R&S®VSE-K106
LTE NB-IoT Measurement Application (Uplink)
User Manual

1178423002
Version 09

ROHDE&SCHWARZ
Make ideas real

This manual applies to the following software, version 2.31 and later:

- R&S®VSE Enterprise Edition base software (1345.1105.06)
- R&S®VSE Basic Edition base software (1345.1011.06)

The following firmware options are described:

- R&S®VSE-K106 LTE NB-IoT Uplink Measurement Application (1320.7900.02)
- R&S®VSE-KT106 LTE NB-IoT Downlink Measurement Application (1345.1757.02)
- R&S®VSE-KP106 LTE NB-IoT Downlink Measurement Application (1345.2553.02)

Muehldorfstr. 15, 81671 Muenchen, Germany
Phone: +49 89 41 29 - 0
Email: info@rohde-schwarz.com
Internet: www.rohde-schwarz.com

1178.4230.02 | Version 09 | R&S®VSE-K106

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

Contents

1 Documentation Overview

This section provides an overview of the R&S VSE user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/VSE

Further documents are available at:

www.rohde-schwarz.com/product/VSE

1.1 User Manuals and Help

Separate user manuals are provided for the base software and additional software applications:

- Base software manual
  Contains the description of the graphical user interface, an introduction to remote control, the description of all remote control commands, programming examples, and information on maintenance, software interfaces and error messages.
- Software application manuals
  Contain the description of the specific functions of a software application, including the remote control commands. Basic information on operating the R&S VSE is not included.

The contents of the user manuals are available as help in the R&S VSE. The help offers quick, context-sensitive access to the complete information for the base software and the software applications.

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

1.2 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S VSE. 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/VSE

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

See www.rohde-schwarz.com/software/VSE

1.4 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/vse/

1.5 Videos

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

2 Welcome to the LTE NB-IoT measurement application

The LTE NB-IoT measurement application is a firmware application that adds functionality to perform measurements on LTE NB-IoT signals according to the 3GPP standard to the R&S VSE.

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

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

2.1 Starting the LTE NB-IoT measurement application

The LTE NB-IoT measurement application adds a new application to the R&S VSE.

To open the LTE NB-IoT application

1. 

   Select the "Add Channel" function in the Sequence tool window.

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

2. Select the "NB-IoT" item.

   The R&S VSE opens a new measurement channel for the NB-IoT application.

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

For more information see Chapter 4, "Configuration", on page 27.

2.2 Understanding the display information

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

1 = Window title bar with information about the diagram and its traces
2 = Channel bar with measurement settings
3 = Diagram area
4 = Diagram footer with information about the contents of the diagram
5 = Color code for windows of the same channel (here: yellow)

Channel bar information

In the LTE NB-IoT measurement application, the R&S VSE shows the following settings:

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

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Offset	Reference level offset
Freq	Center frequency
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
Slot Count	Number of slots that have been captured

NPUSCH	NPUSCH considered in the signal analysis
Slot	Slot considered in the signal analysis

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

Window title bar information

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

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

Status bar information

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

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

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

3 Measurements and result displays

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

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

3.1 Selecting measurements

Access: "Overview" > "Select Measurement"

The "Select Measurement" dialog box contains several buttons. Each button represents a measurement. A measurement in turn is a set of result displays that thematically belong together and that have a particular display configuration. If these predefined display configurations do not suit your requirements, you can add or remove result displays as you like. For more information about selecting result displays, see Chapter 3.2, "Selecting result displays", on page 11.

Depending on the measurement, the R&S VSE changes the way it captures and processes the raw signal data.

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

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

For more information on the result displays, see Chapter 3.4, "I/Q measurements", on page 12.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 105

Channel power ACLR
ACLR measurements process captured the I/Q data.

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

For more information on the result displays, see Chapter 3.5, "Frequency sweep measurements", on page 23.

Remote command:
CONFigure[:LTE]:MEASurement on page 105

SEM
SEM measurements process captured the I/Q data.

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

For more information on the result displays, see Chapter 3.5, "Frequency sweep measurements", on page 23.

Remote command:
CONFigure[:LTE]:MEASurement on page 105

3.2 Selecting result displays

Access: **or** "Window" > "New Window"

The R&S VSE opens a menu to select result displays. Depending on the number of LTE channels you are currently using, there is a submenu that contains all available result displays for each LTE channel.

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

- Capture Buffer
- Power vs Symbol X Carrier
- Constellation Diagram
- Power Spectrum
- Result Summary

From that predefined state, add and remove result displays to the channels as you like from the "Window" menu.

Remote command: LAYout:ADD[:WINDow]? on page 76

3.3 Performing measurements

By default, the application measures the signal continuously. In "Continuous Sweep" mode, the R&S VSE captures and analyzes the data again and again.

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

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

Refreshing captured data

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

For more information, see the documentation of the R&S VSE.

3.4 I/Q measurements

Access: "Overview" > "Select Measurement" > "EVM/Frequency Err/Power"

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

Capture Buffer
The "Capture Buffer" shows the complete range of captured data for the last data capture.

The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time.

The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).

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

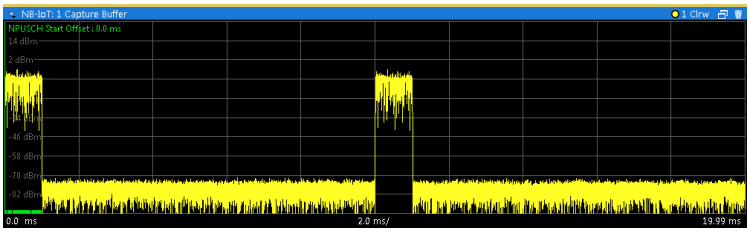


Figure 3-1: Capture buffer without zoom

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

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

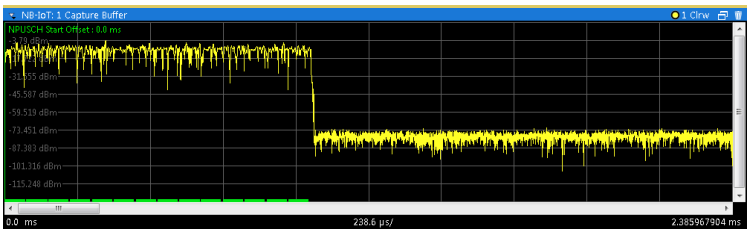


Figure 3-2: Capture buffer after a zoom has been applied

Remote command:
Selection: `LAY:ADD ? '1',LEFT,CBUF`
Query (y-axis): `TRACe:DATA?`
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

EVM vs Carrier

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

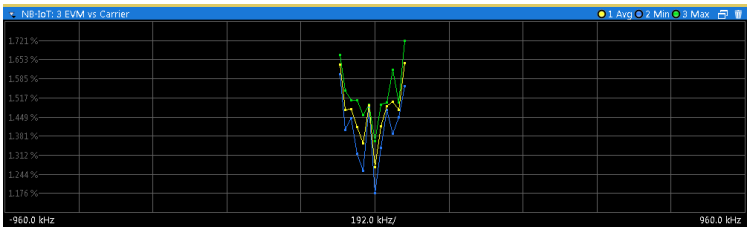
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

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

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

If you select and analyze one slot only, the result display contains one trace that shows the subcarrier EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information, see "Slot Selection" on page 61.

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



Remote command:
Selection `LAY:ADD ? '1',LEFT,EVCA`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

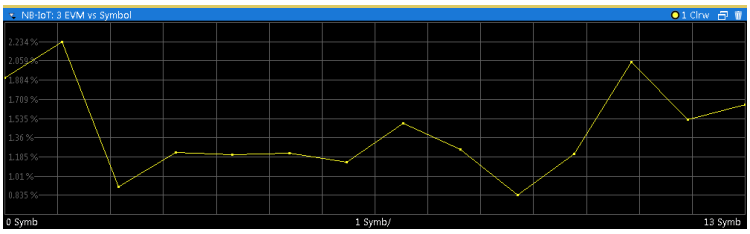
EVM vs Symbol
The "EVM vs Symbol" result display shows the error vector magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

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

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 VSE 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.

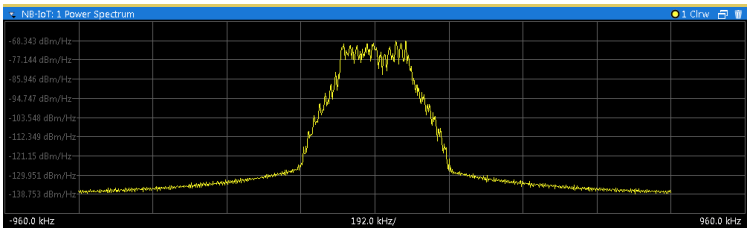


Remote command:
Selection: `LAY:ADD ? '1',LEFT,EVSY`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

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

The displayed bandwidth depends on the subcarrier spacing.

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



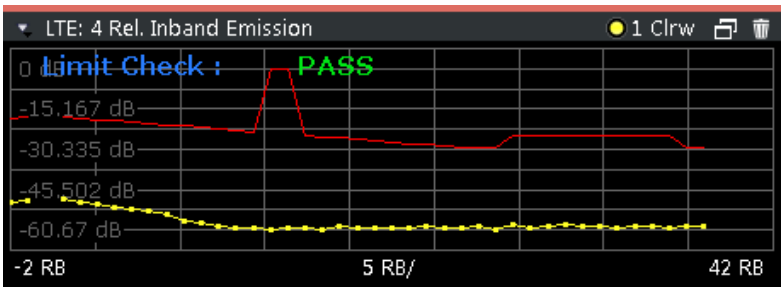
Remote command:
Selection: `LAY:ADD ? '1',LEFT,PSPE`
Query (y-axis): `TRACe:DATA?`
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

Inband Emission
The "Inband Emission" result display shows the power of the unused resource blocks relative to the allocated resource blocks (yellow trace). The diagram also shows the inband emission limit lines (red trace). The allocated resource blocks are not evaluated.

The x-axis represents the resource blocks. The numbering of the resource blocks is based on 3GPP 38.521 as a function of the resource block offset from the edge of the allocated uplink transmission bandwidth.

The y-axis shows the measured power for each resource block.

Because the measurement is evaluated over a single slot, you have to select a specific slot to get valid measurement results.

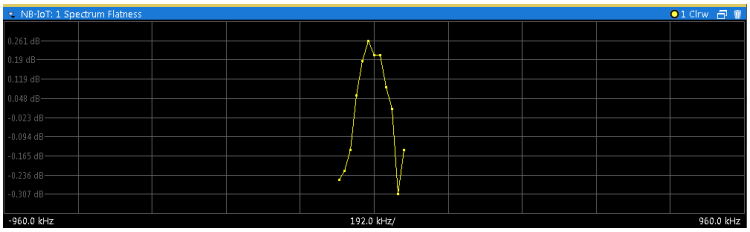


Remote command:
Selection: `LAY:ADD ? '1',LEFT,IEA`
Query (y-axis): `TRACe:DATA?`
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

Spectrum Flatness
The "Spectrum Flatness" result display shows the relative power offset caused by the transmit channel.

The measurement is evaluated over the currently selected slot.

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



Note that the limit lines are only displayed if you match the Operating Band to the center frequency. Limits are defined for each operating band in the standard.

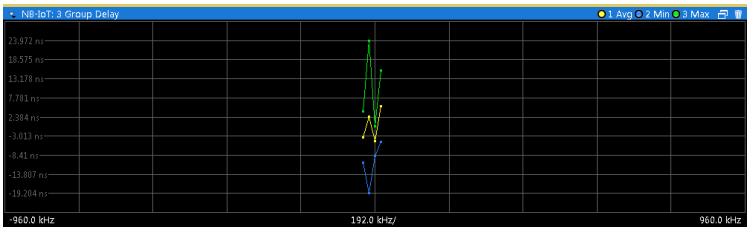
Remote command:
Selecting the result display: `LAY:ADD ? '1',LEFT,SFL`
Querying results:
TRACe:DATA?
`TRACe<n>[:DATA]:X?` on page 92

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

(Note that the evaluation is only possible for signals with 12 subcarriers. If you evaluate a signal with 1, 3 or 6 subcarriers, no results are displayed.)

The measurement is evaluated over the currently selected slot.

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

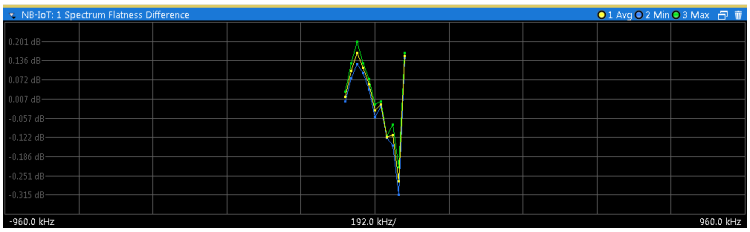


Remote command:
Selection: `LAY:ADD ? '1',LEFT,GDEL`
Query (y-axis): TRACe:DATA?
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

Spectrum Flatness Difference
The "Spectrum Flatness Difference" result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot.

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



Remote command:
Selection: `LAY:ADD ? '1',LEFT,SFD`
Query (y-axis): `TRACe:DATA?`
Query (x-axis): `TRACe<n>[:DATA]:X?` on page 92

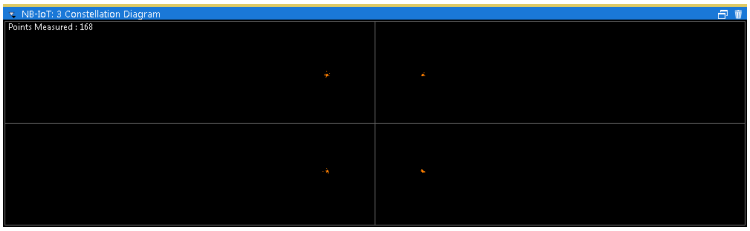
Constellation Diagram
The "Constellation Diagram" shows the in-phase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

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

Each color represents a modulation type.

- : BPSK
- : RBPSK
- : MIXTURE
- : QPSK
- : PSK (CAZAC)

You can filter the results by changing the evaluation range.

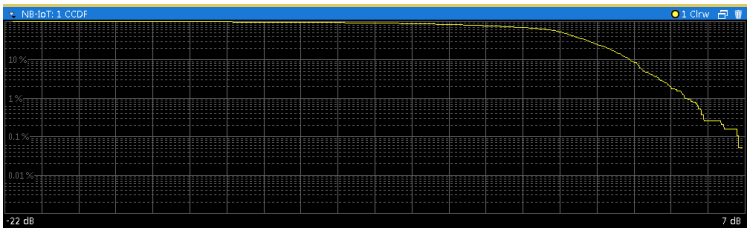


The constellation diagram also contains information about the current evaluation range, including the number of points that are displayed in the diagram.

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

CCDF
The "Complementary Cumulative Distribution Function (CCDF)" shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

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



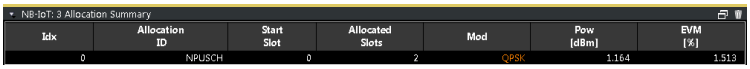
In addition to the diagram, the results for the CCDF measurement are summarized in the CCDF table.

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

Remote command:
Selection: `LAY:ADD ? '1',LEFT,CCDF`
Query (y-axis): TRACe:DATA?
Numerical results: `CALCulate<n>:STATistics:CCDF:X<t>?` on page 103
Numerical results: `CALCulate<n>:STATistics:RESult<res>?` on page 103

Allocation Summary

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



The columns of the table show the following properties for each allocation.

- An index number of the allocation.
- The ID of the allocation (channel type).
- The number of the first slot used by the allocation.
- The number of slots used by the allocation.
- The modulation of the allocation.
- The power of the allocation in dBm.
- The EVM of the allocation.
  The unit depends on the EVM unit

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

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

Bitstream

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

At the end of the table is a summary of the bitstream for certain configurations.

- Total number of bits or symbols
- Total number of coded bits
- Total number of bit errors
- Bit error rate (BER) in percent
- Bits per second (= coded bits - bit errors)

The totals are calculated over all NPUSCH allocations that contribute to the bitstream. If the crc fails for one of the allocations, the R&S VSE returns NAN for the total numbers.

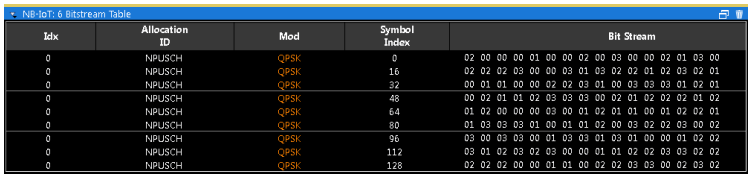
The bitstream summary is displayed under the following conditions.

- Select BER data source = "PN9".

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

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

Resource elements that do not contain data or are not part of the transmission are represented by a "-".



The table contains the following information:

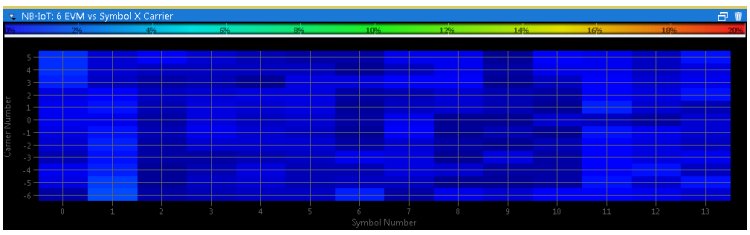
- **Idx**
  Index number of the allocation.
- **Allocation ID**
  Channel the bits belong to.
- **Modulation**
  Modulation type of the channels.
- **Symbol Index** or **Bit Index**
  Indicates the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

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

EVM vs Symbol x Carrier

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

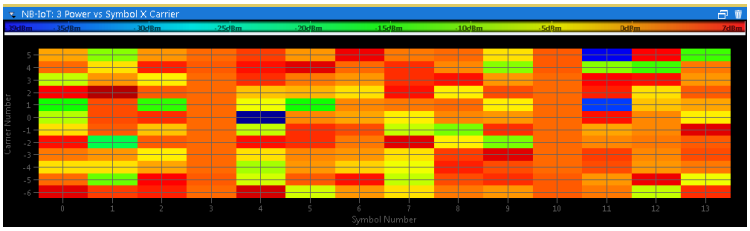
The x-axis represents the symbols. The y-axis represents the subcarriers. Different colors in the diagram area represent the EVM. A color map in the diagram header indicates the corresponding power levels.



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

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

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



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

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

Remote command:

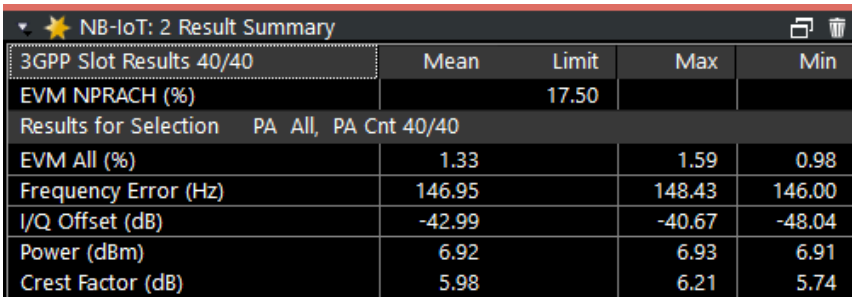
`LAY:ADD ? '1',LEFT,RSUM`

Contents of the result summary

The contents of the result summary depend on the analysis mode you have selected. The first screenshot shows the results for "NPUSCH/NPUCCH" analysis mode, the second one those for "NPRACH" analysis mode.

3GPP Slot Results 12/20	Mean	Limit	Max	Min
EVM NPUSCH BPSK (%)				
EVM NPUSCH QPSK (%)	1.63	17.50		
EVM NDMRS NPUSCH BPSK (%)				
EVM NDMRS NPUSCH QPSK (%)	1.37	17.50		
Frequency Error (Hz)	146.78			
Results for Selection NPUSCH All, Slots All				
EVM All (%)	1.47		1.48	1.47
EVM Phys Channel (%)	1.51		1.51	1.51
EVM Phys Signal (%)	1.22		1.23	1.21
Frequency Error (Hz)	146.78		148.12	145.43
Sampling Error (ppm)				
IQ Offset (dB)	-55.46		-55.30	-55.63
IQ Gain Imbalance (dB)	0.00		0.02	-0.02
IQ Quadrature Error (°)	-0.20		0.05	-0.46
Power (dBm)	1.16		1.17	1.16

Figure 3-3: Result summary in NPUSCH/NPUCCH analysis mode


NB-IoT: 2 Result Summary

3GPP Slot Results 40/40	Mean	Limit	Max	Min
EVM NPRACH (%)		17.50		
Results for Selection PA All, PA Cnt 40/40				
EVM All (%)	1.33		1.59	0.98
Frequency Error (Hz)	146.95		148.43	146.00
I/Q Offset (dB)	-42.99		-40.67	-48.04
Power (dBm)	6.92		6.93	6.91
Crest Factor (dB)	5.98		6.21	5.74

Figure 3-4: Result summary in NPRACH analysis mode

The table is split in two parts. The first part shows results that over a slot as defined by 3GPP. 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 (* 25.60) in front of failed results.

The second part of the table shows results that refer to a specific selection (NPUSCH and slot). The header row of the table contains information about the selection you have made (like the subframe).

Note: The EVM results on a frame level (first part of the table) are calculated as defined by 3GPP at the edges of the cyclic prefix.
The other EVM results (lower part of the table) are calculated at the optimal timing position in the middle of the cyclic prefix.

