

7.6.1.12 Power Spectrum

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

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

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

7.6.1.13 Return Value Codes

<number of symbols or bits>

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

<allocation ID>

Represents the allocation ID. The range is as follows.

- **0** = NPDSCH
- **-1** = Invalid / not used
- **-2** = All
- **-3** = NPSS
- **-4** = NSSS
- **-5** = Reference Signal (Antenna 1)
- **-6** = Reference Signal (Antenna 2)
- **-10** = NPHICH
- **-11** = NPDCCH
- **-12** = NPCH

<channel type>

- **0** = TX channel
- **1** = adjacent channel
- **2** = alternate channel

<modulation>

Represents the modulation scheme.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **7** = mixed modulation
- **8** = BPSK

FORMat[:DATA]....61
TRACe[:DATA]?....62

FORMat[:DATA] <Format>

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

Note that the following result displays do not support the REAL32 format. The return values for those are always in ASCII format.

- Allocation summary

Parameters:
<Format> ASCii | REAL
*RST: ASCii

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

TRACe[:DATA]? <Result>

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

For more information see Chapter 7.6.1, "Using the TRACe[:DATA] Command", on page 55.

Query parameters:
TRACE1 | TRACE2 |
TRACE3

LIST

Usage: Query only

7.7 Remote Commands to Read Numeric Results

7.7.1 Result for Selection

FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]?

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

Suffix:
<cc> irrelevant

Return values:
<CrestFactor> <numeric value>
Crest Factor in dB.

Example: //Query crest factor
`FETC:SUMM:CRES?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:EVM[:ALL]:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM[:ALL]:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Suffix:
<cc> irrelevant

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

Example: //Query EVM
`FETC:SUMM:EVM?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:EVM:PCHannel:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:PCHannel:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]?

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

Suffix:
<cc> irrelevant

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

Example: //Query EVM
`FETC:SUMM:EVM:PCH?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal:MAXimum?
FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal:MINimum?
FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]?

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

Suffix:
<cc> irrelevant

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

Example: //Query EVM
`FETC:SUMM:EVM:PSIG?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:FERRor:MAXimum?
FETCh[:CC<cc>]:SUMMary:FERRor:MINimum?
FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Suffix:
<cc> irrelevant

Return values:

<FreqError> <numeric value>

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

Default unit: Hz

Example: //Query average frequency error

```
FETC:SUMM:FERR?
```

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:OSTP:MAXimum?
FETCh[:CC<cc>]:SUMMary:OSTP:MINimum?
FETCh[:CC<cc>]:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Suffix:

<cc> irrelevant

Return values:

<OSTP> <numeric value>

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

Default unit: dBm

Example: //Query average OSTP

```
FETC:SUMM:OSTP?
```

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:POWer:MAXimum?
FETCh[:CC<cc>]:SUMMary:POWer:MINimum?
FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]?

This command queries the total power.

Suffix:

<cc> irrelevant

Return values:

<Power> <numeric value>

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

Default unit: dBm

Example: //Query average total power

```
FETC:SUMM:POW?
```

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:RSTP:MAXimum?
FETCh[:CC<cc>]:SUMMary:RSTP:MINimum?
FETCh[:CC<cc>]:SUMMary:RSTP[:AVERage]?

This command queries the RSTP.

Suffix:
<cc> irrelevant

Return values:
<RSTP> <numeric value>
Default unit: dBm

Example: //Query RSTP
`FETC:SUMM:RSTP?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:SERRor:MAXimum?
FETCh[:CC<cc>]:SUMMary:SERRor:MINimum?
FETCh[:CC<cc>]:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Suffix:
<cc> irrelevant

Return values:
<SamplingError> <numeric value>
Minimum, maximum or average sampling error, depending on the last command syntax element.
Default unit: ppm

Example: //Query average sampling error
`FETC:SUMM:SERR?`

Usage: Query only

Manual operation: See "Result Summary" on page 13

FETCh[:CC<cc>]:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the capture buffer.

Suffix:
<cc> irrelevant

Return values:

<Offset> Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: //Query subframe start offset
`FETC:SUMM:TFR?`

Usage: Query only

Manual operation: See "Capture Buffer" on page 15

7.7.2 Marker Table

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<m> Marker

<n> Window

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

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

The unit depends on the application of the command.