Because of inter-symbol interference, the EVM calculated at the edges of the cyclic prefix is higher than the EVM calculated in the middle of the cyclic prefix.

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

Note: When you measure a single carrier, Gain Imbalance and Quadrature Error are not calculated.

Table 3-1: Result summary: part containing results as defined by 3GPP (NPUSCH/NPUCCH analysis)

EVM NPUSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the NPUSCH channel in the analyzed frame. This EVM is calculated according to 3GPP. `FETCh[:CC<cc>]:SUMMary:EVM:UNSQ[:AVERage]?` on page 95
EVM NPUSCH BPSK	Shows the EVM for all BPSK-modulated resource elements of the NPUSCH channel in the analyzed frame. This EVM is calculated according to 3GPP. `FETCh[:CC<cc>]:SUMMary:EVM:UNSB[:AVERage]?` on page 95
EVM NDRMS NPUSCH QPSK	Shows the EVM of all NDMRS resource elements with QPSK modulation of the NPUSCH in the analyzed frame. This EVM is calculated according to 3GPP. `FETCh[:CC<cc>]:SUMMary:EVM:UNDQ[:AVERage]?` on page 94

EVM NDRMS NPUSCH BPSK
Shows the EVM of all NDMRS resource elements with BPSK modulation of the NPUSCH in the analyzed frame. This EVM is calculated according to 3GPP.
FETCh[:CC<cc>]:SUMMary:EVM:UNDB[:AVERage]? on page 94

Frequency Error (3GPP)
Shows the frequency error as defined by 3GPP.
FETCh[:CC<cc>]:SUMMary:FE3G[:AVERage]? on page 97

Table 3-2: Result summary: part containing results as defined by 3GPP (NPRACH analysis)

EVM NPRACH
Shows the EVM of all resource elements of the NPRACH channel in the analyzed frame.
FETCh[:CC<cc>]:SUMMary:EVM:UNPR[:AVERage]? on page 94

Table 3-3: Result summary: part containing results for a specific selection

EVM All
Shows the EVM for all resource elements in the analyzed frame.
FETCh[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]? on page 96

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. NPUSCH and NPUCCH are physical channels. For more information, see 3GPP 36.211.
FETCh[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]? on page 96
("NPUSCH/NPUCCH" analysis mode only.)

EVM Phys Signal
Shows the EVM for all physical signal resource elements in the analyzed frame.
The reference signal is a physical signal. For more information, see 3GPP 36.211.
FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]? on page 97
("NPUSCH/NPUCCH" analysis mode only.)

Frequency Error
Shows the difference in the measured center frequency and the reference center frequency.
FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]? on page 98

I/Q Offset
Shows the power at spectral line 0 normalized to the total transmitted power.
FETCh[:CC<cc>]:SUMMary:IQOFfset[:AVERage]? on page 98

I/Q Gain Imbalance
Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
FETCh[:CC<cc>]:SUMMary:GIMBalance[:AVERage]? on page 98
("NPUSCH/NPUCCH" analysis mode only.)

I/Q Quadrature Error
Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
FETCh[:CC<cc>]:SUMMary:QUADerror[:AVERage]? on page 99
("NPUSCH/NPUCCH" analysis mode only.)

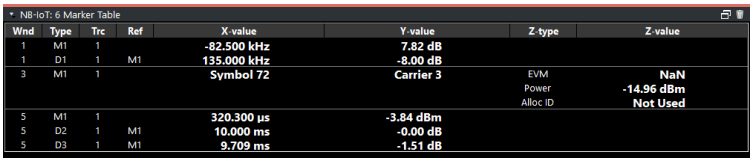
Power
Shows the average time domain power of the allocated resource blocks of the analyzed signal.
FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]? on page 99

Crest Factor
Shows the peak-to-average power ratio of captured signal.
FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]? on page 96

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

This table is displayed automatically if configured accordingly.

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



Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 76
Results:
`CALCulate<n>:MARKer<m>:X` on page 101
`CALCulate<n>:MARKer<m>:Y` on page 101
`CALCulate<n>:MARKer<m>:Z?` on page 102
`CALCulate<n>:MARKer<m>:Z:ALL?` on page 102

3.5 Frequency sweep measurements

Access (ACLR): "Meas Setup" > "Select Measurement" > "Channel Power ACLR"

Access (SEM): "Meas Setup" > "Select Measurement" > "Spectrum Emission Mask"

The NB-IoT aplication supports the following frequency sweep measurements.

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

Frequency sweep measurements also capture and process I/Q data to analyze a signal.

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

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

- "Marker Table" on page 23
- Marker peak list
  Both result displays have the same contents as the spectrum application.

Adjacent Channel Leakage Ratio (ACLR)
The adjacent channel leakage ratio (ACLR) measurement is designed to analyze signals that contain multiple signals for different radio standards. Using the ACLR measurement, you can determine the power of the transmit (Tx) channel and the power of the neighboring (adjacent) channels to the left and right of the Tx channel. Thus, the ACLR measurement provides information about the power in the adjacent channels as well as the leakage into these adjacent channels.

When you measure the ACLR in the NB-IoT application, the R&S VSE automatically selects appropriate ACLR settings based on the selected channel bandwidth.

For a comprehensive description of the ACLR measurement, refer to the user manual of the R&S VSE.

Remote command:
Selection: `CONF:MEAS ACLR`

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

In addition, the R&S VSE highlights the channels (blue: Tx channel, green: adjacent channels).

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

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

In addition, the R&S VSE tests the ACLR measurement results against the limits defined by 3GPP.

Remote command:
Result query: TRACe:DATA?

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

- **Channel**
  Shows the channel type (Tx, adjacent or alternate channel).
- **Bandwidth**
  Shows the channel bandwidth.
- **Offset**
  Shows the channel spacing.
- **Power**
  Shows the power of the Tx channel.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels. The values turn red if the power violates the limits.

Remote command:
Result query: `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]?`

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

For a comprehensive description of the SEM measurement, refer to the user manual of the R&S VSE.

Remote command:
Selection: `CONF:MEAS ESP`

Result diagram ← Spectrum Emission Mask (SEM)
The result diagram is a graphic representation of the signal with a trace that shows the measured signal. The SEM is represented by a red line.

If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test passes. The application labels the limit line to indicate whether the limit check has passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified NB-IoT channel bandwidths. The y-axis shows the signal power in dBm.

Remote command:
Result query: TRACe:DATA?

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

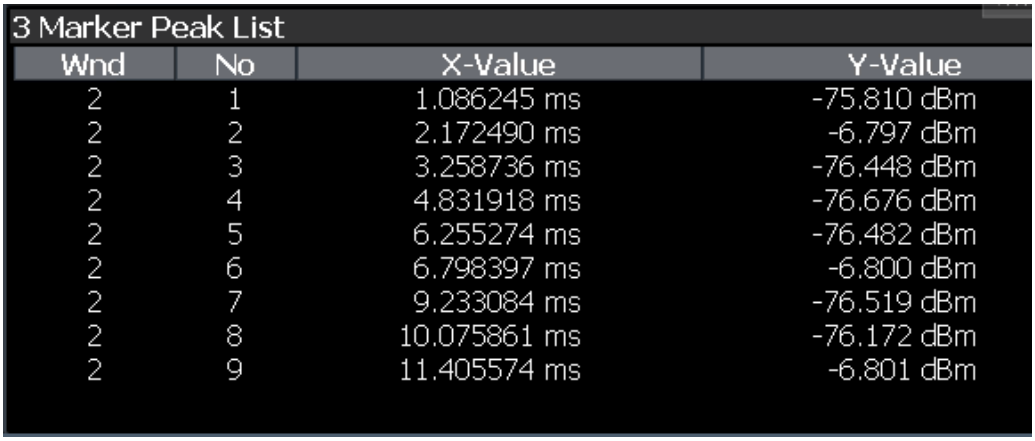
- **Start / Stop Freq Rel**

Shows the start and stop frequency of each section of the spectrum emission mask relative to the center frequency.

- **RBW**
  Shows the resolution bandwidth of each section of the spectrum emission mask.
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate that the trace is below the tolerance limit, positive distances indicate that the trace is above the tolerance limit.

Marker Peak List

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



Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 76
Results:
`CALCulate<n>:MARKer<m>:X` on page 101
`CALCulate<n>:MARKer<m>:Y` on page 101

4 Configuration

LTE NB-IoT measurements require a special application on the R&S VSE, which you can select by adding a new measurement channel or replacing an existing one.

For more information on controlling measurement applications, refer to the documentation of the R&S VSE base software.

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

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

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

Unavailable menus

Note that the "Trace" and "Lines" menus have no contents and no function in the LTE NB-IoT application.

4.1 Configuration overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" menu item from the "Meas Setup" menu.

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

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

1. Signal Description
   See Chapter 4.2.1, "Defining signal characteristics", on page 30.
2. Input / Frontend
   See Chapter 4.2.8, "Selecting the input and output source", on page 41.
3. Trigger / Signal Capture
   See Chapter 4.2.11, "Trigger configuration", on page 50.
   See Chapter 4.2.12, "Configuring the data capture", on page 52
4. Tracking
   n/a
5. Demodulation
   See Chapter 4.2.13, "Signal demodulation", on page 53.
6. Evaluation Range
   See Chapter 5.2.2, "Evaluation range", on page 61.
7. Analysis
   See Chapter 5, "Analysis", on page 57.
8. Display Configuration
   See Chapter 3, "Measurements and result displays", on page 10.

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

To configure settings

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 105

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

For more information about selecting measurements, see Chapter 3.1, "Selecting measurements", on page 10.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 105

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

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

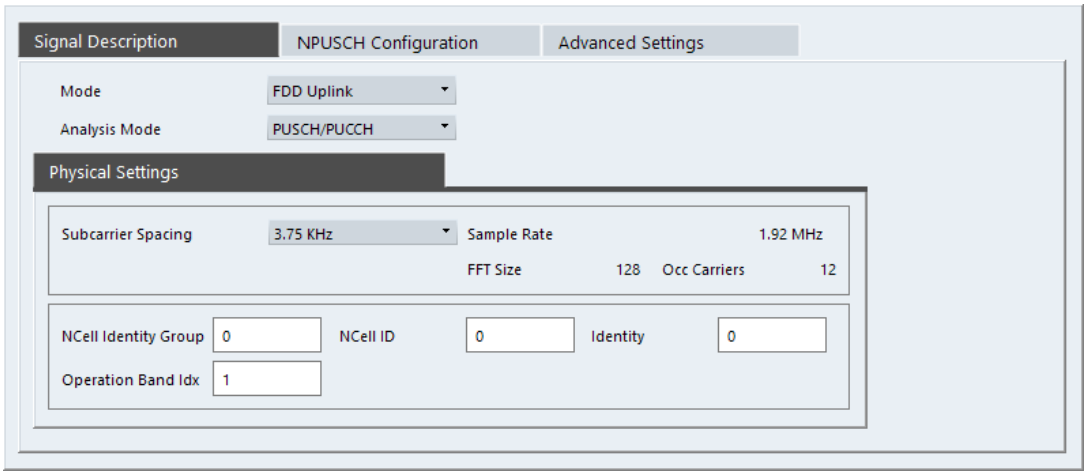
The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

4.2 Configuring I/Q measurements

4.2.1 Defining signal characteristics

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

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



Selecting the 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.
- Uplink is the transmission path from the user equipment to the base station.
  The physical layer mode for the uplink is single-tone operation, optional multitone operation, using SC-FDMA.

Remote command:
Link direction: `CONFigure[:LTE]:LDIRection` on page 106

Analysis Mode
Selects the channel analysis mode.

You can select from "NPUSCH/NPUCCH" mode and "NPRACH" mode.

"NPUSCH/NPUCCH" mode analyzes the NPUSCH and NPUCCH (default mode).

"NPRACH" mode analyzes the NPRACH only. In NPRACH analysis mode, no sub-frame or slot selection is available. Instead you can select a particular preamble that the results are shown for. Note that NPRACH analysis mode does not support all result displays.

Note that the subcarrier spacing is fixed to 3.75 kHz when you analyze the NPRACH, because the NPRACH always has that bandwidth.

Remote command:
`[SENSe:][LTE:]UL:DEMod:MODE` on page 108

Subcarrier Spacing
Selects the bandwidth of the subcarriers in the signal you are measuring.

The total system bandwidth (carrier) in both cases is 180 kHz.

According to 3GPP, each subcarrier is either 15 kHz or 3.75 kHz wide.

The application also calculates the sampling rate from the subcarrier bandwidth. Those are read only.

Remote command:
`CONFigure[:LTE]:UL:SSPacing` on page 107

Configuring the Physical Layer Cell Identity
The "NCell ID", "NCell Identity Group" and physical layer "Identity" are interdependent parameters. In combination, they are responsible for synchronization between network and user equipment.

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

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

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

there is a total of 504 different cell IDs.

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

The cell ID determines:
- The reference signal grouping hopping pattern
- The NPUSCH demodulation reference signal pseudo-random sequence
- The pseudo-random sequence used for scrambling

Remote command:
Cell ID: `CONFigure[:LTE]:UL[:CC<cc>]:PLC:CID` on page 107
Cell Identity Group: `CONFigure[:LTE]:UL[:CC<cc>]:PLC:CIDGroup` on page 107
Identity: `CONFigure[:LTE]:UL[:CC<cc>]:PLC:PLID` on page 108

Operating Band Index
Selects one of the 40 operating bands for spectrum flatness measurements as defined in TS 36.101.

The operating band defines the frequency band and the dedicated duplex mode.

Remote command:
`[SENSe:][LTE:][CC<cc>:]SFLatness:OBANd` on page 108

4.2.2 Test scenarios

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

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

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

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

Remote command:
Save: `MMEMory:STORe<n>[:CC<cc>]:DEModsetting` on page 109
Restore: `MMEMory:LOAD[:CC<cc>]:DEModsetting` on page 108

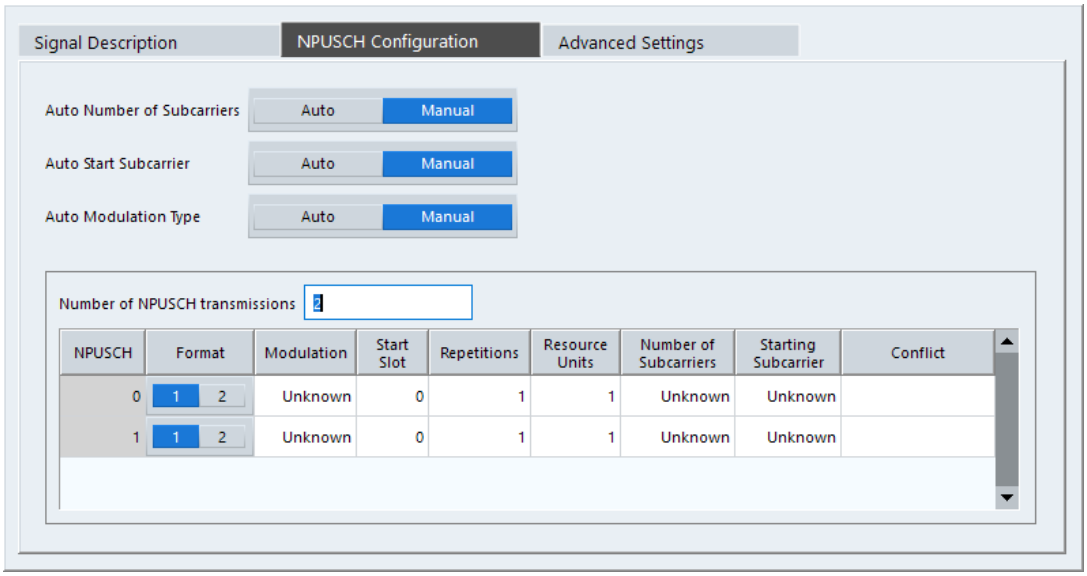
4.2.3 Configuring the NPUSCH

Access: "Overview" > "Signal Description" > "NPUSCH Configuration"

Each LTE NB-IoT uplink slot is represented by a resource grid, which in turn consists of several resource elements. The size of the resource grid depends on the number of subcarriers and thus the subcarrier spacing. Each resource element can be mapped to one of the physical channels.

The NPUSCH (Narrowband Physical Uplink Shared Channel) primarily carries user data. Each slot can carry one or more NPUSCHs, whose size and usage depends on your configuration. A group of resource elements mapped to a specific NPUSCH is called resource unit. Resource units are a group of consecutive subcarriers (frequency domain) and SC-FDMA symbols (time domain). The number of resource elements forming a resource unit depends on the subcarrier spacing and the NPUSCH format.

The configuration for each NPUSCH in the system is shown in the "NPUSCH Configuration Table".



4.2.3.1 General NPUSCH configuration

Automatic detection of NPUSCH characteristics
The application provides functionality that allows you to detect several NPUSCH characteristics automatically, instead of defining them manually.

- "Auto Number Of Subcarriers"
  Automatically detects the number of subcarriers that the corresponding NPUSCH occupies.
  For "Manual" definition, you can define the number of subcarriers in the NPUSCH table.
- "Auto Start Subcarrier"
  Automatically detects the first subcarrier that the corresponding NPUSCH occupies.
  For "Manual" definition, you can define the start subcarrier in the NPUSCH table.
- "Auto Modulation Type"
  Automatically detects the modulation type that the corresponding NPUSCH uses.
  For "Manual" definition, you can define the modulation type in the NPUSCH table.

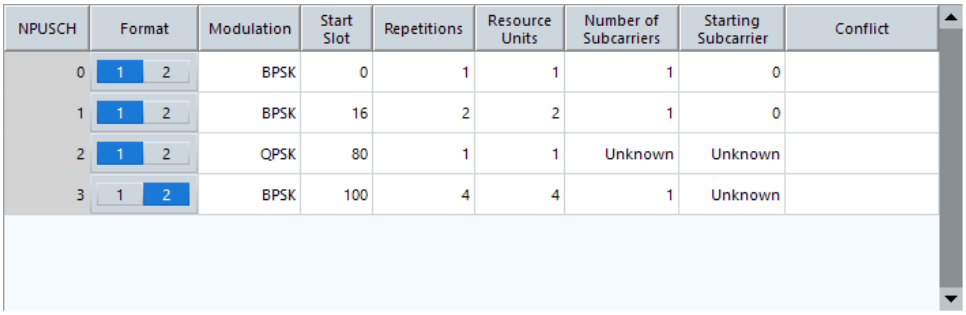
Remote command:
Number of subcarriers: `CONFigure[:LTE]:UL:AUTO:NPUSch:NSUBcarriers` on page 110
Start subcarrier: `CONFigure[:LTE]:UL:AUTO:NPUSch:SSUBcarrier` on page 110
Modulation: `CONFigure[:LTE]:UL:AUTO:NPUSch:MTYPe` on page 109

4.2.3.2 Individual NPUSCH configuration

The "NPUSCH Configuration Table" contains the characteristics for each NPUSCH you are using. The size of the table depends on the "Number of NPUSCH Transmissions" that you have defined or that have been detected in case of automatic demodulation. Each row in the table defines the characteristics of one NPUSCH.

Remote command:

`CONFigure[:LTE]:UL:NONPusch` on page 111



NPUSCH	Format	Modulation	Start Slot	Repetitions	Resource Units	Number of Subcarriers	Starting Subcarrier	Conflict
0	1 2	BPSK	0	1	1	1	0	
1	1 2	BPSK	16	2	2	1	0	
2	1 2	QPSK	80	1	1	Unknown	Unknown	
3	1 2	BPSK	100	4	4	1	Unknown	

When you configure several NPUSCH, you can encounter several allocation conflicts.

Conflicts

- "Overlapped with <x>"
  This is a message you get when one or more NPUSCH use the same slots.
  You can solve this conflict when you change the "Start Slot" value of the affected slot. The number of slots that a NPUSCH uses depends on the NPUSCH format, the subcarrier spacing, the number of resource units it occupies ("N_RU") and the number of repeated transmissions ("M_rep_NPUSCH"). For more information about how to calculate the NPUSCH length, refer to the 3GPP standard.
- "Start Subcarrier"
  This is a message you get when you have selected a "Start Subcarrier" that is not allows for the "Number of Subcarriers" you have selected for the corresponding NPUSCH.
  Usually, the start subcarrier must be a multiple of the number of subcarriers. For example, if you have selected 3 subcarriers, the start subcarrier must be "0", "3", "6", "9" etc.

NPUSCH Number
Shows the index number of the row of the corresponding NPUSCH.

NPUSCH Format
Selects the NPUSCH format.

- **Format 1**: Carries the uplink data.
- **Format 2**: Carries uplink control information.

Remote command:
`CONFigure[:LTE]:UL:NPUSch<np>:FORMat` on page 111

Number of Subcarriers
Selects the number of subcarriers that the NPUSCH uses.

This in turn defines the duration of the NPUSCH, or how many slots it requires. More subcarriers require fewer slots, so the transmission gets faster.

The number of subcarriers that the NPUSCH can use depends on the subcarrier spacing and the NPUSCH Format.

Remote command:
`CONFigure[:LTE]:UL:NPUSch<np>:NOSubcarrier` on page 112

Start Slot
Defines the first slot that the corresponding NPUSCH uses.

When you use more than one NPUSCH, make sure to enter a valid value. Otherwise you can get a conflict of overlapping NPUSCH. For more information about calculating the NPUSCH length, refer to the 3GPP standard.

Remote command:
`CONFigure[:LTE]:UL:NPUSch<np>:SSLot` on page 113

Starting Subcarrier
Defines the first subcarrier that the corresponding NPUSCH uses.

Make sure to define a valid start subcarrier for the corresponding NPUSCH. Otherwise you can get a conflict of subcarriers that are occupied by several NPUSCH.

Remote command:
`CONFigure[:LTE]:UL:NPUSch<np>:SSUBcarrier` on page 113

Resource Units
Defines the number of resource units reserved for the corresponding NPUSCH.

A resource unit describes the mapping of the NPUSCH to individual resource elements in a consecutive order. When you increase the number of resource units, the NPUSCH can carry more data.

Remote command:
`CONFigure[:LTE]:UL:NPUSch<np>:NORU` on page 112

Repetitions
Defines the number of times the NPUSCH is transmitted with the same information and before the resource elements used by NPUSCH get new assignments.

Increasing the number of repetitions increases the reliability of the transmission in favor of speed (because more slots are required in the time domain).

Remote command:
CONFigure[:LTE]:UL:NPUSch<np>:MREP on page 112

Modulation
Selects the modulation scheme for the corresponding allocation.

Availability of modulation schemes for the NPUSCH is as follows.

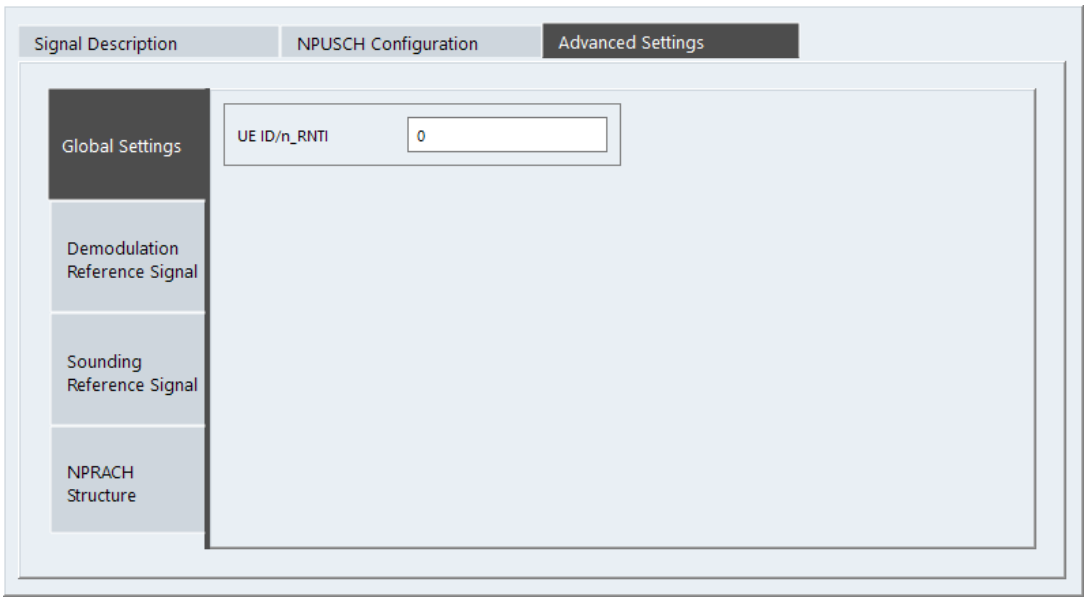
- BPSK and QPSK
  NPUSCH format 1 with one subcarrier.
- QPSK
  NPUSCH format 1 with more than one subcarrier.
- BPSK
  NPUSCH format 2.

Remote command:
CONFigure[:LTE]:UL:NPUSch<np>:MODulation on page 111

4.2.4 Defining global signal characteristics

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

The global settings contain settings that apply to the complete signal.



UE ID/n_RNTI 36

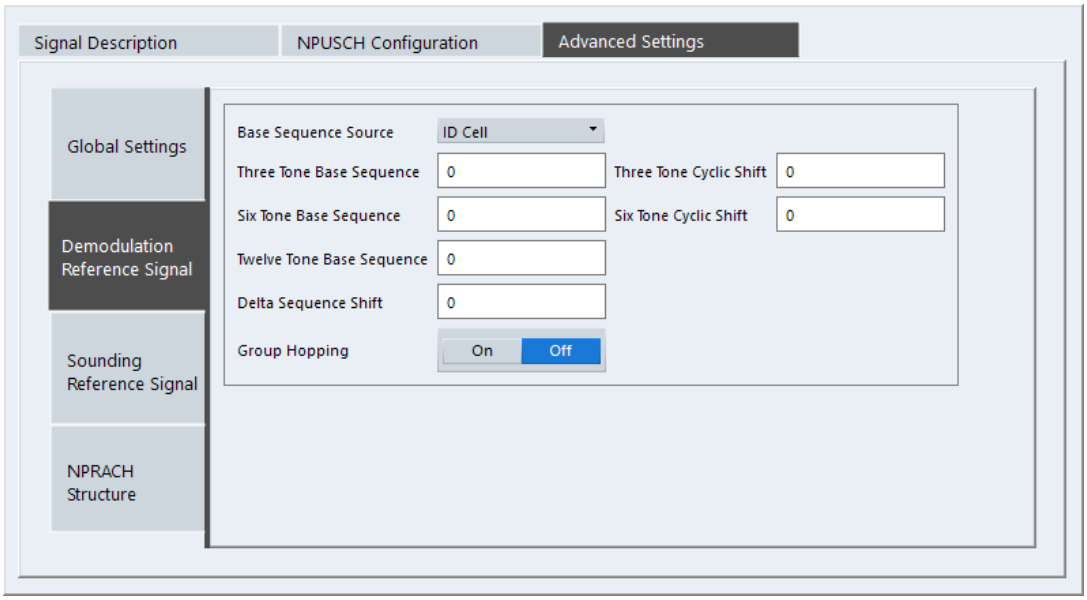
UE ID/n_RNTI
Sets the radio network temporary identifier (RNTI) of the UE.

Remote command:
CONFigure[:LTE]:UL[:CC<cc>]:UEID on page 113

4.2.5 Configuring the demodulation reference signal

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

The global settings contain settings that apply to the complete signal.



Base Sequence Source
Selects the origin of the reference signal sequence.

- "ID Cell"
  The base sequence index is derived from the cell ID.
- "Higher Layer"
  The base sequence index is derived from higher layer parameters.

The base sequence source is relevant in the following cases.

- Select NPUSCH format 1.
- Turn off group hopping for the NDMRS.
- Number of resource units occupied by the NPUSCH is > 1.

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce` on page 114

Base Sequence
"Three Tone Base Sequence", "Six Tone Base Sequence" and "Twelve Tone Base Sequence" are higher layer parameters that define the base sequence index with which the demodulation reference signal (NDMRS) is transmitted.

- "Three Tone Base Sequence": base sequence index in case the signal is modulated onto three subcarriers.
- "Six Tone Base Sequence": base sequence index in case the signal is modulated onto six subcarriers.
- "Twelve Tone Base Sequence": base sequence index in case the signal is modulated onto twelve subcarriers.

The base sequence tone is relevant in the following cases.
- Select NPUSCH format 1.
- Turn off group hopping for the NDMRS.
- Select "Higher Layer" base sequence source.
- Number of resource units occupied by the NPUSCH is 3 (three tone), 6 (six tone) or 12 (twelve tone).

In all other cases, the NDMRS sequence is defined by other parameters.

For more information on the NDMRS sequence, refer to 3GPP 36.211, chapter 10.1.4.

Remote command:
Three tone: `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BTHRee` on page 115
Six tone: `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSIX` on page 114
Twelve tone: `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSTWelve` on page 115

Cyclic Shift
"Three Tone Cyclic Shift" and "Six Tone Cyclic Shift" are higher layer parameters that, in combination with the base sequence, define the sequence with which the demodulation reference signal (NDMRS) is transmitted.

The base sequence tone is relevant in the following cases.
- Select NPUSCH format 1.
- Turn off group hopping for the NDMRS.
- Select "Higher Layer" base sequence source.
- Number of resource units occupied by the NPUSCH is 3 (three tone) or 6 (six tone).

In all other cases, the NDMRS sequence is defined by other parameters.

For more information on the NDMRS sequence, refer to 3GPP 36.211, chapter 10.1.4.

Remote command:
Three tone: `CONFigure[:LTE]:UL[:CC<cc>]:DRS:CSTHree` on page 116
Six tone: `CONFigure[:LTE]:UL[:CC<cc>]:DRS:CSSix` on page 116

Delta Sequence Shift
Defines the delta sequence shift Δ_{SS}.

This value is given by the higher layer parameter groupAssignmentNPUSCH.

The "Delta Sequence Shift" has an effect when you turn on group hopping and thus for NPUSCH format 1.

For more information refer to 3GPP TS 36.211, chapter 10.1.4.1.3 "Group Hopping".

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:DRS:DSSHift` on page 117

Group Hopping
Turns group hopping for the demodulation reference signal on and off.

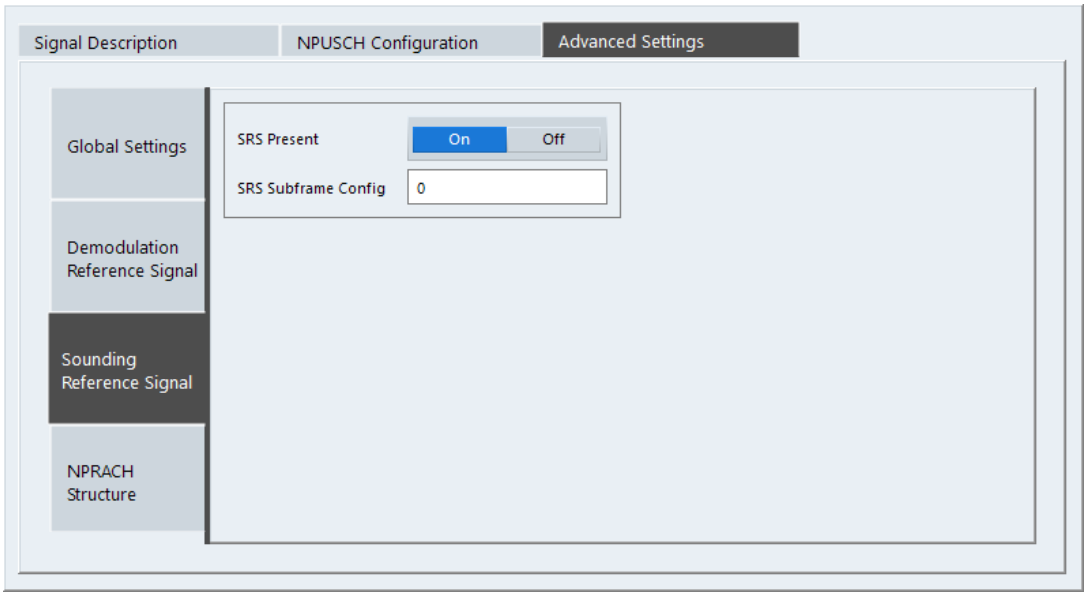
Group hopping is only supported by NPUSCH format 1.

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping` on page 117

4.2.6 Configuring the sounding reference signal

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

The sounding reference signal (SRS) settings contain settings that define the physical attributes and structure of the sounding reference signal.



Present
Includes or excludes the sounding reference signal (SRS) from the test setup.

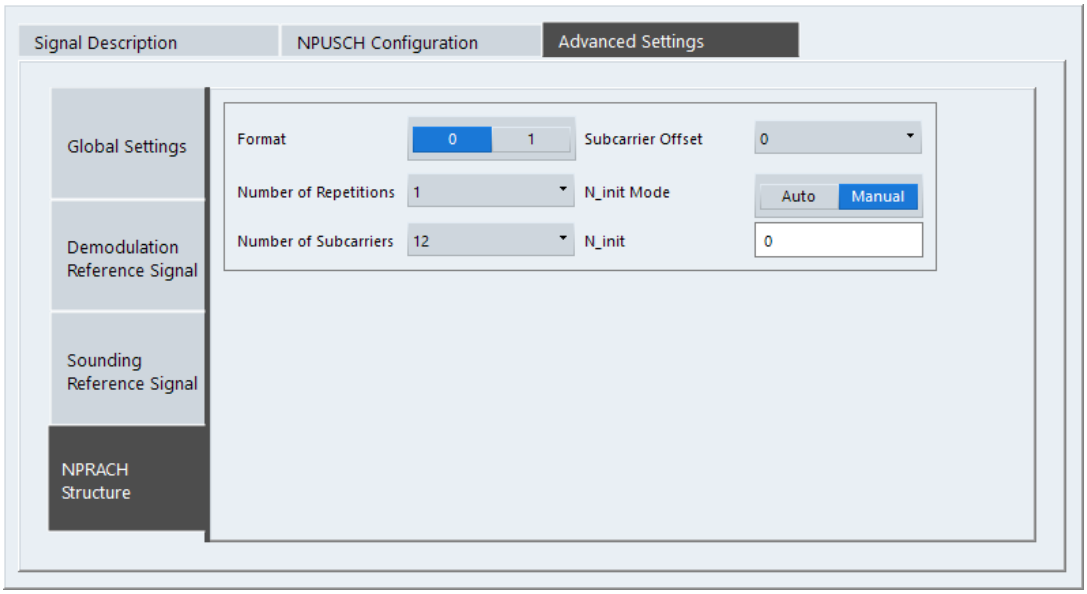
Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:SRS:STAT` on page 117

SRS Subframe Configuration
Defines the subframe configuration of the SRS.

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:SRS:SUConfig` on page 118

4.2.7 Configuring the NPRACH

Access: "Overview" > "Signal Description" > "Advanced Settings" > "NPRACH Structure"



The NPRACH transmits the physical layer random access preamble. The preamble conists of four symbol groups. Each symbol group consists of a cyclic prefix and five identical symbols.

CP*	Symbol	Symbol	Symbol	Symbol	Symbol

Figure 4-1: Random access symbol group

CP = Cyclic prefix (variable length)
Symbol = Sequence of five identical symbols

NPRACH Format
Selects the format of the NPRACH.

3GPP defines different "Formats" of the preamble: format "0" and format "1". The difference lies in the length of the cyclic prefix.

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:NPRach:FORMat` on page 118

Number of Repetitions
Defines the number of times the NPRACH is transmitted.

You can set up the preamble for repeated transmission, for example to make up for bad transmission quality. To control the number of times the preamble is transmitted, change the value of the "Number Of Repetitions" parameter.

Remote command:
`CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NREP` on page 119

Subcarrier Configuration
Defines the subcarrier configuration of the NPRACH.

The NPRACH can use several subcarriers. The "Number Of Subcarriers" parameter selects the number of subcarriers allocated to the NPRACH.

You can define the location of the first subcarrier that is allocated to the NPRACH with the "Subcarrier Offset" property.

Remote command:
Number of subcarriers: `CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NSUB` on page 120
Offset: `CONFigure[:LTE]:UL[:CC<cc>]:NPRach:SOFFset` on page 120

N_init
The parameter N_{init} defines the subcarrier selected by the MAC layer for the NPRACH transmission.

The "N_Init Mode" setting selects the way the N_{init} value is determined.

- "Auto"
  The application automatically determines the N_{init} value.
  Note that all NPRACH parameters have to set correctly. Otherwise, the application is not able to determine N_{init} automatically.
- "Manual"
  You can define the N_{init} value manually in the "N_Init" field.

Remote command:
Mode: `CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NIMode` on page 119
Value: `CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NINit` on page 119

4.2.8 Selecting the input and output source

The application supports several input sources and outputs.

The supported input sources depend on the connected instrument. Refer to the documentation of the instrument in use for a comprehensive description of input sources.

4.2.8.1 RF input

Functions to configure the RF input described elsewhere:

- "Input Coupling" on page 49
- "Impedance" on page 50

Note that the actual functions to configure the RF input depend on the configuration of the connected instrument.

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

For some connected instruments, this function requires an additional hardware option on the instrument.

Note: For RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Remote command:
`INPut<ip>:FILTer:HPASs[:STATe]` on page 121

YIG-Preselector
Enables or disables the YIG-preselector.

This setting requires an additional option on the connected instrument.

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

Note: Note that the YIG-preselector is active only higher frequencies, depending on the connected instrument. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

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

To use the optional 54 GHz frequency extension (R&S FSV3-B54G), the YIG-preselector must be disabled.

Remote command:
`INPut<ip>:FILTer:YIG[:STATe]` on page 122

Capture Mode
Determines how data from an oscilloscope is input to the R&S VSE software.

This function is only available for a connected R&S oscilloscope with a firmware version 3.0.1.1 or higher (for other versions and instruments the input is always I/Q data).

"I/Q" The measured waveform is converted to I/Q data directly on the R&S oscilloscope (requires option K11), and input to the R&S VSE software as I/Q data.
For data imports with small bandwidths, importing data in this format is quicker. However, the maximum record length is restricted by the R&S oscilloscope. (Memory options on the R&S oscilloscope are not available for I/Q data.)

"Waveform" The data is input in its original waveform format and converted to I/Q data in the R&S VSE software. No additional options are required on the R&S oscilloscope.
For data imports with large bandwidths, this format is more convenient as it allows for longer record lengths if appropriate memory options are available on the R&S oscilloscope.

"Auto" Uses "I/Q" mode when possible, and "Waveform" only when required by the application (e.g. Pulse measurement, oscilloscope baseband input).

Remote command:
`INPut<ip>:RF:CAPMode` on page 123

Oscilloscope Sample Rate
Determines the sample rate used by the connected oscilloscope.

This setting is only available if an R&S oscilloscope is used to obtain the input data, either directly or via the R&S FSW.

"10 GHz" Default for waveform Capture Mode (not available for I/Q Capture Mode); provides maximum record length

"20 GHz" Achieves a higher decimation gain, but reduces the record length by half.
Only available for R&S oscilloscope models that support a sample rate of 20 GHz (see data sheet).
For R&S oscilloscopes with an analysis bandwidth of 4 GHz or larger, a sample rate of 20 GHZ is always used in waveform Capture Mode

"40 GHz" Provides a maximum sample rate.
Only available for I/Q Capture Mode, and only for R&S RTP13/RTP16 models that support a sample rate of 40 GHz (see data sheet)

Remote command:
Input source R&S FSW via oscilloscope:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe` on page 125
Input source oscilloscope waveform mode:
`INPut<ip>:RF:CAPMode:WAVeform:SRATe` on page 124
Input source oscilloscope I/Q mode:
`INPut<ip>:RF:CAPMode:IQ:SRATe` on page 123

4.2.8.2 I/Q file input

Or: "Input & Output" > "Input Source" > "I/Q File"

Loading a file via drag&drop

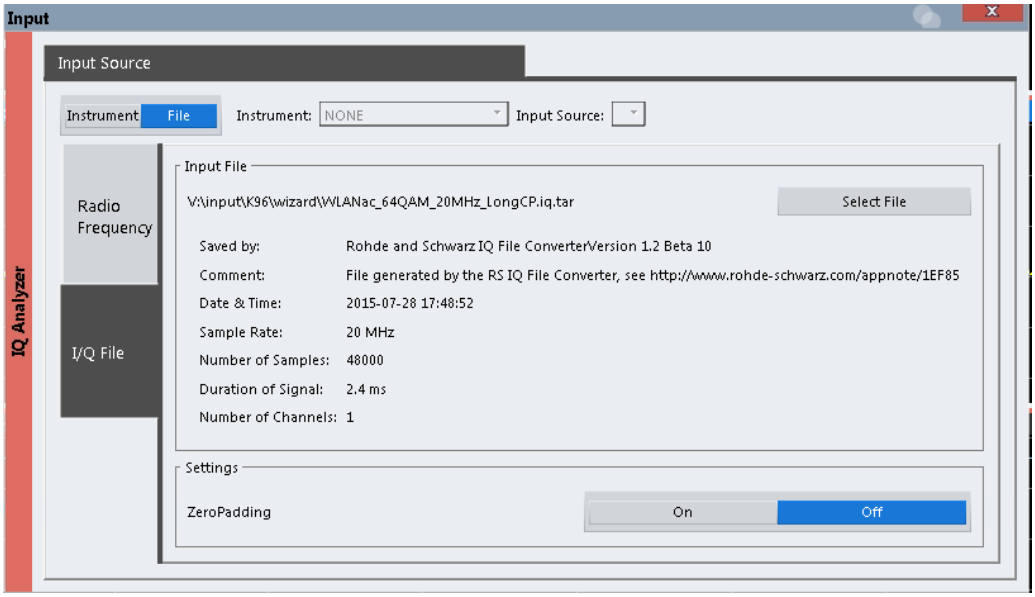
You can load a file simply by selecting it in a file explorer and dragging it to the R&S VSE software. Drop it into the "Measurement Group Setup" window or the channel bar for any channel. The channel is automatically configured for file input, if necessary. If the file contains all essential information, the file input is immediately displayed in the channel. Otherwise, the "Recall I/Q Recording" dialog box is opened for the selected file so you can enter the missing information.

If the file contains data from multiple channels (e.g. from LTE measurements), it can be loaded to individual input sources, if the application supports them.

For details see the R&S VSE Base Software User Manual.