Suffix:

<m> Marker

<n> Window

Return values:

<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:
<m> Marker (query: 1 to 16)

<n> Window

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

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

Suffix:
<n> Window

<m> Marker

Return values:
<Result> Result at the marker position.

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

7.8 Remote Commands to Configure the Application

7.8.1 General Configuration

CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

Example: `CONF:PRES`
Presets the software.

Usage: Event

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example: `DISP:WIND2:SEL`
Selects screen B.

Usage: Event

FORMat[:DATA] <Format>

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

Note that the following result displays do not support the REAL32 format. The return values for those are always in ASCII format.

- Allocation summary

Parameters:
<Format> ASCii | REAL
*RST: ASCii

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

MMEMory:LOAD[:CC<cc>]:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type `.allocation` and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Suffix:
<cc> irrelevant

Setting parameters:
<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Setting parameters:
<Path> String containing the path and name of the source file.

Example: //Load IQ data
`MMEM:LOAD:IQ:STAT 'C:\R_S\Instr\user\data.iqw'`

Usage: Setting only

7.8.2 Configuring I/Q Measurements

7.8.2.1 Signal Characteristics

Physical Settings

CONFigure[:LTE]:DEPLoyment <Deployment>

This command selects the deployment of the NB-IoT carrier.

Parameters:

<Deployment>
INBand
NB-IoT uses resource blocks within an LTE carrier.
SALone
NB-IoT uses a frequency band outside of an LTE carrier.
*RST: SALone

Example:
//Select NB-IoT deployment
```
CONF:DEPL INB
```

Manual operation: See "Deployment" on page 27

CONFigure[:LTE]:EUTRa:FREQuency <Frequency>

This command defines the center frequency of an E-UTRA channel.

Prerequisites for this command

- Select in band deployment of an NB-IoT carrier (`CONFigure[:LTE]:DEPLoyment` on page 71).

Parameters:

<Frequency>
<numeric value>
Default unit: Hz

Example:
//Define E-UTRA channel center frequency
```
CONF:DEPL INB
CONF:EUTR:FREQ 1GHZ
```

Manual operation: See "Defining physical settings for NB-IoT in band deployment" on page 28

CONFigure[:LTE]:DL:PINDex <Index>

This command defines the PRB index of the E-UTRA channel.

Prerequisites for this command

- Select in band deployment of an NB-IoT carrier (`CONFigure[:LTE]:DEPLoyment` on page 71).

Parameters:

<Index> <numeric value> (integer only)

*RST: depends on the E-UTRA channel bandwidth

Example: //Define E-UTRA PRB index

```
CONF:DEPL INB
CONF:DL:BW BW10_00
CONF:DL:PIND 9
```

Manual operation: See "Defining physical settings for NB-IoT in band deployment" on page 28

CONFigure[:LTE]:DL:SINFo <Sequence>

This command defines the CRS sequence info of the E-UTRA channel.

Prerequisites for this command

- Select in band deployment of an NB-IoT carrier (`CONFigure[:LTE]:DEPLoyment` on page 71).

Parameters:

<Sequence> <numeric value> (integer only)

*RST: depends on the E-UTRA channel bandwidth

Example: //Define E-UTRA CRS sequence

```
CONF:DEPL INB
CONF:DL:BW BW10_00
CONF:DL:SINF 20
```

Manual operation: See "Defining physical settings for NB-IoT in band deployment" on page 28

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

This command selects the channel bandwidth.

Suffix:

<cc> irrelevant

Parameters:

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

*RST: BW10_00

Example: Single carrier measurement:
`CONF:DL:BW BW1_40`
Defines a channel bandwidth of 1.4 MHz.

Manual operation: See "Defining physical settings for NB-IoT in band deployment" on page 28

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

This command defines the cell ID.

Suffix:

<cc> irrelevant

Parameters:

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

<numeric value> (integer only)
Number of the cell ID.

Range: 0 to 503

Example: //Select cell ID
`CONF:DL:PLC:CID 15`

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

This command selects the cell ID group.

Suffix:

<cc> irrelevant

Parameters:

<GroupNumber> **AUTO**
Automatic selection

0...167 (integer only)
Manual selection

*RST: AUTO

Example: //Select cell identity group
`CONF:DL:PLC:CIDG 134`
//Turn on automatic cell identity group detection
`CONF:DL:PLC:CIDG AUTO`

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

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

Suffix:
<cc> irrelevant

Parameters:
<Identity> **AUTO**
Automatic selection
0...2 (integer only)
Manual selection
*RST: AUTO

Example: //Select physical layer cell identity
`CONF:DL:PLC:PLID 1`

FETCh[:CC<cc>]:PLC:CIDGroup?

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

Suffix:
<cc> irrelevant

Return values:
<CidGroup> The command returns -1 if no valid result has been detected yet.
Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

FETCh[:CC<cc>]:PLC:PLID?

This command queries the cell identity that has been detected.

Suffix:
<cc> irrelevant

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

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

Usage: Query only

[SENSe:]FREQuency:CENTer[:CC<cc>] <Frequency>

This command sets the center frequency for RF measurements.

Note that the [:CC<cc>] part of the syntax is not supported.

Suffix:
<cc> irrelevant

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: //Define frequency for measurement on one carrier:
```
FREQ:CENT 1GHZ
```

Manual operation: See "Defining the Signal Frequency" on page 27

MIMO Configuration

CONFigure[:LTE]:DL[:CC<cc>]:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Suffix:

<cc> irrelevant

Parameters:

<Antenna> **ANT1 | ANT2**
Select a single antenna to be analyzed

*RST: ANT1

Example: //Select a MIMO setup with two antennas and test antenna number two
```
CONF:DL:MIMO:CONF TX2
CONF:DL:MIMO:ASEL ANT2
```

Manual operation: See "MIMO Configuration" on page 31

CONFigure[:LTE]:DL[:CC<cc>]:MIMO:CONFig <Antennas>

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

Suffix:

<cc> irrelevant

Parameters:

<Antennas> **TX1**
Use one Tx-antenna

TX2
Use two Tx-antennas

*RST: TX1

Example: //Select MIMO configuration with two antennas
```
CONF:DL:MIMO:CONF TX2
```

Manual operation: See "MIMO Configuration" on page 31

Control Channel

CONFigure[:LTE]:DL[:CC<cc>]:PSOFfset <Offset>

This command defines the symbol offset for NPDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Suffix:
<cc> irrelevant

Parameters:
<Offset> **AUTO**
Automatically determines the symbol offset.

<numeric value>
Manual selection of the symbol offset.

Range: 0 to 4
*RST: AUTO

Example: //Define PRB symbol offset
`CONF:DL:PSOF 2`

Manual operation: See "PRB Symbol Offset" on page 38

7.8.2.2 Configuring the Input Level

CONFigure:POWer:EXPected:IQ<instrument> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:
<RefLevel> <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

Example: `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

Manual operation: See "Defining a Reference Level" on page 29

CONFigure:POWer:EXPected:RF<instrument> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel> *RST: -30 dBm
Default unit: DBM

Example: `CONF:POW:EXP:RF3 -20`
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

Manual operation: See "Defining a Reference Level" on page 29

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation> <numeric value>
*RST: 0
Default unit: dB

Example: `DISP:TRAC:Y:RLEV:OFFS 10`
Sets an external attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 29

INPut<n>:ATTenuation<instrument> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation> <numeric value>
*RST: 5 dB
Default unit: dB

Example: `INP:ATT 10`
Defines an RF attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 29

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 the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Suffix:

<n> Window

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example: `INP:EATT 10`

Defines an attenuation level of 10 dB.

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Suffix:

<n> Window

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`

Turns on the electronic attenuator.

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 the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Suffix:

<n> Window

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

[SENSe:]POWer:AUTO<instrument>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>

OFF
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection before each measurement.

ONCE
Performs an automatic reference level once.

*RST: ON

Example: `POW:AUTO2 ON`
Activate auto level for analyzer number 2.

Manual operation: See "Auto Level" on page 26
See "Defining a Reference Level" on page 29

[SENSe:]POWer:AUTO<instrument>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time> <numeric value>

*RST: 100 ms
Default unit: s

Example: `POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

Manual operation: See "Defining a Reference Level" on page 29

7.8.2.3 Signal Capture

Data Capture

[SENSe:][LTE:]FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: //Define number of frames to analyze manually
```
FRAM:COUN:STAT ON
FRAM:COUN:AUTO OFF
FRAM:COUN 20
```

Manual operation: See "Number of Frames to Analyze" on page 31

[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 analyzed number of frames according to the NB-IoT standard.

OFF
Turns on manual selection of the number of frames.