The "Input Source" settings defined in the "Input" dialog box are identical to those configured for a specific channel in the "Measurement Group Setup" window.

(See "Controlling Instruments and Capturing Data" in the R&S VSE User Manual).



If the Frequency Response Correction option (R&S VSE-K544) is installed, the LTE NB-IoT measurement application also supports frequency response correction using Touchstone (`.snp`) files or `.fres` files.

For details on user-defined frequency response correction, see the R&S VSE Base Software User Manual.

Encrypted `.wv` files can also be imported. Note, however, that traces resulting from encrypted file input cannot be exported or stored in a saveset.

Input Type (Instrument / File)
Selects an instrument or a file as the type of input provided to the channel.

Note: External mixers are only available for input from a connected instrument.

Note: If the R&S VSE software is installed directly on an instrument, or integrated in Cadence®AWR®VSS, some restrictions apply on the available input type.

Remote command:
`INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si>` on page 124
`INPut:SELect` on page 122

Input File
Specifies the I/Q data file to be used for input.

Select "Select File" to open the "Load I/Q File" dialog box.

(See "Data Management - Loading the I/Q Data File" in the R&S VSE base software user manual).

Zero Padding
Enables or disables zero padding for input from an I/Q data file that requires resampling. For resampling, a number of samples are required due to filter settling. These samples can either be taken from the provided I/Q data, or the software can add the required number of samples (zeros) at the beginning and end of the file.

If enabled, the required number of samples are inserted as zeros at the beginning and end of the file. The entire input data is analyzed. However, the additional zeros can effect the determined spectrum of the I/Q data. If zero padding is enabled, a status message is displayed.

If disabled (default), no zeros are added. The required samples for filter settling are taken from the provided I/Q data in the file. The start time in the R&S VSE Player is adapted to the actual start (after filter settling).

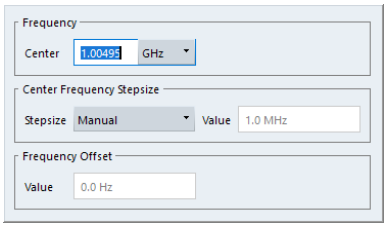
Note: You can activate zero padding directly when you load the file, or afterwards in the "Input Source" settings.

Remote command:
`INPut<ip>:FILE:ZPADing` on page 121

4.2.9 Frequency configuration

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

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



The remote commands required to configure the frequency are described in Chapter 6.7.2.3, "Frequency configuration", on page 125.

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

Center Frequency ← Signal Frequency
Defines the center frequency of the signal and thus the frequency the R&S VSE tunes to.

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

Remote command:
Center frequency: `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 125
Frequency offset: `[SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet` on page 126

Frequency Stepsize ← Signal Frequency
In addition to the frequency itself, you can also define a frequency stepsize. The frequency stepsize defines the extent of a frequency change if you change it, for example with the rotary knob.

You can define the stepsize in two ways.

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

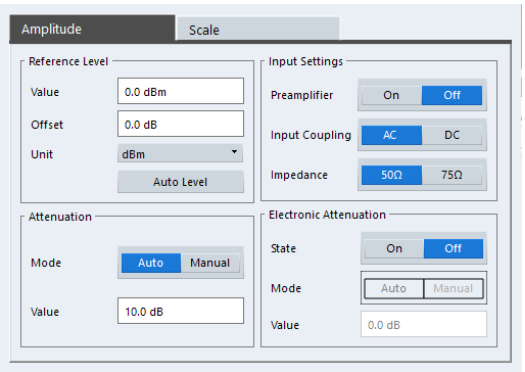
Remote command:
Frequency stepsize: `[SENSe:]FREQuency:CENTer:STEP` on page 126

4.2.10 Amplitude configuration

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

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

Level characteristics are available when you capture data with an instrument. In addition, the functions that are available depend on the configuration of the connected instrument.



The remote commands required to configure the amplitude are described in Chapter 6.7.2.4, "Amplitude configuration", on page 127.

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.

The reference level is a value in dBm.

Remote command:
Reference level: `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>` on page 127

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

Automatic level detection also optimizes RF attenuation.

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

Remote command:
Automatic: `[SENSe:]ADJust:LEVel<ant>` on page 132
Auto level mode: `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE` on page 132
Auto level time: `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation` on page 132

Reference Level Offset ← Reference Level
The reference level offset is an arithmetic level offset. A level offset is useful if the signal is attenuated or amplified before it is fed into the analyzer. All displayed power level results are shifted by this value. Note however, that the reference value ignores the level offset. Thus, it is still mandatory to define the actual power level that the analyzer has to handle as the reference level.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>:OFFSet` on page 127

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

For a comprehensive information about signal attenuation, refer to the user manual of the R&S VSE.

The NB-IoT measurement application provides several attenuation modes.

RF Attenuation ← Attenuating the Signal
Controls the RF (or mechanical) attenuator at the RF input.

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

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

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

Remote command:
State: `INPut<ip>:ATTenuation<ant>:AUTO` on page 128
Level: `INPut<ip>:ATTenuation<ant>` on page 128

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

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

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

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

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

Remote command:
Electronic attenuation: `INPut<ip>:EATT<ant>:STATe` on page 131
Electronic attenuation: `INPut<ip>:EATT<ant>:AUTO` on page 131
Electronic attenuation: `INPut<ip>:EATT<ant>` on page 130

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

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

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

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

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

Depending on the connected instrument, different settings are available. See the instrument's documentation for details.

Remote command:
`INPut<ip>:GAIN<ant>:STATe` on page 129
`INPut<ip>:GAIN<ant>[:VALue]` on page 129

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

The RF input of the connected instrument can be coupled by alternating current (AC) or direct current (DC).

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

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

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

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

Remote command:
`INPut<ip>:COUPling<ant>` on page 128

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

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

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

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

Remote command:
`INPut<ip>:IMPedance<ant>` on page 130

4.2.11 Trigger configuration

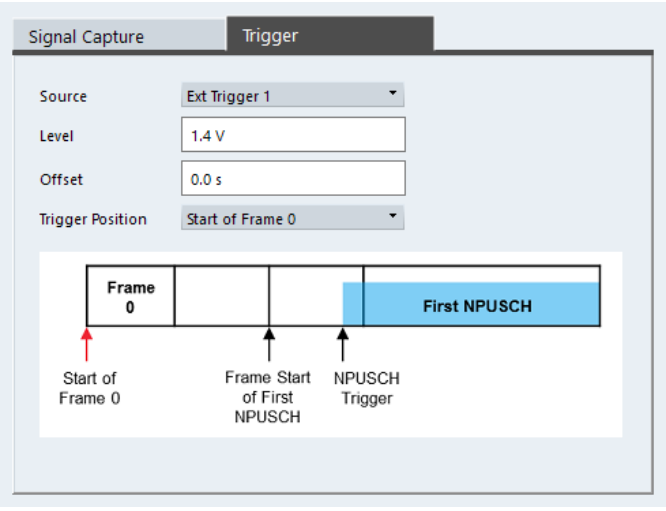
Access: "Overview" > "Trig / Sig Capture" > "Trigger"

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

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

Except for the trigger position, and the available trigger sources are the same as in the I/Q analyzer. For a comprehensive description, refer to the manual of the I/Q analyzer.

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



Trigger Source
The application supports several trigger modes or sources.

- **Free Run**
  Starts the measurement immediately and measures continuously.
  When you analyze a signal from an I/Q file, then the trigger source is always to "Free Run".
- **External <x>**
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the trigger input. Some measurement devices have several trigger ports. When you use one of these, several external trigger sources are available.
- **I/Q Power**
  The trigger event is the magnitude of the sampled I/Q data. The measurement starts when the magnitude of the I/Q data meets or exceeds the trigger level.
- **IF Power**
  The trigger event is the level of the intermediate frequency (IF). The measurement starts when the level of the IF meets or exceeds the trigger level.
- **RF Power**
  The trigger event is the level measured at the RF input. The measurement starts when the level of the signal meets or exceeds the trigger level.

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

- The trigger "Level" defines the signal level that initiates the measurement.
- The trigger "Offset" is the time that must pass between the trigger event and the start of the measurement. This can be a negative value (a pretrigger).
- The trigger "Position" selects a point in the signal structure where a measurement should begin. See "Trigger Position" on page 52 for details.
- The trigger "Drop-out Time" defines the time the input signal must stay below the trigger level before triggering again.
- The trigger "Slope" defines whether triggering occurs when the signal rises to the trigger level or falls down to it.
- The trigger "Holdoff" defines a time period that must at least pass between one trigger event and the next.
- The trigger "Hysteresis" is available for the IF power trigger. It defines a distance to the trigger level that the input signal must stay below to fulfill the trigger condition.

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

Remote command:
Source: `TRIGger[:SEQuence]:SOURce<ant>` on page 140
Level (external): `TRIGger[:SEQuence]:LEVel<ant>[:EXTernal<tp>]` on page 136
Level (I/Q power): `TRIGger[:SEQuence]:LEVel<ant>:IQPower` on page 137
Level (IF power): `TRIGger[:SEQuence]:LEVel<ant>:IFPower` on page 137
Level (RF power): `TRIGger[:SEQuence]:LEVel<ant>:RFPower` on page 138
Offset: `TRIGger[:SEQuence]:HOLDoff<ant>[:TIME]` on page 135
Hysteresis: `TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 136
Drop-out time: `TRIGger[:SEQuence]:DTIMe` on page 135

Slope: TRIGger[:SEQuence]:SLOPe on page 140
Holdoff: TRIGger[:SEQuence]:IFPower:HOLDoff on page 136

Trigger Position
The trigger position selects a point in the signal structure where a measurement should begin.

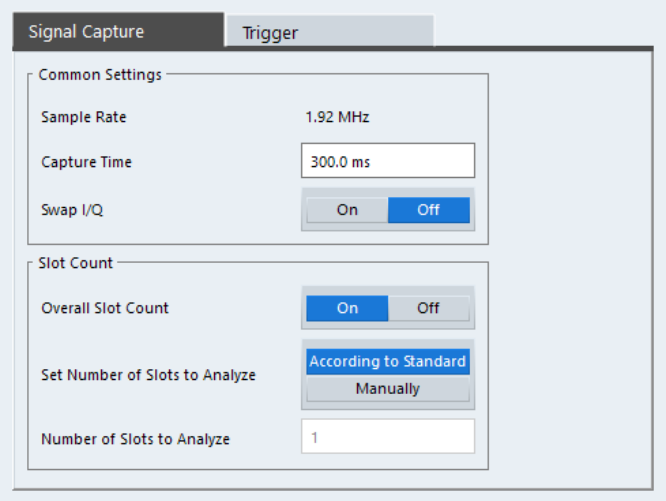
- "Start of frame 0" (available in "NPUSCH/NPUCCH" analysis mode).
  The trigger is sent at the start of frame 0.
- "Frame start of first NPUSCH" (available in "NPUSCH/NPUCCH" analysis mode).
  The trigger is sent at the start of the frame in which the first NPUSCH is found.
- "Start of NPUSCH" (available in "NPUSCH/NPUCCH" analysis mode).
  The trigger is sent at the start of the first NPUSCH.
- "Start of NPRACH" (available in "NPRACH" analysis mode).
  The trigger is sent at the start of the first NPRACH.

When you analyze a signal from an I/Q file, then the trigger source is always to "Free Run". In this case, the parameter describes the start of the I/Q file. If the position of the NPUSCH is unknown, select the "Unknown" trigger source. In that case, the application searches the I/Q data until it finds an NPUSCH and starts the measurement.

Remote command:
TRIGger[:SEQuence]:POSition on page 139

4.2.12 Configuring the data capture

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



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

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

Remote command:
`[SENSe:]SWEep:TIME` on page 134

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

Remote command:
`[SENSe:]SWAPiq` on page 134

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

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

If the overall slot count is inactive, the application analyzes all complete slots currently in the capture buffer.

Remote command:
`[SENSe:][LTE:][CC<cc>:]SLOT:COUNt:STATe` on page 134

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

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

If inactive, you can define the number of slots you want to analyze.

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

Remote command:
`[SENSe:][LTE:][CC<cc>:]SLOT:COUNt:AUTO` on page 133

Number of Slots to Analyze
Selects the number of slots that you want to capture and analyze.

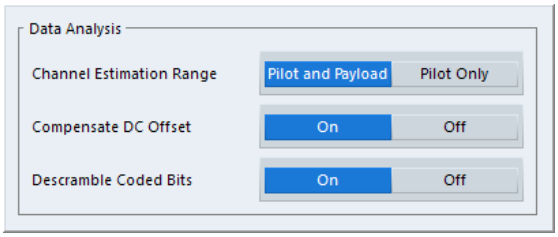
If the number of slots you have set last longer than a single measurement, the application continues the measurement until all slots have been captured.

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

Remote command:
`[SENSe:][LTE:][CC<cc>:]SLOT:COUNt` on page 133

4.2.13 Signal demodulation

Access: "Overview" > "Demodulation"



Channel Estimation Range
Selects the method for channel estimation.

You can select if only the pilot symbols are used to perform channel estimation or if both pilot and payload carriers are used.

Remote command:
`[SENSe:][LTE:]UL:DEMod:CESTimation` on page 142

Compensate DC Offset
Turns DC offset compensation when calculating measurement results on and off.

According to 3GPP TS 36.101 (Annex F.4), the R&S VSE removes the carrier leakage (I/Q origin offset) from the evaluated signal before it calculates the EVM and in-band emissions.

Remote command:
`[SENSe:][LTE:]UL:DEMod:CDCoffset` on page 142

Scrambling of Coded Bits
Turns the scrambling of coded bits for the NPUSCH on and off.

The scrambling of coded bits affects the bitstream results.

Remote command:
`[SENSe:][LTE:]UL:DEMod:CBSCrambling` on page 141

4.2.14 Automatic configuration

Access: in the toolbar: "Auto Level" / "Auto Config" / "Auto Scale" / "Auto S-All" / "Auto All"

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

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

Remote command:
`[SENSe:]ADJust:LEVel<ant>` on page 132

Auto Scaling
Scales the y-axis for best viewing results. Also see "Automatic scaling of the y-axis" on page 59.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO`
on page 148

4.3 Configuring frequency sweep measurements

After starting one of the frequency sweep measurements, the application automatically loads the configuration required by measurements according to the 3GPP standard.

- The channel configuration defined in the standard for the ACLR measurement.
- The spectral mask as defined in the 3GPP standard for SEM measurements.

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

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

4.3.1 Channel power ACLR measurement

Access: "Meas Setup" > "Overview"

Access: "Meas Setup" > "CP / ACLR Config"

The ACLR measurement and its settings are basically the same as in the spectrum application of the connected instrument. For a comprehensive description, see the connected instrument user manual.

In addition, the ACLR measurement in the NB-IoT application has several exclusive settings not available in the spectrum application.

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

Access: "Meas Setup" > "Signal Description"

- NB-IoT "Mode": The NB-IoT mode is always "FDD Uplink".
- "Analysis Mode": The analysis mode selects whether the NPUSCH and NPUCCH or the NPRACH are analyzed.
- "Subcarrier Spacing": The subcarrier spacing selects the bandwidth of the carrier.
- "Adjacent Channels": Selects the adjacent channel configuration as specified by 3GPP 36.104 chapter 6.6.2.

4.3.2 SEM measurement configuration

Access: "Meas Setup" > "Overview"

Access: "Meas Setup" > "Overview" > "SEM Setup"

The SEM measurement and its settings are basically the same as in the spectrum application of the connected instrument. For a comprehensive description, see the connected instrument user manual.

In addition, the SEM measurement in the NB-IoT application has several exclusive settings not available in the spectrum application.

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

Access: "Meas Setup" > "Signal Description"

- NB-IoT "Mode": The NB-IoT mode is always "FDD Uplink".
- "Analysis Mode": The SEM measurement only supports the NPUSCH/NPUCCH analysis mode.

Note that SEM measurements are not possible if you measure with an R&S FSL.

5 Analysis

The R&S VSE provides various tools to analyze the measurement results.

5.1 General analysis tools

The general analysis tools are tools available for all measurements.

5.1.1 Data export

Access: [TRACE] > "Trace Export Config"

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

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

The data export is available for:

- I/Q measurements

Exporting trace data

1. Select [TRACE] > "Trace Export Config".
2. Select the data you would like to export.
3. Select the results you would like to export from the "Specifics For" dropdown menu.
4. Export the data with the "Export Trace to ASCII File" feature.
5. Select the location where you would like to save the data (as a `.dat` file).

   Note that the measurement data stored in the file depend on the selected result display ("Specifics For" selection).

Exporting I/Q data

1. Select the disk icon in the toolbar.
2. Select "Export" > "I/Q Export".

3. Define a file name and location for the I/Q data.
   The file type is `iq.tar`.
4. Later on, you can import the I/Q data using the I/Q file input source.

Data import and export
The basic principle for both trace export and I/Q data export and import is the same as in the spectrum application. For a comprehensive description, refer to the R&S VSE user manual.

Remote command:
Trace export: `TRACe<n>[:DATA]?` on page 91
I/Q export: `MMEMory:STORe<n>:IQ:STATe` on page 105
I/Q import: `INPut:FILE<fi>:PATH` on page 121

5.1.2 Microservice export

Access: "Edit" > "Microservice Export"

For a comprehensive description of the microservice, refer to the microservice user manual.

Remote command:

`MMEMory:STORe<n>:MSERvice` on page 145

5.1.3 Diagram scale

Access: "Overview" > "Analysis" > "Scale"

You can change the scale of the y-axis in various diagrams. The y-axis scale determines the vertical resolution of the measurement results.

The scale of the x-axis in the diagrams is fix. If you want to get a better resolution of the x-axis, you have to zoom into the diagram.

The remote commands required to configure the y-axis scale are described in Chapter 6.8.4, "Y-axis scale", on page 147.

Manual scaling of the y-axis
The "Y Minimum" and "Y Maximum" properties define a custom scale of the y-axis.

The "Y Minimum" corresponds to the value at the origin. The "Y Maximum" corresponds to the last value on the y-axis. The scale you select applies to the currently active window.

You can restore the original scale anytime with "Restore Scale".

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum
on page 148
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum
on page 148

Automatic scaling of the y-axis
Usually, the best way to view the results is if they fit ideally in the diagram area and display the complete trace. The "Auto Scale Once" automatically determines the scale of the y-axis that fits this criteria in the currently active window.

Tip: You can also scale the windows in the "Auto Set" menu. In addition to scaling the selected window ("Auto Scale Window"), you can change the scale of all windows at the same time ("Auto Scale All").

You can restore the original scale anytime with "Restore Scale".

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO
on page 148

5.1.4 Zoom

The zoom feature allows you to zoom into any graphical result display. This can be a useful tool if you want to analyze certain parts of a diagram in more detail.

The zoom functionality is the same as in the spectrum application.

The following zoom functions are supported.

- : Magnifies the selected diagram area.
- : Magnifies the selected diagram area, but keeps the original diagram in a separate window.
- : Restores the original diagram.

Note that the zoom is a graphical feature that magnifies the data in the capture buffer. Zooming into the diagram does not reevaluate the I/Q data.

For a comprehensive description of the zoom, refer to the R&S VSE user manual.

5.1.5 Markers

Access: "Overview" > "Analysis" > "Marker"

Markers are a tool that help you to identify measurement results at specific trace points. When you turn on a marker, it gives you the coordinates of its position, for example the frequency and its level value or the symbol and its EVM value.

In general, the marker functionality of setting and positioning markers is similar to the spectrum application.

For I/Q measurement, the R&S VSE supports up to four markers, for frequency sweep measurements there are more. Markers give either absolute values (normal markers)

or values relative to the first marker (deltamarkers). If a result display has more than one trace, for example the "EVM vs Symbol" result display, you can position the marker on either trace. By default, all markers are positioned on trace 1.

Note that if you analyze more than one bandwidth part, each bandwidth part is represented by a different trace.

The R&S VSE also supports several automatic positioning mechanisms that allow you to move the marker to the maximum trace value (peak), the minimum trace value or move it from peak to subsequent peak.

The marker table summarizes the marker characteristics.

For a comprehensive description, refer to the R&S VSE user manual.

Markers in result displays with a third quantity

In result displays that show a third quantity, for example the "EVM vs Symbol x Carrier" result, the R&S VSE provides an extended marker functionality.

You can position the marker on a specific resource element, whose position is defined by the following coordinates:

- The "Symbol" input field selects the symbol.
- The "Carrier" input field selects the carrier.

Alternatively, you can define the marker position in the "Marker Configuration" dialog box, which is expanded accordingly.

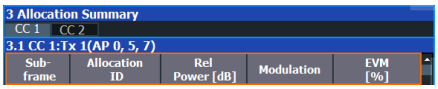
The marker information shows the EVM, the power and the allocation ID of the resource element you have selected as the marker position.

5.2 Analysis tools for I/Q measurements

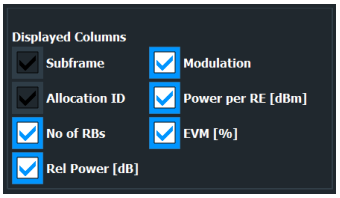
5.2.1 Layout of numerical results

You can customize the displayed information of some numerical result displays or tables, for example the allocation summary.

► Select some point in the header row of the table.



The application opens a dialog box to add or remove columns.