Example: //Turn on automatic selection of analyzed frames
```
FRAM:COUN:AUTO ON
```

Manual operation: See "Auto According to Standard" on page 31

[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 FSVA/FSV analyzes the frames captured in a single sweep.

*RST: ON

Example: //Turn on manual selection of number of frames
```
FRAM:COUN:STAT ON
```

Manual operation: See "Overall Frame Count" on page 30

[SENSe:]SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State>

ON | OFF | 1 | 0

*RST: OFF

Example: //Swap I and Q branches
```
SWAP ON
```

Manual operation: See "Swap I/Q" on page 32

[SENSe:]SWEep:TIME <CaptLength>

This command defines the capture time.

When you are performing an ACLR measurement, the command defines the sweep time. (Note that you have to select the ACLR measurement first, before defining a sweep time - otherwise, the command defines the capture time for I/Q measurements.)

Parameters:

<CaptLength> <numeric value>

*RST: 20.1 ms
Default unit: s

Example: //Define capture time
`SWE:TIME 40ms`

Manual operation: See "Capture Time" on page 30

7.8.2.4 Advanced Settings

Controlling I/Q Data

[SENSe:]SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Swap I and Q branches
`SWAP ON`

Manual operation: See "Swap I/Q" on page 32

Controlling the Input

For information on the remote commands for reference level and attenuation settings see Chapter 7.8.2.2, "Configuring the Input Level", on page 76.

INPut:SELect <Source>

This command selects the signal source.

Parameters:

<Source>

RF
Selects the RF input as the signal source.

AIQ
Selects the analog baseband input as the data source. This source is available only with option R&S FSVA/FSV-B71.

DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSVA/FSV-B17.

Example: `INP DIQ`
Selects the digital baseband input.

Manual operation: See "Selecting the Input Source" on page 33

INPut<n>:FILTer:YIG:AUTO <State>

This command turns automatic control of the YIG filter on and off.

Parameters:

<State>

ON | OFF

*RST: ON

Example: `INP:FILT:YIG:AUTO ON`
Activates automatic control of the YIG filter.

Manual operation: See "Yig Filter" on page 33

INPut<n>:FILTer:YIG[:STATe] <State>

This command removes or adds the YIG filter from the signal path.

If you remove the filter, you can use the maximum bandwidth, but image frequency rejection is no longer ensured.

Parameters:

<State>

ON | OFF

*RST: ON

Example: `INP:FILT:YIG OFF`
Removes the YIG filter from the signal path.

Manual operation: See "Yig Filter" on page 33

TRACe:IQ:FILTer:FLATness <FilterType>

This command turns the wideband filter on and off.

Parameters:

<FilterType>

NORMal
Uses the normal filter.

WIDE
Turns the wideband filter on.

*RST: NORMal

Example: `TRAC:IQ:FILT:FLAT WIDE`
Turns the wideband filter on.

Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate>

*RST: 10 MHz
Default unit: Hz

Example: `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

Manual operation: See "Sampling Rate (Input Data Rate)" on page 34

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:

<ScaleLevel>

*RST: 1 V
Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

Manual operation: See "Full Scale Level" on page 34

7.8.2.5 Trigger Configuration

The trigger functionality of the NB-IoT measurement application is the same as that of the R&S FSVA/FSV.

For a comprehensive description of the available remote control commands for trigger configuration, see the documentation of the R&S FSVA/FSV.

TRIGger[:SEQuence]:HOLDoff<in> <Offset>

This command defines the trigger offset.

Parameters:

<Offset> <numeric value>

*RST: 0 s
Default unit: s

Example: //Define trigger offset
`TRIG:HOLD 5MS`

TRIGger[:SEQuence]:IFPower:HOLDoff <Offset>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

Parameters:

<Offset> Range: 150 ns to 10 s
*RST: 150 ns
Default unit: s

Example: `TRIG:IFP:HOLD 1`
Defines a holdoff of 1 second.

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis.

Parameters:

<Hysteresis> Range: 3 to 50
*RST: 3
Default unit: dB

Example: `TRIG:IFP:HYST 10`
Defines a trigger hysteresis of 10 dB.

TRIGger[:SEQuence]:LEVel<in>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level> Default unit: DBM

Example: `TRIG:LEV:POW 10`
Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:

<Source>

EXTernal
Selects external trigger source.

IFPower
Selects the IF power trigger source.

IMMediate
Selects free run trigger source.

PSEN
Selects power sensor trigger source.

RFPower
Selects RF power trigger source.

*RST: IMMediate

Example:

```
TRIG:MODE EXT
```

Selects an external trigger source.

7.8.2.6 Demodulation

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

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State>

ON | OFF | 1 | 0

*RST: OFF

Example:

//Turn on interference suppression

```
DL:DEM:MCF ON
```

Manual operation: See "Multicarrier Filter" on page 37

[SENSe:][LTE:]DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method.

Parameters:

<Calculation>

TGPP
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: //Select EVM calculation method
`DL:DEM:EVMC TGPP`

Manual operation: See "EVM Calculation Method" on page 36

[SENSe:][LTE:]DL:DEMod:PRData <Reference>

This command selects the type of reference data to calculate the EVM for the NPDSCH.

Parameters:

<Reference>
AUTO
Automatic identification of reference data.

ALL0
Reference data is 0, according to the test model definition.

Example: //Select reference data for NPDSCH demodulation
`DL:DEM:PRD ALL0`

Manual operation: See "NPDSCH Reference Data" on page 37

7.8.2.7 Parameter Estimation

Estimating Parameters

[SENSe:][LTE:]DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type>
PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

TGPP
3GPP EVM definition

*RST: TGPP

Example: //Select channel estimation type
`DL:DEM:CEST TGPP`

Manual operation: See "Channel Estimation" on page 38

Compensating Measurement Errors

[SENSe:][LTE:]DL:TRACking:PHASe <Type>

This command selects the phase tracking type.

Parameters:

<Type>
OFF
Deactivate phase tracking
PIL
Pilot only
PILP
Pilot and payload
*RST: OFF

Example: //Select phase tracking type
`DL:TRAC:PHAS PILPAY`

Manual operation: See "Phase" on page 37

[SENSe:][LTE:]DL:TRACking:TIME <State>

This command turns timing tracking on and off.

Parameters:

<State>
ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on timing tracking
`DL:TRAC:TIME ON`

Manual operation: See "Timing" on page 38

7.9 Measurement Result Analysis

7.9.1 Selecting Displayed Data

[SENSe:][LTE:][CC<cc>:]ALLocation:SELect <Allocation>

This command filters the displayed results in the constellation diagram by a particular type of allocation.

Suffix:
<cc> irrelevant

Parameters:
<Allocation> **ALL**
Shows the results for all allocations.

<numeric_value>
Shows the results for a single allocation type.
Allocation types are mapped to numeric values. For the code assignment, see Chapter 7.6.1.13, "Return Value Codes", on page 61.

*RST: ALL

Example: //Display results for allocation 2
```
ALL:SEL 2
```

Manual operation: See "Evaluation range for the constellation diagram" on page 41

[SENSe:][LTE:][CC<cc>:]CARRier:SELect <Carrier>

This command filters the displayed results in the constellation diagram by a particular subcarrier.

Suffix:
<cc> irrelevant

Parameters:
<Carrier> **ALL**
Shows the results for all subcarriers.

<numeric_value>
Shows the results for a single subcarrier.

*RST: ALL

Example: //Display results for subcarrier 1
```
CARR:SEL 1
```

Manual operation: See "Evaluation range for the constellation diagram" on page 41

[SENSe:][LTE:][CC<cc>:]MODulation:SELect <Modulation>

This command filters the displayed results in the constellation diagram by a particular type of modulation.

Suffix:
<cc> irrelevant

Parameters:

<Modulation>

ALL
Shows the results for all modulation types.

<numeric_value>
Shows the results for a single modulation type.
Modulation types are mapped to numeric values. For the code assignment, see Chapter 7.6.1.13, "Return Value Codes", on page 61.

*RST: ALL

Example:
//Display results for all elements with a QPSK modulation
```
MOD:SEL 2
```

Manual operation: See "Evaluation range for the constellation diagram" on page 41

[SENSe:][LTE:][CC<cc>:]SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Suffix:

<cc> irrelevant

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example:
//Display results for all subframes
```
SUBF:SEL ALL
```

Manual operation: See "Subframe Selection" on page 39

[SENSe:][LTE:][CC<cc>:]SYMBol:SELect <Symbol>

This command filters the displayed results in the constellation diagram by a particular OFDM symbol.