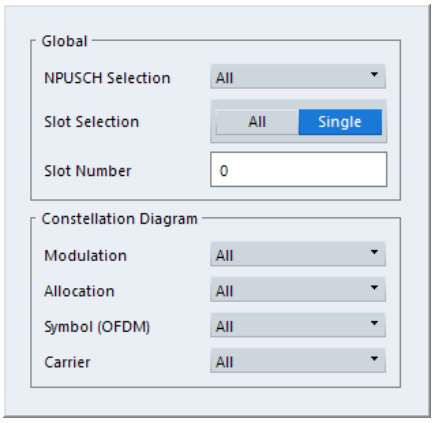


Add and remove columns as required.

5.2.2 Evaluation range

Access: "Overview" > "Evaluation Range"

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



NPUSCH Selection
Selects a particular NPUSCH whose results the application displays.

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

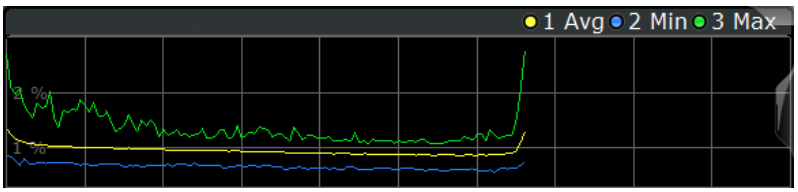
Remote command:
`[SENSe:][LTE:][CC<cc>:]NPUSch:SELect` on page 146

Slot Selection
The "Slot" selection filters the results by a specific slot number.

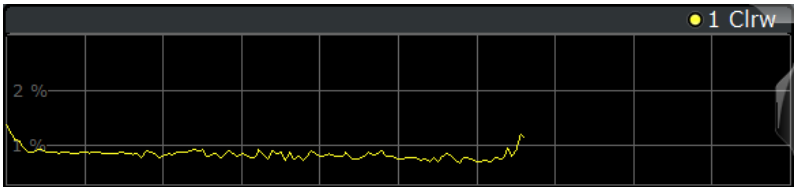
You can display the results over "All" slots, or a "Single" slot. If you select a single slot, you can define the "Slot Nr" (number of the slot) that the results are displayed for.

The R&S VSE shows three traces if you display the results for all slots.

- One trace ("Min") shows the minimum values measured over all slots.
- One trace ("Max") shows the maximum values measured over all slots.
- One trace ("Avg") shows the average values measured over all slots.



If you filter by a single slot, the R&S VSE shows one trace that represents the values measured for that slot only.



You can apply the filter to the following result displays.

- Result Summary
- EVM vs Carrier / EVM vs Symbol / EVM vs Symbol X Carrier
- Inband Emission
- Spectrum Flatness / Spectrum Flatness Difference
- Group Delay
- Power vs Symbol X Carrier
- Constellation Diagram

Remote command:
`[SENSe:][LTE:][CC<cc>:]SLOT:SELect` on page 147

Evaluation range for the constellation diagram
The "Evaluation Range" for the constellation diagram selects the information displayed in the constellation diagram.

By default, the constellation diagram contains the constellation points of the complete data that has been analyzed. However, you can filter the results by several aspects.

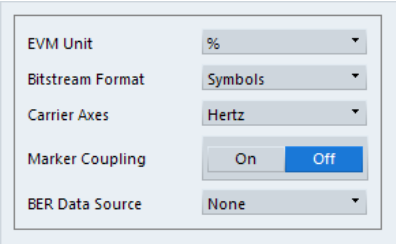
- Modulation
  Filters the results by the selected type of modulation.
- Allocation
  Filters the results by a certain type of allocation.
- Symbol (OFDM)
  Filters the results by a certain OFDM symbol.
- Carrier
  Filters the results by a certain subcarrier.

Remote command:
Modulation: `[SENSe:][LTE:][CC<cc>:]MODulation:SELect` on page 146
Allocation: `[SENSe:][LTE:][CC<cc>:]ALLocation:SELect` on page 145
Symbol: `[SENSe:][LTE:][CC<cc>:]SYMBol:SELect` on page 147
Carrier: `[SENSe:][LTE:][CC<cc>:]CARRier:SELect` on page 146

5.2.3 Result settings

Access: "Overview" > "Analysis" > "Result Settings"

Result settings define the way certain measurement results are displayed.



EVM Unit
The "EVM Unit" selects the unit for the EVM measurement results in diagrams and numerical result displays.

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 150

Bit Stream Format
Selects the way the bit stream is displayed.

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

Example:

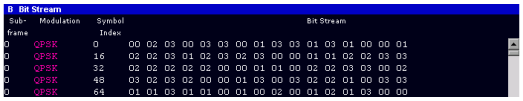


Figure 5-1: Bit stream display in uplink application if the bit stream format is set to "symbols"

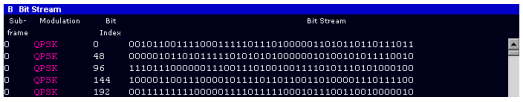


Figure 5-2: Bit stream display in uplink application if the bit stream format is set to "bits"

Remote command:
`UNIT:BSTR` on page 150

Carrier Axes
The "Carrier Axes" selects the unit of the x-axis in result displays that show results over the subcarriers.

- "Hertz"
  X-axis shows the results in terms of the subcarrier frequency.
- "Subcarrier Number"
  X-axis shows the results in terms of the subcarrier number.

Remote command:
`UNIT:CAXes` on page 150

Marker Coupling
Couples or decouples markers that are active in multiple result displays.

When you turn on this feature, the application moves the marker to its new position in all active result displays.

When you turn it off, you can move the markers in different result displays independent from each other.

Remote command:
`CALCulate<n>:MARKer<m>:COUPling` on page 149

BER Data Source
Selects the type of reference data source to calculate bit error rate (BER) measurement for the NPUSCH.

"None" No specific NPUSCH reference values.

"PN9" Assumes the NPUSCH to be based on the pseudo random sequence 9 as defined by 3GPP.
You have to select "PN9" to evaluate the bit error and bit error rate in the bitstream result display.

Remote command:
`CONFigure[:LTE]:UL:BDSource` on page 149

5.3 Analysis tools for frequency sweep measurements

Access: "Overview" > "Analysis"

Access: "Overview" > "Analysis"

The analysis tools available for the frequency sweep measurements are the same as in the spectrum analyzer.

For more information, refer to the R&S VSE user manual.

6 Remote control

The following remote control commands are required to configure and perform LTE NB-IoT measurements in a remote environment. The R&S VSE 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 VSE 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).

6.1 Common suffixes

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

Table 6-1: 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
	1 to 8	Limit line
<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)

6.2 Introduction

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

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

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

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

Remote command examples

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

6.2.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

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

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

6.2.2 Long and short form

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

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

Example:

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

6.2.3 Numeric suffixes

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

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

If you do not quote a suffix for keywords that support one, a 1 is assumed.

Example:

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

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

6.2.4 Optional keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

6.2.5 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`.

6.2.6 SCPI parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters can have different forms of values.

6.2.6.1 Numeric values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

Sometimes, numeric values are returned as text.

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

6.2.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

6.2.6.3 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 6.2.2, "Long and short form", on page 67.

Querying text parameters

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

Example:

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

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

6.2.6.4 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'
```

6.2.6.5 Block data

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

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

6.3 NB-IoT application selection

INSTrument[:SELect] <ChannelType>

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`

6.4 Screen layout

6.4.1 General layout

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel*.

DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect

Sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

Example: //Put the focus on window 1
`DISP:WIND1:SEL`

Example: //Put the focus on subwindow 2 in window 1
`DISP:WIND1:SUBW2:SEL`

DISPlay[:WINDow<n>]:TAB<tab>:SELect

Selects a tab in diagrams with multiple subwindows (or views).

Note that selecting a tab does not actually select a subwindow. To select a subwindow, for example to query the results of a subwindow, use `DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect`.

Suffix:
<n> Window

<tab> 1..n
Tab

Example: //Select a tab
`DISP:WIND2:TAB2:SEL`

6.4.2 Layout over all channels

The following commands are required to change the evaluation type and rearrange the screen layout across measurement channels as you do in manual operation.

For compatibility with other Rohde & Schwarz Signal and Spectrum Analyzers, the layout commands described in Chapter 6.4.3, "Layout of a single channel", on page 75 are also supported. Note, however, that the commands described there only allow you to configure the layout within the *active* measurement channel.

LAYout:GLOBal:ADD[:WINDow]?
<ExChanName>,<ExWinName>,<Direction>,<NewChanName>,<NewWinType>

Adds a window to the display next to an existing window. The new window may belong to a different channel than the existing window.

To replace an existing window, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Parameters:
<ExChanName> string
Name of an existing channel

<ExWinName> string
Name of the existing window within the <ExChanName> channel the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows use the `LAYout:GLOBal:IDENtify[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | TAB

Direction the new window is added relative to the existing window.

TAB
The new window is added as a new tab in the specified existing window.

<NewChanName> string

Name of the channel for which a new window is to be added.

<NewWinType> string

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAYout:GLOBal:ADD:WINDow? 'IQ
Analyzer','1',RIGH,'IQ Analyzer2','FREQ'
```

Adds a new window named 'Spectrum' with a Spectrum display to the right of window 1 in the channel 'IQ Analyzer'.

Usage: Query only

Table 6-2: <WindowType> parameter values for NB-IoT uplink measurement application

Parameter value	Window type
I/Q measurements	
ASUM	Allocation Summary
BSTR	Bitstream
CBUF	Capture Buffer
CCDF	CCDF
CONS	Constellation Diagram
EVCA	EVM vs. Carrier
EVSY	EVM vs. Symbol
EVSC	EVM vs. Symbol X Carrier
GDEL	Group Delay
IE	Inband Emission
IEA	Inband Emission All
MTAB	Marker Table
PSPE	Power Spectrum
PVSC	Power vs. Symbol X Carrier
RSUM	Result Summary
SFD	Spectrum Flatness Difference

Parameter value	Window type
SFL	Spectrum Flatness
ACLR and SEM measurements	
DIAG	Diagram
PEAK	Peak List
MTAB	Marker Table
RSUM	Result Summary

LAYout:GLOBal:CATalog[:WINDow]?

Queries the name and index of all active windows from top left to bottom right for each active channel. The result is a comma-separated list of values for each window, with the syntax:

<ChannelName_1>: <WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

..

<ChannelName_m>: <WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example:
```
LAY:GLOB:CAT?
```
Result:
```
IQ Analyzer: '1',1,'2',2
Analog Demod: '1',1,'4',4
```
For the I/Q Analyzer channel, two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).
For the Analog Demodulation channel, two windows are displayed, named '1' (at the top or left), and '4' (at the bottom or right).

Usage: Query only

LAYout:GLOBal:IDENtify[:WINDow]? <ChannelName>,<WindowName>

Queries the **index** of a particular display window in the specified channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Parameters:
<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.

Query parameters:
<WindowName> String containing the name of a window.

Return values:
<WindowIndex> Index number of the window.

Example: `LAYout:GLOBal:ADD:WINDow? IQ,'1',RIGH,'Spectrum',FREQ`
Adds a new window named 'Spectrum' with a Spectrum display to the right of window 1.

Example: `LAYout:GLOBal:IDENtify? 'IQ Analyzer','Spectrum'`
Result:
`2`
Window index is: 2.

Usage: Query only

LAYout:GLOBal:REMove[:WINDow] <ChannelName>, <WindowName>

Setting parameters:
<ChannelName>

<WindowName>

Usage: Setting only

LAYout:GLOBal:REPLace[:WINDow] <ExChannelName>, <WindowName>, <NewChannelName>, <WindowType>

Setting parameters:
<ExChannelName>

<WindowName>

<NewChannelName>

<WindowType>

Usage: Setting only

6.4.3 Layout of a single channel

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application,

some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel*.

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel.

Is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Query parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.
Note that the window type must be valid for the active channel.
To create a window for a different channel, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

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

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation:
See "Capture Buffer" on page 12
See "EVM vs Carrier" on page 13
See "EVM vs Symbol" on page 14
See "Power Spectrum" on page 14
See "Inband Emission" on page 15
See "Spectrum Flatness" on page 15
See "Group Delay" on page 16
See "Spectrum Flatness Difference" on page 16
See "Constellation Diagram" on page 17
See "CCDF" on page 17
See "Allocation Summary" on page 18
See "Bitstream" on page 18
See "EVM vs Symbol x Carrier" on page 19
See "Power vs Symbol x Carrier" on page 20
See "Marker Table" on page 23
See "Marker Peak List" on page 26

Table 6-3: <WindowType> parameter values for NB-IoT uplink measurement application

Parameter value	Window type
I/Q measurements	
ASUM	"Allocation Summary"
BSTR	"Bitstream"
CBUF	"Capture Buffer"
CCDF	"CCDF"
CONS	"Constellation Diagram"
EVCA	"EVM vs. Carrier"
EVSY	"EVM vs. Symbol"
EVSC	"EVM vs. Symbol X Carrier"
GDEL	"Group Delay"
IEA	"Inband Emission All"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
PVSC	"Power vs. Symbol X Carrier"
RSUM	"Result Summary"
SFD	"Spectrum Flatness Difference"
SFL	"Spectrum Flatness"
ACLR and SEM measurements	
DIAG	"Diagram"
PEAK	"Peak List"

Parameter value	Window type
MTAB	"Marker Table"
RSUM	"Result Summary"

LAYout:CATalog[:WINDow]?

Queries the name and index of all active windows in the active channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

To query the name and index of all windows in all channels, use the `LAYout:GLOBal:CATalog[:WINDow]?` command.

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

Queries the **index** of a particular display window in the active channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

To query the index of a window in a different channel, use the `LAYout:GLOBal:IDENtify[:WINDow]?` command.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active channel.

Setting parameters:

<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 76 for a list of available window types.
Note that the window type must be valid for the active channel. To create a window for a different channel, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

Adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

Is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:

<n> Window

Query parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See LAYout:ADD[:WINDow]? on page 76 for a list of available window types.
Note that the window type must be valid for the active channel.
To create a window for a different channel, use the LAYout:GLOBal:ADD[:WINDow]? command.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:WIND1:ADD? LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel.

Note: to query the **index** of a particular window, use the LAYout:IDENtify[:WINDow]? command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example:
```
LAY:WIND2:IDEN?
```
Queries the name of the result display in window 2.
Response:
```
'2'
```

Usage: Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active channel.

The result of this command is identical to the LAYout:REMove[:WINDow] command.

To remove a window in a different channel, use the LAYout:GLOBal:REMove[:WINDow] command.

Suffix:
<n> Window

Example: LAY:WIND2:REM
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active channel.

The effect of this command is identical to the LAYout:REPLace[:WINDow] command.

To add a new window, use the LAYout:WINDow<n>:ADD? command.

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See LAYout:ADD[:WINDow]? on page 76 for a list of available window types.
Note that the window type must be valid for the active channel. To create a window for a different channel, use the LAYout:GLOBal:REPLace[:WINDow] command.

Example: LAY:WIND2:REPL MTAB
Replaces the result display in window 2 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see LAYout:ADD[:WINDow]? on page 76.

Note that this command is not available in all applications and measurements.

Suffix:
<n> 1..n
Window

Parameters:
<WindowType>

Example: LAY:WIND2:TYPE?

6.5 Trace data readout

6.5.1 Using the TRACe[:DATA] command

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

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

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

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

Example:

```
TRAC2:DATA? TRACE1
```

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

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

Selecting a measurement window

Before querying results, you have to select the measurement window with the suffix <n> at `TRACe`. The range of <n> depends on the number of active measurement windows.

On an R&S FSQ or R&S FSV, the suffix <n> was not supported. On these instruments, you had to select the measurement window with `DISPlay:WINDow<n>:SELect` first.

6.5.1.1 Adjacent channel leakage ratio

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

- `TRAC:DATA TRACE1`
  Returns one value for each trace point.

6.5.1.2 Allocation summary

For the allocation summary, the command returns several values for each line of the table.

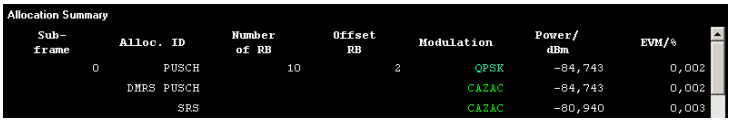
- `<subframe>`
- `<allocation ID>`
- `<number of RB>`
- `<offset RB>`
- `<modulation>`
- `<absolute power>`
- `<EVM>`

The data format of the return values is always ASCII.

The return values have the following characteristics.

- The `<allocation ID` is encoded.
  For the code assignment, see Chapter 6.5.1.18, "Return value codes", on page 90.
- The `<modulation>` is encoded.
  For the code assignment, see Chapter 6.5.1.18, "Return value codes", on page 90.
- The unit for `<absolute power>` is always dBm.
- The unit for `<EVM>` depends on `UNIT:EVM`.

Example:



Allocation Summary

Sub-frame	Alloc. ID	Number of RB	Offset RB	Modulation	Power/ dBm	EVM/%
0	PUSCH	10	2	QPSK	-84,743	0,002
	DMRS PUSCH			CAZAC	-84,743	0,002
	SRS			CAZAC	-80,940	0,003

`TRAC:DATA? TRACE1` would return:

```
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
0, -42, 0, 0, 6, -80.9404231343884, 3.97834623871343E-06,
...
```

Additional information "ALL"

(Note: this is does not apply to NB-IoT uplink queries.)

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,
(...)
//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 all subframes
-2,-2,,,,,2.13196434228374E-06
```

6.5.1.3 Bit stream

For the bitstream result display, the number of return values depends on the parameter.

- `TRACE:DATA TRACE1`
  Returns several values and the bitstream for each line of the table.
  `<index>, <allocation ID>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`
- `TRACE:DATA TRACE2`
  Returns all informative values of an allocation, including the totals over all NPUSCH allocations that contribute to the bitstream, but not the bitstream itself.
  `<index>, <allocation ID>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...,<total # bits>, <total # bit errors>, <total # decoded bits>, <total bit error rate>`

All values have no unit. The format of the bit stream depends on Bit Stream Format.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see Chapter 6.5.1.18, "Return value codes", on page 90.

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

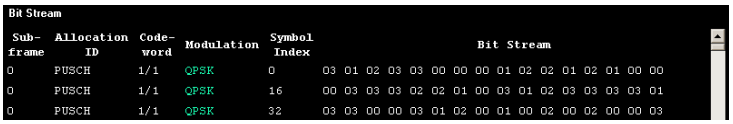
- "FFF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FFE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

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

Example:



`TRAC:DATA? TRACE1` would return:

```
0, -40 ,8, 96, 01, 00, 00, 00, 00, 00, 01, 00, ...
<continues like this until the next data block starts or the end of data is reached>
1, -40, 2, 96, 02, 00, 01, 02, 00, 02, 03, 00, ...
```

6.5.1.4 Capture buffer

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

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

The unit is always dBm.

The following parameters are supported.

- `TRAC:DATA TRACE1`

Note that the command returns positive peak values only.

6.5.1.5 CCDF

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

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

6.5.1.6 Channel and spectrum flatness

For the channel flatness result display, the command returns one value for each trace point.

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

The unit is always dB.

The following parameters are supported.

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

6.5.1.7 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.

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

6.5.1.8 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.

- `TRAC:DATA TRACE1`
  Returns the group delay.

6.5.1.9 Constellation diagram

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

<I[Slot0][Sym0][Carrier1]>, <Q[Slot0][Sym0][Carrier1]>, ..., <I[Slot0][Sym0][Carrier(n)]>, <Q[Slot0][Sym0][Carrier(n)]>,
<I[Slot0][Sym1][Carrier1]>, <Q[Slot0][Sym1][Carrier1]>, ..., <I[Slot0][Sym1][Carrier(n)]>, <Q[Slot0][Sym1][Carrier(n)]>,
<I[Slot0][Sym(n)][Carrier1]>, <Q[Slot0][Sym(n)][Carrier1]>, ..., <I[Slot0][Sym(n)][Carrier(n)]>, <Q[Slot0][Sym(n)][Carrier(n)]>,
<I[Slot1][Sym0][Carrier1]>, <Q[Slot1][Sym0][Carrier1]>, ..., <I[Slot1][Sym0][Carrier(n)]>, <Q[Slot1][Sym0][Carrier(n)]>,
<I[Slot1][Sym1][Carrier1]>, <Q[Slot1][Sym1][Carrier1]>, ..., <I[Slot1][Sym1][Carrier(n)]>, <Q[Slot1][Sym1][Carrier(n)]>,
<I[Slot(n)][Sym(n)][Carrier1]>, <Q[Slot(n)][Sym(n)][Carrier1]>, ..., <I[Slot(n)][Sym(n)][Carrier(n)]>, <Q[Slot(n)][Sym(n)][Carrier(n)]>

With Slot = slot number and Sym = symbol of that slot.

The I and Q values have no unit.

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

The following parameters are supported.

- `TRAC:DATA TRACE1`
  Returns all constellation points included in the selection.

6.5.1.10 EVM vs carrier

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

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

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

6.5.1.11 EVM vs symbol

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

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

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

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- `TRAC:DATA TRACE1`

6.5.1.12 EVM vs symbol x carrier

For the EVM vs symbol x carrier, the command returns one value for each resource element.