Suffix:

<cc> irrelevant

Parameters:

<Symbol>

ALL
Shows the results for all subcarriers.

<numeric_value>
Shows the results for a single OFDM symbol.

*RST: ALL

Example:
//Display result for OFDM symbol 2
```
SYMB:SEL 2
```

Manual operation: See "Evaluation range for the constellation diagram" on page 41

7.9.2 Selecting Units

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: //Display EVM results in %
`UNIT:EVM PCT`

Manual operation: See "EVM Unit" on page 40

7.9.3 Using Markers

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Suffix:

<m> 1

Example: `CALC:MARK:AOFF`
Turns off all markers.

Usage: Event

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:

<m> 1..n

Example: CALC:MARK2:MAX
Positions marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a marker on the minimum value of the trace.

Suffix:
<m> 1..n

Example: CALC:MARK:MIN
Positions marker 1 on the trace minimum.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off.

Suffix:
<m> 1

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

Example: CALC:MARK3 ON
Turns on marker 3.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command positions the marker on a particular trace.

If necessary, the command turns on the marker first.

Suffix:
<m> 1

Parameters:
<Trace> 1 | 2 | 3
Number of the trace you want the marker positioned on.

CALCulate<n>:MARKer<m>:X <Position>

This command positions a marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the marker.

Suffix:
<m> 1

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Default unit: The unit depends on the result display.

Example: `CALC:MARK:X 1GHZ`

Moves the marker to the frequency of 1 GHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

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

Suffix:

<m> 1

Example: `INIT:CONT OFF`

Switches to single measurement mode.

`CALC:MARK2 ON`

Switches marker 2.

`INIT;*WAI`

Starts a measurement and waits for the end.

`CALC:MARK2:Y?`

Outputs the measured value of marker 2.

Usage: Query only

7.9.4 Using Delta Markers

CALCulate<n>:DELTamarker<m>:AOFF

This command turns all delta markers off.

Suffix:

<m> 1

Example: `CALC:DELT:AOFF`

Turns off all delta markers.

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:
<m> 1..n

Example: CALC:DELT2:MAX
Positions delta marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a delta marker on the minimum value of the trace.

Suffix:
<m> 1..n

Example: CALC:DELT2:MIN
Positions delta marker 2 on the trace minimum.

Usage: Event

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

Suffix:
<m> 1

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

Example: CALC:DELT3 ON
Turns on delta marker 3.

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command positions a delta marker on a particular trace.

Suffix:
<m> 1

Parameters:
<Trace> 1 | 2 | 3
Number of the trace you want the delta marker positioned on.

CALCulate<n>:DELTamarker<m>:X <Position>

This command positions a delta marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the delta marker.

Suffix:
<m> 1

Parameters:
<Position> Numeric value that defines the delta marker position on the x-axis.
Default unit: The unit depends on the result display.

Example: `CALC:DELT2:X 1GHZ`
Positions delta marker 2 on the frequency of 1 GHz.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

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

Suffix:
<m> 1

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:DELT2 ON`
Turns on delta marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Queries the measurement result at the position of delta marker 2.

Usage: Query only

7.9.5 Scaling the Vertical Diagram Axis

Programming example to scale the y-axis

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSY'
//Refresh the measurement results based on the contents of the capture buffer
INIT:IMM
//Select screen B.
DISP:WIND2:SEL
//Select dB as the EVM unit.
UNIT:EVM DB
//Define the point of origin of 5 dB on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:OFFS 5
```

```
//Define the distance of 10 dB between two grid lines on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:PERD 10
```


DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO

This command automatically adjusts the scale of the y-axis to the current measurement results.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Example: `DISP:TRAC:Y:SCAL:AUTO`
Scales the y-axis of the selected result display.

Usage: Event

Manual operation: See "Y-Axis Scale" on page 41

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet <Origin>

This command defines the point of origin of the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:
<Origin> Point of origin of the y-axis.
The unit depends on the result display you want to scale.

Example: See Chapter 7.9, "Measurement Result Analysis", on page 87.

Manual operation: See "Y-Axis Scale" on page 41

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv <Distance>

This command defines the distance between two grid lines on the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:
<Distance> The unit depends on the result display you want to scale.

Example: See Chapter 7.9, "Measurement Result Analysis", on page 87.

Manual operation: See "Y-Axis Scale" on page 41

List of Commands

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