```
<EVM[Symbol(0),Carrier(1)]>, ..., <EVM[Symbol(0),Carrier(n)]>,
<EVM[Symbol(1),Carrier(1)]>, ..., <EVM[Symbol(1),Carrier(n)]>,
...
<EVM[Symbol(n),Carrier(1)]>, ..., <EVM[Symbol(n),Carrier(n)]>,
```

The unit depends on `UNIT:EVM`.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- `TRAC:DATA TRACE1`

6.5.1.13 Frequency error vs symbol

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

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

The unit is always Hz.

The following parameters are supported.

- `TRAC:DATA TRACE1`

6.5.1.14 Inband emission

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

- `TRAC:DATA TRACE1`
  Returns the relative resource block indices (x-axis values).
  `<RB index>, ...`

The resource block index has no unit.

- `TRAC:DATA TRACE2`
  Returns one value for each resource block index.
  `<relative power>, ...`
  The unit of the relative inband emission is dB.
- `TRAC:DATA TRACE3`
  Returns the data points of the upper limit line.
  `<limit>, ...`
  The unit is always dB.

Note that you have to select a particular subframe to get results.

6.5.1.15 Power spectrum

For the power spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- `TRAC:DATA TRACE1`

6.5.1.16 Power vs symbol x carrier

For the power vs symbol x carrier, the command returns one value for each resource element.

`<P[Symbol(0),Carrier(1)]>, ..., <P[Symbol(0),Carrier(n)]>,`

`<P[Symbol(1),Carrier(1)]>, ..., <P[Symbol(1),Carrier(n)]>,`

`...`

`<P[Symbol(n),Carrier(1)]>, ..., <P[Symbol(n),Carrier(n)]>,`

with P = Power of a resource element.

The unit is always dBm.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- `TRAC:DATA TRACE1`

6.5.1.17 Spectrum emission mask

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

- `TRAC:DATA TRACE1`
  Returns one value for each trace point.
  `<absolute power>, ...`

The unit is always dBm.

- `TRAC:DATA LIST`
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns 11 values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, <reserved>, <reserved>...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

6.5.1.18 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 value is a number in the range {1...-70}.

- **1** = Reference symbol
- **0** = Data symbol
- **-1** = Invalid
- **-40** = NPUSCH
- **-41** = NDMRS NPUSCH
- **-70** = NPRACH

<channel type>

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

<codeword>

Represents the codeword of an allocation. The range is {0...6}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2
- **3** = 1/4
- **4** = 2/4
- **5** = 3/4
- **6** = 4/4

<modulation>

Represents the modulation scheme.

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

FORMat[:DATA] <Format>

Selects the data format for the data transmission between the R&S VSE and the remote client.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: //Select data format

```
FORM REAL
```

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

This command queries the trace data for each measurement point (y-axis values).

In combination with `TRACe<n>[:DATA]:X?`, you can thus query the coordinates of each measurement point.

Suffix:

<n> Window

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**
Queries the trace data of the corresponding trace.

LIST Queries the results for the SEM measurement.

Return values:

<TraceData> For more information about the type of return values in the different result displays, see Chapter 6.5.1, "Using the TRACe[:DATA] command", on page 82.

Example: //Query results of the second measurement window. The type of data that is returned by the parameter (`TRACE1`) depends on the result display shown in measurement window 2.

```
TRAC2? TRACE1
```

Usage: Query only

Manual operation: See "Data import and export" on page 58

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

Queries the horizontal trace data for each measurement point (x-axis values).

In combination with `TRACe<n>[:DATA]?`, you can thus query the coordinates of each measurement point.

Suffix:
<n> Window

Query parameters:
<TraceNumber> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6

Return values:
<TraceData> The type of value depends on the information displayed on the x-axis of the result display whose contents you query.

Example:
```
//Query trace data of trace 1 in window 2
TRAC2? TRACE1
TRAC2:X? TRACE1
```

Usage: Query only

Manual operation: See "Capture Buffer" on page 12
See "EVM vs Carrier" on page 13
See "EVM vs Symbol" on page 14
See "Power Spectrum" on page 14
See "Inband Emission" on page 15
See "Spectrum Flatness" on page 15
See "Group Delay" on page 16
See "Spectrum Flatness Difference" on page 16

6.5.2 Result readout

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult[:CURRent]?
[<Measurement>]

Queries the results of the ACLR measurement or the total signal power level of the SEM measurement.

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

Suffix:
<n> Window

<m> Marker

<sb> irrelevant

Query parameters:

<Measurement>

CPOW
This parameter queries the channel power of the reference range.

MCAC
Queries the channel powers of the ACLR measurements as shown in the ACLR table.
Where available, this parameter also queries the power of the adjacent channels (for example in the ACLR measurement).

Return values:

<Result>

Results for the Spectrum Emission Mask measurement:
Power level in dBm.

Results for the ACLR measurements:
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES? MCAC`
Returns the current ACLR measurement results.

Usage: Query only

Manual operation: See "Result summary" on page 25

6.6 Numeric result readout

6.6.1 Frame results

FETCh[:CC<cc>]:SUMMary:EVM:UNDB[:AVERage]?

Queries the EVM of all NDMRS NPUSCH resource elements with a BPSK modulation.

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:UNDB?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:UNDQ[:AVERage]?

Queries the EVM of all NDMRS NPUSCH resource elements with a QPSK modulation.

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:UNDQ?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:UNPR[:AVERage]?

Queries the EVM of all NPRACH 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:UNPR?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:UNSB[:AVERage]?

Queries the EVM of all NPUSCH resource elements with a BPSK modulation.

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:UNSB?`

Usage: Query only

FETCh[:CC<cc>]:SUMMary:EVM:UNSQ[:AVERage]?

Queries the EVM of all NPUSCH resource elements with a QPSK modulation.

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:UNSQ?`

Usage: Query only

6.6.2 Result for selection

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

Queries the average crest factor as shown in the result summary.

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

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

Queries the EVM of all resource elements.

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

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

Queries the EVM of all physical channel resource elements.

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

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

Queries the EVM of all physical signal resource elements.

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

FETCh[:CC<cc>]:SUMMary:FE3G[:AVERage]?

Queries the frequency error as defined by 3GPP.

Suffix:
<cc> irrelevant

Return values:
<3GPPFrequencyError> <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:FE3G?`

Usage: Query only

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

Queries the frequency error.

Suffix:
<cc> Component Carrier

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

Example: //Query average frequency error
`FETC:SUMM:FERR?`

Usage: Query only

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

Queries the I/Q gain imbalance.

Suffix:
<cc> Component Carrier

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

Example: //Query average gain imbalance
`FETC:SUMM:GIMB?`

Usage: Query only

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

Queries the I/Q offset.

Suffix:
<cc> Component Carrier

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: //Query average IQ offset
`FETC:SUMM:IQOF?`

Usage: Query only

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

Queries the total power.

Suffix:

<cc> Component Carrier

Return values:

<Power> <numeric value>

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

Default unit: dBm

Example: //Query average total power
`FETC:SUMM:POW?`

Usage: Query only

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

Queries the quadrature error.

Suffix:

<cc> Component Carrier

Return values:

<QuadratureError> <numeric value>

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

Default unit: deg

Example: //Query average quadrature error
`FETC:SUMM:QUAD?`

Usage: Query only

6.6.3 Marker table

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

Moves a delta marker to a particular coordinate on the x-axis.

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

Suffix:

<n> Window

<m> Marker

Parameters:

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

Range: The value range and unit depend on the measurement and scale of the x-axis.

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

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

Queries the position of a deltamarker on the y-axis.

If necessary, the command activates the deltamarker first.

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

Note that result displays with a third aspect (for example "EVM vs Symbol x Carrier") do not support deltamarkers.

Suffix:

<n> Window

<m> Marker

Return values:

<Result> <numeric value>

Result at the deltamarker position. The return value is a value relative to the position of marker 1.
The type of value and its unit depend on the selected result display.

Example: //Query coordinates of deltamarker 2 in window 4
CALC4:DELT2:X?
CALC4:DELT2:Y?

Usage: Query only

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

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

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

Suffix:
<n> Window

<m> Marker
Note that 3D diagrams only support one marker.

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

Range: The range depends on the current x-axis range.
Default unit: Hz

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

Manual operation: See "Marker Table" on page 23
See "Marker Peak List" on page 26

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

Queries the position of a marker on the y-axis.

In result displays with a third aspect (for example "EVM vs Symbol x Carrier"), you can also use the command to define the position of the marker on the y-axis.

If necessary, the command activates the marker first.

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

Suffix:
<n> Window

<m> Marker
Note that 3D diagrams only support one marker.

Parameters:

<Result> <numeric value>

Result at the marker position.
The type of value and its unit depend on the selected result display.

Example: //Query coordinates of marker 2 in window 4

```
CALC4:MARK2:X?
CALC4:MARK2:Y?
```

Example: //Define position of marker in 3D diagram

```
CALC:MARK:X 16
CALC:MARK:Y 6
```

Manual operation: See "Marker Table" on page 23
See "Marker Peak List" on page 26

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

Queries the marker position on the z-axis of three-dimensional result displays.

Returns the type of value displayed in the selected result display (EVM or Power).

Suffix:

<n> Window

<m> Marker

Return values:

<Position> <numeric value>

Default unit: Depends on result display

Example: //Query marker position

```
CALC:MARK:Z?
```

Usage: Query only

Manual operation: See "Marker Table" on page 23

CALCulate<n>:MARKer<m>:Z:ALL?

Queries the marker position on the z-axis of three-dimensional result displays.

Instead of returning a certain type of value (EVM **or** Power), which is possible with `CALCulate<n>:MARKer<m>:Z?`, this command returns all types of values (EVM **and** Power), regardless of the result display type.

Suffix:

<n> Window

<m> irrelevant

Return values:

<Position> <numeric value>

EVM
EVM at the marker position.

Power
Power at the marker position.

Modulation
Modulation type at the marker position.

Example: //Query EVM and Power at the marker position.
```
CALC:MARK:Z:ALL?
```

Usage: Query only

Manual operation: See "Marker Table" on page 23

6.6.4 CCDF table

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

Queries the results of the CCDF.

Suffix:
<n> Window

<t> Trace

Query parameters:
<Probability>

P0_01
Level value for 0.01 % probability

P0_1
Level value for 0.1 % probability

P1
P1: Level value for 1 % probability

P10
Level value for 10 % probability

Return values:
<CCDF Result>

Example:
```
CALC:STAT:CCDF:X1? P10
```
Returns the level values that are over 10 % above the mean value.

Usage: Query only

Manual operation: See "CCDF" on page 17

CALCulate<n>:STATistics:RESult<res>? <ResultType>

Queries the results of a measurement for a specific trace.

Suffix:
<n> Window

<res> Trace

Query parameters:
<ResultType>

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example: `CALC:STAT:RES2? ALL`
Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage: Query only

Manual operation: See "CCDF" on page 17

6.7 Remote commands to configure the application

6.7.1 General configuration

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

The remote control commands to select the result displays for I/Q measurements are described in Chapter 6.4, "Screen layout", on page 71.

CONFigure[:LTE]:MEASurement <Measurement>

Selects the measurement.

Parameters:

<Measurement>

ACLR
Selects the Adjacent Channel Leakage Ratio measurement.

ESPectrum
Selects the Spectrum Emission Mask measurement.

EVM
Selects I/Q measurements.

TAERor
Selects the Time Alignment Error measurement.

*RST: EVM

Example:

//Select measurement
`CONF:MEAS EVM`

Manual operation:

See "EVM" on page 10
See "Channel power ACLR" on page 10
See "SEM" on page 11
See "Adjacent Channel Leakage Ratio (ACLR)" on page 24
See "Spectrum Emission Mask (SEM)" on page 25
See "Select Measurement" on page 29

MMEMory:STORe<n>:IQ:STATe <Value>,<FileName>

Saves I/Q data to a file.

Suffix:

<n> irrelevant

Parameters:

<Value> 1

<FileName> String containing the path and name of the target file.

Example:

```
MMEM:STOR:IQ:STAT 'C:
\R_S\Instr\user\data.iq.tar'
```
Saves I/Q data to the specified file.

Manual operation:

See "Data import and export" on page 58

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default software settings in the current channel.

Use `INST:SEL` to select the channel.

Example:

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

Usage: Event

Manual operation: See "Preset Channel" on page 29

6.7.2 Configuring I/Q measurements

6.7.2.1 Signal characteristics

Physical settings

CONFigure[:LTE]:LDIRection <Direction>

Selects the link direction.

Parameters:

<Direction>

DL
Selects the mode to analyze downlink signals.

UL
Selects the mode to analyze uplink signals.

Example: //Select downlink mode
```
CONF:LDIR DL
```

Manual operation: See "Selecting the NB-IoT mode" on page 30

CONFigure[:LTE]:UL:SSPacing <Bandwidth>

Selects the subcarrier spacing of the signal.

Parameters:

<Bandwidth>

SS_15
Selects 15 kHz subcarrier bandwidth.

SS_3_75
Selects a 3.75 kHz subcarrier bandwidth.

*RST: SS_15

Example:
//Select 15 kHz subcarrier spacing
```
CONF:UL:SSP SS_15
```

Manual operation: See "Subcarrier Spacing" on page 31

CONFigure[:LTE]:UL[:CC<cc>]:PLC:CID <CellID>

Defines the cell ID.

Suffix:

<cc> Component Carrier

Parameters:

<CellID>

AUTO
Automatically determines the cell ID.

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

Range: 0 to 503

Example:
//Select automatic detection of the cell ID
```
CONF:UL:PLC:CID AUTO
```

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 31

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

Selects the cell identity group.

Suffix:

<cc> Component Carrier

Parameters:

<GroupNumber> <numeric value> (integer only)

Range: 1 to 167
*RST: 0

Example:
//Select cell identity group 12
```
CONF:UL:PLCI:CIDG 12
```

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 31

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

Selects the physical layer identity.

Suffix:
<cc> Component Carrier

Parameters:
<Identity> 0 | 1 | 2

Example: //Select physical layer identity 2
`CONF:DL:PLC:PLID 2`

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 31

[SENSe:][LTE:][CC<cc>:]SFLatness:OBANd <Subbands>

Selects the operating band for spectrum flatness measurements.

Suffix:
<cc> Component Carrier

Parameters:
<Subbands> <numeric value> (integer only)
Range: 1 to 40
*RST: 1

Example: //Select operating band 10
`SFL:OBAN 10`

Manual operation: See "Operating Band Index" on page 32

[SENSe:][LTE:]UL:DEMod:MODE <Mode>

Selects the uplink analysis mode.

Parameters:
<Mode> **NPUSch**
Analyzes the NPUSCH and NPUCCH.
NPRach
Analyzes the NPRACH.
*RST: NPUSch

Example: //Select NPRACH analysis mode
`UL:DEM:MODE PRAC`

Manual operation: See "Analysis Mode" on page 30

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

Restores previously saved demodulation settings.

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

Suffix:
<cc> Component Carrier

Parameters:
<File> String containing the path and name of the file.

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

Manual operation: See "User defined test scenarios" on page 32

MMEMory:STORe<n>[:CC<cc>]:DEModsetting <FileName>

Saves the signal description.

Suffix:
<n> irrelevant

<cc> irrelevant

Parameters:
<FileName> String containing the path and name of the file.
The file extension is `.allocation`.

Example: //Save signal description
```
MMEM:STOR:DEM 'c:\TestSignal.allocation'
```

Manual operation: See "User defined test scenarios" on page 32

NPUSCH configuration

CONFigure[:LTE]:UL:AUTO:NPUSch:MTYPe <State>

Turn automatic detection of the modulation type that an NPUSCH uses on and off.

Parameters:
<State> **ON | 1**
Automatically detects the modulation type of an NPUSCH.

OFF | 0
You can define the modulation type manually with `CONFigure[:LTE]:UL:NPUSch<np>:MODulation`.

*RST: ON

Example: //Detect modulation type of NPUSCH
`CONF:UL:AUTO:NPUS:MTYP ON`

Manual operation: See "Automatic detection of NPUSCH characteristics" on page 33

CONFigure[:LTE]:UL:AUTO:NPUSch:NSUBcarriers <State>

Turn automatic detection of the number of subcarriers that an NPUSCH occupies on and off.

Parameters:
<State>

ON | 1
Automatically detects the number of subcarriers occupied by an NPUSCH.

OFF | 0
You can define the number of subcarriers manually with `CONFigure[:LTE]:UL:NPUSch<np>:NOSubcarrier`.

*RST: ON

Example: //Detect number of subcarriers occupied by an NPUSCH
`CONF:UL:AUTO:NPUS:NSUB ON`

Manual operation: See "Automatic detection of NPUSCH characteristics" on page 33

CONFigure[:LTE]:UL:AUTO:NPUSch:SSUBcarrier <State>

Turn automatic detection of the first subcarrier that an NPUSCH occupies on and off.

Parameters:
<State>

ON | 1
Automatically detects the start subcarrier of an NPUSCH.

OFF | 0
You can define the start subcarrier manually with `CONFigure[:LTE]:UL:NPUSch<np>:SSUBcarrier`.

*RST: ON

Example: //Detect start subcarrier of NPUSCH
`CONF:UL:AUTO:NPUS:SSUB ON`

Manual operation: See "Automatic detection of NPUSCH characteristics" on page 33

CONFigure[:LTE]:UL:NONPusch <NPUSCHs>

Defines the number of NPUSCH channels in the system.

Commands to customize each NPUSCH separately.

- NPUSCH format: `CONFigure[:LTE]:UL:NPUSch<np>:FORMat`
- Subcarriers: `CONFigure[:LTE]:UL:NPUSch<np>:NOSubcarrier`
- Start slot: `CONFigure[:LTE]:UL:NPUSch<np>:SSLot`
- Start subcarrier: `CONFigure[:LTE]:UL:NPUSch<np>:SSUBcarrier`
- Resource units: `CONFigure[:LTE]:UL:NPUSch<np>:NORU`
- Repetitions: `CONFigure[:LTE]:UL:NPUSch<np>:MREP`
- Modulation: `CONFigure[:LTE]:UL:NPUSch<np>:MODulation`

Parameters:

<NPUSCHs> <numeric value> (integer only)

Range: 0 to 20
*RST: 1

Example: //Select 5 NPUSCHs

```
CONF:UL:NONP 5
```

CONFigure[:LTE]:UL:NPUSch<np>:FORMat <Format>

Selects the format of the corresponding NPUSCH.

Suffix:

<np> NPUSCH

Parameters:

<Format> F1 | F2

*RST: F1

Example: //Select format F1 for the second NPUSCH

```
CONF:UL:NPUS2:FORM F1
```

Manual operation: See "NPUSCH Format" on page 35

CONFigure[:LTE]:UL:NPUSch<np>:MODulation <Modulation>

Selects the modulation type for the corresponding NPUSCH.

Suffix:

<np> NPUSCH

Parameters:

<Modulation> BPSK | QPSK

Note: Availability of modulation types depend on NPUSCH format and number of subcarriers reserved for the NPUSCH.
• NPUSCH format 1 with one subcarrier: BPSK and QPSK
• NPUSCH format 1 with more than one subcarrier: QPSK

• NPUSCH format 2: BPSK

*RST: QPSK (F1 is default for any NPUSCH)

Example: //Configure the second NPUSCH for QPSK modulation
`CONF:UL:NPUS2:MOD QPSK`

Manual operation: See "Modulation" on page 36

CONFigure[:LTE]:UL:NPUSch<np>:MREP <Repetitions>

Defines how often the NPUSCH is transmitted with the same information.

Suffix:
<np> NPUSCH

Parameters:
<Repetitions> 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128

*RST: 1

Example: //Configure the second NPUSCH to be repeated 16 times
`CONF:UL:NPUS2:MREP 16`

Manual operation: See "Repetitions" on page 35

CONFigure[:LTE]:UL:NPUSch<np>:NORU <ResourceUnits>

Defines the number of resource units the NPUSCH is mapped to.

Suffix:
<np> NPUSCH

Parameters:
<ResourceUnits> 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10

*RST: 1

Example: //Map the second NPUSCH to 5 resource units
`CONF:UL:NPUS2:NOR 5`

Manual operation: See "Resource Units" on page 35

CONFigure[:LTE]:UL:NPUSch<np>:NOSubcarrier <Subcarrier>

Defines the number of subcarriers used by the corresponding NPUSCH.

Suffix:
<np> NPUSCH

Parameters:
<Subcarrier> 1 | 3 | 6 | 12

Note: Values other than "1" are only availble for a subcarrier spacing of 15 kHz and NPUSCHs configured as format 1.

*RST: 1

Example: //Assign 4 subcarriers to the second NPUSCH.
`CONF:UL:NPUS2:NOS 4`

Manual operation: See "Number of Subcarriers" on page 35

CONFigure[:LTE]:UL:NPUSch<np>:SSLot <Slot>

Defines the start slot of the corresponding NPUSCH.

Suffix:
<np> NPUSCH

Parameters:
<Slot> <numeric value> (integer only)
Range: 0 to 40960
*RST: 0

Example: //Configure the second NPUSCH to start on slot number 10.
`CONF:UL:NPUS2:SSL 10`

Manual operation: See "Start Slot" on page 35

CONFigure[:LTE]:UL:NPUSch<np>:SSUBcarrier <Subcarrier>

Defines the start subcarrier for the corresponding NPUSCH.

Suffix:
<np> NPUSCH

Parameters:
<Subcarrier> <numeric value> (integer only)
Range: 0 to 47
*RST: 0

Example: //Configure the second NPUSCH to start on subcarrier number 10.
`CONF:UL:NPUS2:SSUB 10`

Manual operation: See "Starting Subcarrier" on page 35

Global settings

CONFigure[:LTE]:UL[:CC<cc>]:UEID <ID>

Defines the radio network temporary identifier (RNTI) of the UE.

Suffix:
<cc> Component Carrier

Parameters:

<ID> <numeric value> (integer only)

Range: 0 to 65535
*RST: 0

Example: //Define a RNTI of 2
`CONF:UL:UEID 2`

Manual operation: See "UE ID/n_RNTI" on page 36

Demodulation reference signal

CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSIX <BaseSequence>

Defines the base sequence for the demodulation reference signal in case it is based on a six tone.

Prerequisites for this command

- Group hopping is off, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping`
- Source of the reference signal is a higher layer, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce`.

Suffix:

<cc> irrelevant

Parameters:

<BaseSequence> <numeric value> (integer only)

Range: 0 to 0
*RST: 13

Example: //Select base sequence
`CONF:UL:DRS:BSIX 4`

Manual operation: See "Base Sequence" on page 37

CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce <Source>

Selects the source of the demodulation reference signal.

Suffix:
<cc> irrelevant

Parameters:
<Source> **HLAYer**
Source of the NDMRS is a higher layer.

IDCell
Source of the NDMRS is the cell ID.

*RST: IDCell

Example: //Select the higher layer as the source of the NDMRS
`CONF:UL:DRS:BSO HLAY`

Manual operation: See "Base Sequence Source" on page 37

CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSTWelve <BaseSequence>

Defines the base sequence for the demodulation reference signal in case it is based on a twelve tone.

Prerequisites for this command

- Group hopping is off, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping`
- Source of the reference signal is a higher layer, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce`.

Suffix:
<cc> irrelevant

Parameters:
<BaseSequence> <numeric value> (integer only)

Range: 0 to 0
*RST: 29

Example: //Select base sequence
`CONF:UL:DRS:BSTW 4`

Manual operation: See "Base Sequence" on page 37

CONFigure[:LTE]:UL[:CC<cc>]:DRS:BTHRee <BaseSequence>

Defines the base sequence for the demodulation reference signal in case it is based on a three tone.

Prerequisites for this command

- Group hopping is off, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping`
- Source of the reference signal is a higher layer, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce`.

Suffix:
<cc> irrelevant

Parameters:

<BaseSequence> <numeric value> (integer only)

Range: 0 to 0
*RST: 11

Example: //Select base sequence
`CONF:UL:DRS:BTHR 4`

Manual operation: See "Base Sequence" on page 37

CONFigure[:LTE]:UL[:CC<cc>]:DRS:CSSix <CyclicShift>

Defines the cyclic shift for the demodulation reference signal in case it is based on a six tone.

Prerequisites for this command

- Group hopping is off, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping`
- Source of the reference signal is a higher layer, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce`.

Suffix:

<cc> irrelevant

Parameters:

<CyclicShift> 0 | 1 | 2 | 3

*RST: 0

Example: //Select six tone cyclic shift 2
`CONF:UL:DRS:CSS 2`

Manual operation: See "Cyclic Shift" on page 38

CONFigure[:LTE]:UL[:CC<cc>]:DRS:CSTHree <CyclicShift>

Defines the cyclic shift for the demodulation reference signal in case it is based on a three tone.

Prerequisites for this command

- Group hopping is off, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping` .
- Source of the reference signal is a higher layer, see `CONFigure[:LTE]:UL[:CC<cc>]:DRS:BSOurce`.

Suffix:

<cc> irrelevant

Parameters:

<CyclicShift> 0 | 1 | 2

*RST: 0

Example: //Select three tone cyclic shift 2
`CONF:UL:DRS:CSTH`

Manual operation: See "Cyclic Shift" on page 38

CONFigure[:LTE]:UL[:CC<cc>]:DRS:DSSHift <Shift>

Selects the delta sequence shift of the uplink signal.

Prerequisites for this command

- Turn on group hopping (`CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping` on page 117).

Suffix:
<cc> Component Carrier

Parameters:
<Shift> <numeric value> (integer only)
*RST: 0

Example: //Select delta sequence shift
`CONF:UL:DRS:DSSH 3`

Manual operation: See " Delta Sequence Shift" on page 38

CONFigure[:LTE]:UL[:CC<cc>]:DRS:GRPHopping <State>

Turns group hopping for uplink signals on and off.

Suffix:
<cc> Component Carrier

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

Example: //Turn on group hopping
`CONF:UL:DRS:GRPH ON`

Manual operation: See " Group Hopping" on page 38

Sounding reference signal

CONFigure[:LTE]:UL[:CC<cc>]:SRS:STAT <State>

Turns the sounding reference signal on and off.

Suffix:
<cc> Component Carrier

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

Example: //Turn on the sounding reference signal
`CONF:UL:SRS:STAT ON`

Manual operation: See " Present" on page 39

CONFigure[:LTE]:UL[:CC<cc>]:SRS:SUConfig <Configuration>

Defines the SRS subframe configuration.

Prerequisites for this command

- Turn on the sounding reference signal with `CONFigure[:LTE]:UL[:CC<cc>]:SRS:STAT`.

Suffix:
<cc> Component Carrier

Parameters:
<Configuration> <numeric value> (integer only)
Range: 0 to 14
*RST: 0

Example: //Select SRS subframe configuration 4
`CONF:UL:SRS:SUC 4`

Manual operation: See " SRS Subframe Configuration" on page 39

NPRACH structure

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:FORMat <Format>

Selects the NPRACH format.

Suffix:
<cc> irrelevant

Parameters:
<Format> F0 | F1
*RST: F1

Example: //Select NPRACH format F1
`CONF:UL:NPR:FORM F1`

Manual operation: See "NPRACH Format" on page 40

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NIMode <Mode>

Selects the way that the N_{Init} is determined (location of the NPRACH).

Suffix:
<cc> irrelevant

Parameters:
<Mode>

AUTO
Automatically determines the N_{Init}.

MANual
You can define the N_{Init} manually with `CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NINit`.

*RST: AUTO

Example:
```
//Select mode to determine N_init
CONF:UL:NPR:NIM AUTO
```

Manual operation: See "N_init" on page 41

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NINit <Value>

Defines the N_{Init} value.

Prerequisites for this command
- Select manual N_{Init} mode (`CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NIMode`).

Suffix:
<cc> irrelevant

Parameters:
<Value>

<numeric value> (integer only)

Range: 0 to 47
*RST: 0

Example:
```
//Select n_init
CONF:UL:NPR:NIM MAN
CONF:UL:NPR:NIN 10
```

Manual operation: See "N_init" on page 41

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NREP <Repetitions>

Defines how often identical NPRACH information is transmitted.

Suffix:
<cc> irrelevant

Parameters:
<Repetitions> 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128

*RST: 0

Example: //Transmit the NPRACH information 16 times
`CONF:UL:NPR:NREP 16`

Manual operation: See "Number of Repetitions" on page 40

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:NSUB <Subcarrier>

Defines the number of subcarriers allocated to the NPRACH.

Suffix:
<cc> irrelevant

Parameters:
<Subcarrier> 12 | 24 | 36 | 48
*RST: 12

Example: //Allocate 24 subcarriers to the NPRACH
`CONF:UL:NPR:NSUB 24`

Manual operation: See "Subcarrier Configuration" on page 40

CONFigure[:LTE]:UL[:CC<cc>]:NPRach:SOFFset <Offset>

Defines the first subcarrier allocated to the NPRACH.

Suffix:
<cc> irrelevant

Parameters:
<Offset> 0 | 2 | 12 | 18 | 24 | 34 | 36
*RST: 0

Example: //Select an offset of 2
`CONF:UL:NPR:SOFF 2`

Manual operation: See "Subcarrier Configuration" on page 40

6.7.2.2 Inputs configuration

Useful commands to perform measurements described elsewhere:

- `INPut<ip>:COUPling<ant>` on page 128
- `INPut<ip>:IMPedance<ant>` on page 130

INPut:FILE<fi>:PATH <FileName>[, <AnalysisBW>]

Selects the I/Q data file to be used as input for further measurements.

Suffix:
<fi> 1..n

Parameters:
<FileName> String containing the path and name of the source file.
The file extension is `*.iq.tar`.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.

Default unit: HZ

Example: `INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'`
Uses I/Q data from the specified file as input.

Manual operation: See "Data import and export" on page 58

INPut<ip>:FILE:ZPADding <State>

Enables or disables zeropadding for input from an I/Q data file that requires resampling. For resampling, a number of samples are required due to filter settling. These samples can either be taken from the provided I/Q data, or the software can add the required number of samples (zeros) at the beginning and end of the file.

Suffix:
<ip> 1..n

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILE:ZPAD ON`

Manual operation: See "Zero Padding" on page 45

INPut<ip>:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the connected instrument to measure the harmonics for a DUT, for example.

Requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Suffix:
<ip> 1..n

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Manual operation: See "High Pass Filter 1 to 3 GHz" on page 42

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

Enables or disables the YIG filter.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<State> ON | OFF | 0 | 1

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 42

INPut:SELect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S VSE.

If no additional input options are installed, only RF input or file input is supported.

Parameters:
<Source>

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file

AIQ
Analog Baseband signal (only available with optional "Analog Baseband" interface)

*RST: RF

Manual operation: See "Input Type (Instrument / File)" on page 45

INPut<ip>:RF:CAPMode <CAPMode>

Determines how data from an oscilloscope is input to the R&S VSE software.

Is only available for connected oscilloscopes.

Suffix:
<ip> 1..n

Parameters:
<CAPMode> AUTO | IQ | WAVeform

IQ
The measured waveform is converted to I/Q data directly on the R&S oscilloscope (requires option K11), and input to the R&S VSE software as I/Q data.

WAVeform
The data is input in its original waveform format and converted to I/Q data in the R&S VSE software. No additional options are required on the R&S oscilloscope.

AUTO
Uses "I/Q" mode when possible, and "Waveform" only when required by the application (e.g. Pulse measurement).

*RST: IQ

Example:
```
INP:RF:CAPM WAV
```

Manual operation: See "Capture Mode" on page 42

INPut<ip>:RF:CAPMode:IQ:SRATe <SamplingRate>

Determines the sample rate used by the connected oscilloscope for I/Q capture mode (see `INPut<ip>:RF:CAPMode` on page 123).

This setting is only available if an R&S oscilloscope is used to obtain the input data.

Suffix:
<ip> 1..n

Parameters:
<SamplingRate> 20 GHz | 40 GHz

No other sample rate values are allowed.

20 GHz
Achieves a higher decimation gain, but reduces the record length by half.
Only available for R&S oscilloscope models that support a sample rate of 20 GHz (see data sheet).

40 GHz
Provides a maximum sample rate.
Only available for R&S RTP13/RTP16 models that support a sample rate of 40 GHz (see data sheet).

*RST: 20 GHz
Default unit: HZ

Example:
```
INP:RF:CAPM IQ
INP:RF:CAPM:IQ:SRAT 40 GHZ
```

Manual operation: See "Oscilloscope Sample Rate" on page 43

INPut<ip>:RF:CAPMode:WAVeform:SRATe <SamplingRate>

Determines the sample rate used by the connected oscilloscope for waveform capture mode (see `INPut<ip>:RF:CAPMode` on page 123).

This setting is only available if an R&S oscilloscope is used to obtain the input data, either directly or via the R&S FSW.

Suffix:
<ip> 1..n

Parameters:
<SamplingRate> 10 GHz | 20 GHz

No other sample rate values are allowed.

10 GHz
Default ; provides maximum record length

20 GHz
Achieves a higher decimation gain, but reduces the record length by half.
Only available for R&S oscilloscope models that support a sample rate of 20 GHz (see data sheet).
For R&S oscilloscopes with an analysis bandwidth of 4 GHz or larger, a sample rate of 20 GHZ is always used.

*RST: 10 GHz
Default unit: HZ

Example:
```
INP:RF:CAPM WAV
INP:RF:CAPM:WAVE:SRAT 10000000
```

Manual operation: See "Oscilloscope Sample Rate" on page 43

INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si> <Type>

Selects an instrument or a file as the source of input provided to the channel.

Suffix:
<si> 1 to 99
LTE-MIMO only: input source number

Parameters:
<Type> FILE | DEVice | NONE

FILE
A loaded file is used for input.

DEVice
A configured device provides input for the measurement

NONE
No input source defined.

Manual operation: See "Input Type (Instrument / File)" on page 45

SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe <Rate>

Determines whether the 10 GHz mode (default) or 20 GHz mode of the connected oscilloscope is used. The 20 GHZ mode achieves a higher decimation gain, but reduces the record length by half.

Parameters:
<Rate> 10 GHz | 20 GHz

No other sample rate values are allowed.

*RST: 10 GHz
Default unit: HZ

Example:
```
TRAC:IQ:SRAT?
//Result: 100000000
TRAC:IQ:RLEN?
//Result: 3128
SYST:COMM:RDEV:OSC:SRAT 20GHZ
TRAC:IQ:SRAT?
//Result: 200000000
TRAC:IQ:RLEN?
//Result: 1564
```

Manual operation: See "Oscilloscope Sample Rate" on page 43

6.7.2.3 Frequency configuration

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

Sets the center frequency for RF measurements.

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

Suffix:
<cc> Component Carrier

Parameters:
<Frequency> <numeric value>

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

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

Manual operation: See "Center Frequency" on page 46

[SENSe:]FREQuency:CENTer[:CC<cc>]:OFFSet <Offset>

Defines the general frequency offset.

Suffix:
<cc> Component Carrier

Parameters:
<Offset> <numeric value>

• General frequency offset: frequency offset in Hz.

Default unit: Hz

Example: //Add a frequency offset of 50 Hz to the measurement frequency.
```
FREQ:CENT:OFFS 50HZ
```

Manual operation: See "Center Frequency" on page 46

[SENSe:]FREQuency:CENTer:STEP <StepSize>

Defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` and `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 125.

Parameters:
<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example: //Set the center frequency to 110 MHz.
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Frequency Stepsize" on page 46

6.7.2.4 Amplitude configuration

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant> <ReferenceLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm
Default unit: DBM

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See "Reference Level" on page 47

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>:OFFSet <Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

Example:
```
DISP:TRAC:Y:RLEV:OFFS -10dB
```

Manual operation: See "Reference Level Offset" on page 48

INPut<ip>:ATTenuation<ant> <Attenuation>

Defines the RF attenuation level.

Prerequisites for this command

- Decouple attenuation from reference level (`INPut<ip>:ATTenuation<ant>:AUTO`).

Suffix:

<ip> irrelevant

<ant> irrelevant

Parameters:

<Attenuation> *RST: 10 dB
Default unit: dB

Example:
```
//Define RF attenuation
INP:ATT:AUTO OFF
INP:ATT 10
```

Manual operation: See "RF Attenuation" on page 48

INPut<ip>:ATTenuation<ant>:AUTO <State>

Couples and decouples the RF attenuation to the reference level.

Suffix:

<ip> irrelevant

<ant> irrelevant

Parameters:

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

Example:
```
//Couple attenuation to reference level (auto attenuation)
INP:ATT:AUTO ON
```

Manual operation: See "RF Attenuation" on page 48

INPut<ip>:COUPling<ant> <CouplingType>

Selects the coupling type of the RF input.

If an external frontend is active, the coupling is automatically set to AC.

Suffix:
<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:
<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: INP:COUP DC

Manual operation: See "Input Coupling" on page 49

INPut<ip>:GAIN<ant>:STATe <State>

Turns the internal preamplifier on the connected instrument on and off. It requires the additional preamplifier hardware option on the connected instrument.

Suffix:
<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```
Switches on 15 dB preamplification.

Manual operation: See "Preamplifier" on page 49

INPut<ip>:GAIN<ant>[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (INP:GAIN:STAT ON, see INPut<ip>:GAIN<ant>:STATe on page 129).

The command requires the additional preamplifier hardware option.

Suffix:
<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:
<Gain> 15 dB and 30 dB
All other values are rounded to the nearest of these two.
30 dB

Default unit: DB

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```
Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 49

INPut<ip>:IMPedance<ant> <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Suffix:
<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:
<Impedance> 50 | 75

*RST: 50 Ω
Default unit: OHM

Example:
```
INP:IMP 75
```

Manual operation: See "Impedance" on page 50

INPut<ip>:EATT<ant> <Attenuation>

Defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Suffix:
<ip> irrelevant

<ant> Connected instrument

Parameters:
<Attenuation> Attenuation level in dB.

Default unit: dB

Example: //Define signal attenuation
`INP:EATT 10`

Manual operation: See "Electronic Attenuation" on page 48

INPut<ip>:EATT<ant>:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Suffix:
<ip> irrelevant

<ant> 1...4
Connected instrument

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

Example: //Turn on automatic selection of electronic attenuation
`INP:EATT:AUTO ON`

Manual operation: See "Electronic Attenuation" on page 48

INPut<ip>:EATT<ant>:STATe <State>

Turns the electronic attenuator on and off.

Suffix:
<ip> irrelevant

<ant> 1...4
Connected instrument

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

Example: //Turn on electronic attenuation
`INP:EATT:STAT ON`

Manual operation: See "Electronic Attenuation" on page 48

6.7.2.5 Automatic configuration

Commands to configure the application automatically described elsewhere.

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO`

[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation <Duration>

To determine the ideal reference level, the R&S VSE performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE` is set to `MANual`.

Suffix:
<ip> 1..n

Parameters:
<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Auto Level" on page 47

[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the R&S VSE performs a measurement on the current input data. This command selects the way the R&S VSE determines the length of the measurement .

Suffix:
<ip> 1..n

Parameters:
<Mode>

AUTO
The R&S VSE determines the measurement length automatically according to the current input data.

MANual
The R&S VSE uses the measurement length defined by `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation` on page 132.

*RST: AUTO

Manual operation: See "Auto Level" on page 47

[SENSe:]ADJust:LEVel<ant>

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S VSE or limiting the dynamic range by an S/N ratio that is too small.

Suffix:
<ant> 1...4
Connected instrument

Example: //Auto level on one instrument
`ADJ:LEV2`

Usage: Event

Manual operation: See "Auto Level" on page 47
See "Auto leveling" on page 54

6.7.2.6 Signal capture

[SENSe:][LTE:][CC<cc>:]SLOT:COUNt <Slots>

Defines the number of slots you want to analyze.

Prerequisites for this command

- Turn off automatic evaluation of slots (`[SENSe:][LTE:][CC<cc>:]SLOT:COUNt:AUTO`).

Suffix:
<cc> Component Carrier

Parameters:
<Slots> <numeric value> (integer only)
*RST: 1

Example: //Analyze 4 slots
```
SLOT:COUN:AUTO OFF
SLOT:COUN 4
```

Manual operation: See "Number of Slots to Analyze" on page 53

[SENSe:][LTE:][CC<cc>:]SLOT:COUNt:AUTO <State>

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

Suffix:
<cc> Component Carrier

Parameters:
<State> **ON | 1**
Selects the number of slots to analyze according to the NB-IoT standard.

OFF | 0
Turns on manual selection of the number of analyzed slots.
In case of manual selection, you can select the number of slots with `[SENSe:][LTE:][CC<cc>:]SLOT:COUNt`

*RST: ON

Example: //Analyze slots according to standard
```
SLOT:COUN:AUTO ON
```

Manual operation: See "Auto According to Standard" on page 53

[SENSe:][LTE:][CC<cc>:]SLOT:COUNt:STATe <State>

Turns manual selection of the number of frames you want to analyze on and off.

Suffix:
<cc> Component Carrier

Parameters:
<State>

ON | 1
Define the number of slots to analyze manually.

OFF | 0
Analyze all slots included in a single sweep.

*RST: ON

Example: //Analyze all captured slots
```
SLOT:COUN:STAT OFF
```

Manual operation: See "Overall Slot Count" on page 53

[SENSe:]SWAPiq <State>

Turns a swap of the I and Q branches on and off.

Parameters:
<State> ON | OFF | 1 | 0

*RST: OFF

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

Manual operation: See "Swap I/Q" on page 53

[SENSe:]SWEep:TIME <CaptureLength>

Defines the capture time.

Parameters:
<CaptureLength> <numeric value>

*RST: 40.1 ms
Default unit: s

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

Manual operation: See "Capture Time" on page 53

6.7.2.7 Trigger

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

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

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

For input from the "Analog Baseband" interface using the baseband power trigger (BBP), the default drop out time is set to 100 ns to avoid unintentional trigger events (as no hysteresis can be configured in this case).

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:HOLDoff<ant>[:TIME] <Offset>

Defines the trigger offset.

Suffix:

<ant> Instrument

Parameters:

<Offset> <numeric value>

*RST: 0 s
Default unit: s

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

Manual operation: See "Trigger Source" on page 51

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

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example: `TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Source" on page 51

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

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

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

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:LEVel<ant>[:EXTernal<tp>] <Level>

Defines the level for an external trigger.

Suffix:

<ant> Instrument

<tp> Trigger port

Parameters:

<Level>
Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example:
//Define trigger level
```
TRIG:LEV 2V
```

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:LEVel<ant>:IFPower <Level>

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Suffix:

<ant> Instrument

Parameters:

<Level>
<numeric value>

For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -10 dBm
Default unit: dBm

Example:
//Define trigger level
```
TRIG:SOUR IFP
TRIG:LEV:IFP -30dBm
```

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:LEVel<ant>:IQPower <Level>

Defines the magnitude the I/Q data must exceed to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Suffix:

<ant> Instrument

Parameters:

<Level>
<numeric value>

Range: -130 dBm to 30 dBm
*RST: -20 dBm
Default unit: dBm

Example:
//Define trigger level
```
TRIG:SOUR IQP
TRIG:LEV:IQP -30dBm
```

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:LEVel<ant>:RFPower <Level>

Defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Suffix:
<ant> Instrument

Parameters:
<Level> <numeric value>

For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -20 dBm
Default unit: dBm

Example: //Define trigger level
```
TRIG:SOUR RFP
TRIG:LEV:RFP -30dBm
```

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:LEVel:MAPower <TriggerLevel>

Defines the power level that must be exceeded to cause a trigger event for (offline) input from a file.

Parameters:
<TriggerLevel> For details on available trigger levels and trigger bandwidths, see the data sheet.

Default unit: DBM

Example:
```
TRIG:LEV:MAP -30DBM
```

TRIGger[:SEQuence]:MAPower:HOLDoff <Period>

Defines the holding time before the next trigger event for (offline) input from a file.

Parameters:
<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example:
```
TRIG:SOUR MAGN
```
Sets an offline magnitude trigger source.
```
TRIG:MAP:HOLD 200 ns
```
Sets the holding time to 200 ns.

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

Defines the trigger hysteresis for the (offline) magnitude trigger source (used for input from a file).

Parameters:

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

Example:
```
TRIG:SOUR MAP
```
Sets the (offline) magnitude trigger source.
```
TRIG:MAP:HYST 10DB
```
Sets the hysteresis limit value.

TRIGger[:SEQuence]:PORT<ant> <port>

Selects the trigger port for measurements with devices that have several trigger ports.

Suffix:

<ant> Analyzer

Parameters:

<port>
PORT1
PORT2
PORT3

Example:
//Select trigger port 1
```
TRIG:PORT PORT1
```

TRIGger[:SEQuence]:POSition <Position>

Selects the position in an NB-IoT signal where the trigger condition must be met.

Parameters:

<Position>
FRAMe
The trigger is sent at the start of frame 0.
FNPusch
The trigger is sent at the start of the frame in which the first NPUSCH is found.
NPRach
The trigger is sent at the start of the first NPRACH.
NPUSch
The trigger is sent at the start of the first NPUSCH.

UNKNown
The measurement starts when the first NPUSCH has been found.
Prerequisites for this parameter:
• Data source is an I/Q file.
• Trigger source is "Free Run" (this is always the case when you analyze an I/Q file).

*RST: FRAMe

Example: //Select triggering on the first occurence of the NPUSCH
`TRIG:POS NPUS`

Manual operation: See "Trigger Position" on page 52

TRIGger[:SEQuence]:SLOPe <Type>

Selects the trigger slope.

Parameters:
<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Trigger Source" on page 51

TRIGger[:SEQuence]:SOURce<ant> <Source>

Selects the trigger source.

Note that the availability of trigger sources depends on the connected instrument.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Suffix:
<ant> Analyzer

Parameters:
<Source>

IMMediate
Free run (no trigger event to start a measurement).

EXT | EXT2 | EXT3 | EXT4
Trigger signal from the corresponding "Trigger Input / Output" connector on the connected instrument, or the oscilloscope's corresponding input channel (if not used as an input source).
For details on the connectors see the instrument's Getting Started manual.

RFPower
Measurement starts when the first intermediate frequency exceeds a certain level.
(Frequency and time domain measurements only.)

IFPower
Measurement starts when the second intermediate frequency exceeds a certain level.

IQPower
Measurement starts when the sampled I/Q data exceeds a certain magnitude.
For applications that process I/Q data, such as the I/Q analyzer or optional applications.

PSEN
External power sensor

MAGNitude
For (offline) input from a file, rather than an instrument.
The trigger level is specified by `TRIGger[:SEQuence]:LEVel:MAPower`.

*RST: IMMediate

Manual operation: See "Trigger Source" on page 51

6.7.2.8 Demodulation

[SENSe:][LTE:]UL:DEMod:CBSCrambling <State>

Turns scrambling of coded bits on and off.

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

Example: //Turn off descrambling of coded bits
`UL:DEM:CBSC OFF`

Manual operation: See "Scrambling of Coded Bits" on page 54

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

Selects the channel estimation type.

Parameters:

<Type> **PIL**
Pilot only
PILP
Pilot and payload
*RST: PILP

Example: //Use the pilot signal for channel estimation
`UL:DEM:CEST PIL`

Manual operation: See "Channel Estimation Range" on page 54

[SENSe:][LTE:]UL:DEMod:CDCoffset <State>

Turns DC offset compensation on and off.

Parameters:

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

Example: //Turn off DC offset compensation
`UL:DEM:CDC OFF`

Manual operation: See "Compensate DC Offset" on page 54

6.7.3 Configuring frequency sweep measurements

The remote commands to configure the ACLR and SEM measurements are the same as in the spectrum application.

For a comprehensive description, see the R&S VSE user manual.

In addition, the SEM measurement in the NB-IoT application has several exclusive settings not available in the spectrum application.

Commands to configure exclusive ACLR settings described elsewhere.

- NB-IoT mode: `CONFigure[:LTE]:LDIRection` on page 106
- Analysis mode: `[SENSe:][LTE:]UL:DEMod:MODE` on page 108
- Subcarrier spacing: `CONFigure[:LTE]:UL:SSPacing` on page 107

Commands to configure exclusive SEM settings described elsewhere.

- NB-IoT mode: `CONFigure[:LTE]:LDIRection` on page 106
- SEM measurements are only possible in NPUSCH/NPUCCH analysis mode.

[SENSe:]POWer:ACHannel:AACHannel 143

[SENSe:]POWer:ACHannel:AACHannel <Channel>

Selects the bandwidth of the adjacent channel for ACLR measurements.

Parameters:

<Channel>

N1GSm
Selects a GSM signal as assumed adjacent channel carrier.

N1UTra
Selects an UTRA signal as assumed adjacent channel carrier.

*RST: EUTRA

Example:

```
//Select assumed adjacent channel
POW:ACH:AACH N1GS
```

6.8 Analysis

6.8.1 Trace export

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example:

```
FORM:DEXP:DSEP POIN
```

Sets the decimal point as separator.

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Trace data resulting from encrypted file input cannot be queried.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 144).

Trace data resulting from encrypted file input cannot be queried.

Parameters:

<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports trace data from the specified window to an ASCII file.

You cannot query trace data resulting from encrypted file input.

Suffix:

<n> Window

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

6.8.2 Microservice export

MMEMory:STORe<n>:MSERvice <FileName>

Exports the signal configuration to the microservice.

Suffix:
<n> irrelevant

Parameters:
<FileName> String containing the path and name of the file.
The file extension is `.m5g`.

Example: //Export to microservice
```
MMEM:STOR:MSER 'signal.xxx'
```

6.8.3 Evaluation range

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

Filters the displayed results in the constellation diagram by a certain type of allocation.

Suffix:
<cc> Component Carrier

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

<numeric_value> (integer only)
Shows the results for a single allocation type.
Allocation types are mapped to numeric values. For the code assignment, see Chapter 6.5.1.18, "Return value codes", on page 90.

*RST: ALL

Example: //Display results for NPUSCH
```
ALL:SEL -40
```

Manual operation: See "Evaluation range for the constellation diagram" on page 62

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

Filters the results in the constellation diagram by a certain subcarrier.

Suffix:
<cc> Component Carrier

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

<numeric_value> (integer only)
Shows the results for a single subcarrier.

*RST: ALL

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

Manual operation: See "Evaluation range for the constellation diagram" on page 62

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

Filters the results in the constellation diagram by a certain type of modulation.

Suffix:
<cc> Component Carrier

Parameters:
<Modulation> **ALL**
Shows the results for all modulation types.

<numeric_value> (integer only)
Shows the results for a single modulation type.
Modulation types are mapped to numeric values. For the code assignment, see Chapter 6.5.1.18, "Return value codes", on page 90.

*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 62

[SENSe:][LTE:][CC<cc>:]NPUSch:SELect <NPUSCH>

Filters the displayed results by a specific NPUSCH.

Suffix:
<cc> Component Carrier

Parameters:
<NPUSCH> **ALL**
Shows the results for all slots.

<numeric_value> (integer only)
Shows the results for a single slot.

*RST: ALL

Example: //Display results for all NPUSCH
`NPUS:SEL ALL`

Manual operation: See "NPUSCH Selection" on page 61

[SENSe:][LTE:][CC<cc>:]SLOT:SELect <Slot>

Filters the results in the constellation diagram by a particular slot.

Suffix:
<cc> Component Carrier

Parameters:
<Slot> **ALL**
Shows the results for all slots.

<numeric_value> (integer only)
Shows the results for a single slot.

*RST: ALL

Example: //Display results for all slots
`SLOT:SEL ALL`

Manual operation: See "Slot Selection" on page 61

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

Filters the results in the constellation diagram by a certain OFDM symbol.

Suffix:
<cc> Component Carrier

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

<numeric_value> (integer only)
Shows the results for a single OFDM symbol.

*RST: ALL

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

Manual operation: See "Evaluation range for the constellation diagram" on page 62

6.8.4 Y-axis scale

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO <ONCE>

Automatically scales the y-axis of a diagram based on the displayed results.

Suffix:
<n> Window

<w> Subwindow

<t> irrelevant

Setting parameters:
<ONCE> **ALL**
Scales the y-axis in all windows for an ideal viewing experience.

DEFault
Restores the default scale of the y-axis.

ONCE
Scales the y-axis in a specific window for an ideal viewing experience.

Example: //Automatically scale the y-axis in subwindow 2 of window 2
```
DISP:WIND2:SUBW2:TRAC:Y:AUTO ONCE
```

Usage: Setting only

Manual operation: See "Auto Scaling" on page 55
See "Automatic scaling of the y-axis" on page 59

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum
<Value>

Defines the maximum value displayed on the y-axis of a diagram.

Suffix:
<n> Window

<w> Subwindow

<t> irrelevant

Parameters:
<Value> Maximum displayed value. The unit and value range depend on the selected diagram.

Example: //Define maximum value on y-axis in subwindow 2 of window 2
```
DISP:WIND2:SUBW2:TRAC:Y:MAX 0
```

Manual operation: See "Manual scaling of the y-axis" on page 58

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum
<Value>

Defines the minimum value displayed on the vertical diagram axis.

Suffix:
<n> Window
<w> Subwindow
<t> irrelevant

Parameters:
<Value> Minimum displayed value. The unit and value range depend on the selected diagram.

Example: //Define minimum value on y-axis in subwindow 2 of window 2
`DISP:WIND2:SUBW2:TRAC:Y:MIN -50`

Manual operation: See "Manual scaling of the y-axis" on page 58

6.8.5 Result settings

CALCulate<n>:MARKer<m>:COUPling <State>

Couples or decouples markers in different result displays to each other.

Suffix:
<n> irrelevant
<m> irrelevant

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

Example: //Couple markers to each other.
`CALC:MARK:COUP ON`

Manual operation: See "Marker Coupling" on page 64

CONFigure[:LTE]:UL:BDSource <Reference>

Selects the type of reference data source to calculate bit error rate for the NPUSCH.

Parameters:
<Reference> **NONE**
No specific reference data source.
PN9
NPUSCH based on PN9 (pseudo random sequence 9).
*RST: NONE

Example: //Select reference data source
`CONF:UL:BDS PN9`

Manual operation: See "BER Data Source" on page 64

UNIT:BSTR <Unit>

Selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: //Display bit stream as bits
`UNIT:BSTR BIT`

Manual operation: See "Bit Stream Format" on page 63

UNIT:CAXes <Unit>

Selects the scale of the x-axis for result displays that show subcarrier results.

Parameters:

<Unit>

CARR
Shows the number of the subcarriers on the x-axis.

HZ
Shows the frequency of the subcarriers on the x-axis.

Example: //Display frequency on the x-axis
`UNIT:CAX HZ`

Manual operation: See "Carrier Axes" on page 64

UNIT:EVM <Unit>

Selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

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

Manual operation: See "EVM Unit" on page 63

Annex

A Annex: reference

A.1 Menu reference

Most functions in the R&S VSE are available from the menus.

A.1.1 Common R&S VSE menus

The following menus provide **basic functions for all applications**:

A.1.1.1 File menu

The "File" menu includes all functionality directly related to any file operations, printing or setting up general parameters.

Menu item	Corresponding icon in toolbar	Description
Save		Saves the current software configuration to a file
Recall		Recalls a saved software configuration from a file
Save IQ Recording	-	Saves the recorded I/Q data from a measurement channel to a file
Recall IQ Recording	-	Loads the recorded I/Q data from a file
Measurement Group >	-	Configures measurement channels and groups
> New Group	-	Inserts a new group in the measurement sequence
> Rename Group	-	Changes the name of the selected group
> New Measurement Channel	-	Inserts a new channel in the selected group

Menu item	Corresponding icon in toolbar	Description
> Replace Measurement Channel	-	Replaces the currently selected channel by the selected application.
> Rename Measurement Channel	-	Changes the name of the selected channel.
> Delete Current Measurement Channel	-	Deletes the currently selected channel.
> Measurement Group Setup	-	Displays the "Measurement Group Setup" tool window.
Instruments >	-	Configures instruments to be used for input to the R&S VSE software
> New	-	Creates a new instrument configuration
> Search	-	Searches for connected instruments in the network
> Delete All	-	Deletes all current instrument configurations
> Setup	-	Hides or displays the "Instrument" tool window
Preset >	-	Restores stored settings
> Selected Channel	-	Restores the default software configuration for an individual channel
> All	-	Restores the default software configuration globally for the entire software
> All & Delete Instruments		Restores the default software configuration globally for the entire software and deletes all instrument configurations
> Reset VSE Layout	-	Restores the default layout of windows, toolbars etc. in the R&S VSE
Preferences >	-	Configures global software settings
> General	-	
> Displayed Items	-	Hides or shows individual screen elements
> Theme & Color	-	Configures the style of individual screen elements
> Network & Remote	-	Configures the network settings and remote access to or from other devices
> Recording	-	Configures general recording parameters
Print	-	Opens "Print" dialog to print selected measurement results
Exit	-	Closes the R&S VSE

A.1.1.2 Window menu

The "Window" menu allows you to hide or show individual windows.

Menu item	Corresponding icon in toolbar	Description
Player	-	Displays the "Player" tool window to recall I/Q data recordings
Instruments	-	Displays the "Instruments" window to configure input instruments
Measurement Group Setup	-	Displays the "Measurement Group Setup" window to configure a measurement sequence
New Window >		Inserts a new result display window for the selected measurement channel
Channel Information >	-	Displays the channel bar with global channel information for the selected measurement channel
Active Windows >	-	Selects a result display as the active window; the corresponding channel is also activated

A.1.1.3 Help menu

The "Help" menu provides access to help, support and licensing functions.

Menu item	Corresponding icon in toolbar	Description
Help	?	Opens the Online help window
License	-	Licensing, version and options information
Support	-	Support functions
Register VSE	-	Opens the Rohde & Schwarz support page (http://www.rohde-schwarz.com/support) in a browser for registration.
Online Support	-	Opens the default web browser and attempts to establish an Internet connection to the Rohde & Schwarz product site.
About	-	Software version information

A.1.2 LTE measurement menus

A.1.2.1 Input & output menu

The "Input & Output" menu provides functions to configure the input source, frontend parameters and output settings for the measurement.

This menu is application-specific.

Table A-1: "Input" menu items for LTE measurements

Menu item	Description
Amplitude	Chapter 4.2.10, "Amplitude configuration", on page 46
Scale	Chapter 5.1.3, "Diagram scale", on page 58
Frequency	Chapter 4.2.9, "Frequency configuration", on page 45
Trigger	Chapter 4.2.11, "Trigger configuration", on page 50
Input Source	Chapter 4.2.8, "Selecting the input and output source", on page 41
Output Source	

A.1.2.2 Meas setup menu

The "Meas Setup" menu provides access to most measurement-specific settings, as well as bandwidth, sweep and auto configuration settings, and the configuration "Overview" window.

This menu is application-specific.

Table A-2: "Meas Setup" menu items for NB-IoT measurements

Menu item	Description
Select Measurement	Chapter 3, "Measurements and result displays", on page 10
Signal Description	Chapter 4.2.1, "Defining signal characteristics", on page 30
NPUSCH Configuration	Chapter 4.2.3, "Configuring the NPUSCH", on page 32
Signal Capture	Chapter 4.2.12, "Configuring the data capture", on page 52
Trigger	Chapter 4.2.11, "Trigger configuration", on page 50
Demod	Chapter 4.2.13, "Signal demodulation", on page 53
Evaluation Range	Chapter 5.2.2, "Evaluation range", on page 61
Result Settings	Chapter 5.2.3, "Result settings", on page 63
Overview	Chapter 4.1, "Configuration overview", on page 27

A.1.2.3 Trace menu

The "Trace" does not contain any functions for LTE measurements, traces are generally not configurable.

A.1.2.4 Marker menu

The "Marker" menu provides access to marker-specific functions.

This menu is application-specific.

Table A-3: "Marker" menu items for NB-IoT measurements

Menu item	Corresponding icon in toolbar	Description
Select marker <x>		Chapter 5.1.5, "Markers", on page 59
Marker to Trace	-	Chapter 5.1.5, "Markers", on page 59
All Markers Off		Chapter 5.1.5, "Markers", on page 59
Marker...		Chapter 5.1.5, "Markers", on page 59
Search	-	Chapter 5.1.5, "Markers", on page 59

A.1.2.5 Limits menu

The "Limits" menu does not contain any functions for LTE measurements.

A.2 Reference of toolbar functions

Common functions can be performed via the icons in the toolbars.

Individual toolbars can be hidden or displayed.

Hiding and displaying a toolbar

1. Right-click any toolbar or the menu bar.
   A context menu with a list of all available toolbars is displayed.
2. Select the toolbar you want to hide or display.
   A checkmark indicates that the toolbar is currently displayed.
   The toolbar is toggled on or off.

Note that some icons are only available for specific applications. Those functions are described in the individual application's User Manual.

General toolbars

The following functions are generally available for all applications:

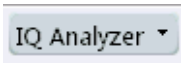
"Main" toolbar

Table A-4: Functions in the "Main" toolbar

Icon	Description
	Overview: Displays the configuration overview for the current measurement channel
	Save: Saves the current software configuration to a file
	Recall: Recalls a saved software configuration from a file
	Save I/Q recording: Stores the recorded I/Q data to a file
	Recall I/Q recording: Loads recorded I/Q data from a file
	Print immediately: prints the current display (screenshot) as configured
	Add Window: Inserts a new result display window for the selected measurement channel
	MultiView mode: displays windows for all active measurement channels (disabled: only windows for currently selected channel are displayed)

"Control" toolbar

Table A-5: Functions in the "Control" toolbar

Icon	Description
	Selects the currently active channel
	Capture: performs the selected measurement
	Pause: temporarily stops the current measurement
	Continuous: toggles to continuous measurement mode for next capture
	Single: toggles to single measurement mode for next capture
	Record: performs the selected measurement and records the captured data and results
	Refresh: Repeats the evaluation of the data currently in the capture buffer without capturing new data (VSA application only).

"Help" toolbar

Table A-6: Functions in the "Help" toolbar

Icon	Description
	Help (+ Select): allows you to select an object for which context-specific help is displayed (not available in standard Windows dialog boxes or measurement result windows)
	Help: displays context-sensitive help topic for currently selected element

Application-specific toolbars

The following toolbars are application-specific; not all functions shown here may be available in each application:

"Zoom" toolbar

Table A-7: Functions in the "Zoom" toolbar

Icon	Description
	Normal mouse mode: the cursor can be used to select (and move) markers in a zoomed display
	Zoom mode: displays a dotted rectangle in the diagram that can be expanded to define the zoom area
	Multiple zoom mode: multiple zoom areas can be defined for the same diagram
	Zoom off: displays the diagram in its original size

Table A-8: Functions in the "Marker" toolbar

Icon	Description
	Place new marker
	Percent Marker (CCDF only)
	Select marker
	Marker type "normal"
	Marker type "delta"
	Global peak
	Absolute peak (Currently only for GSM application)
	Next peak to the left
	Next peak to the right

Icon	Description
	Next peak up (for spectrograms only: search in more recent frames)
	Next peak down (for spectrograms only: search in previous frames)
	Global minimum
	Next minimum left
	Next minimum right
	Next min up (for spectrograms only: search in more recent frames)
	Next min down (for spectrograms only: search in previous frames)
	Set marker value to center frequency
	Set reference level to marker value
	All markers off
	Marker search configuration
	Marker configuration

Table A-9: Functions in the "AutoSet" toolbar

Icon	Description
	Refresh measurement results (R&S VSE VSA and OFDM VSA applications only)
	Auto level
	Auto frequency
	Auto trigger (R&S VSE GSM application only)
	Auto frame (R&S VSE GSM application only)
	Auto search (R&S VSE 3GPP FDD application only)
	Auto scale (R&S VSE 3GPP FDD + Pulse applications only)
	Auto scale all (R&S VSE 3GPP FDD + Pulse applications only)
	Auto all
	Configure auto settings

List of commands

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