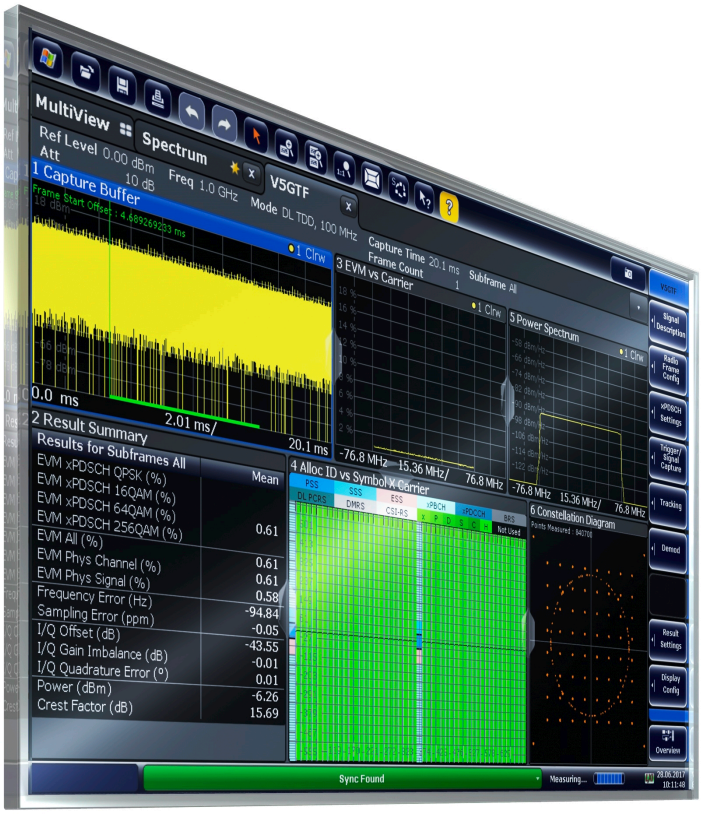
R&S®FPS-K118
Verizon 5GTF Measurement Application (Downlink)
User Manual



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User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FPS models with firmware version 1.50 and higher:

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

The following firmware options are described:

- R&S®FPS-K118 Verizon 5GTF Downlink Measurement Application (1321.4962.02)

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

Contents

1 Preface

1.1 About this Manual

This V5GTF User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FPS User Manual.

The main focus in this manual is on the V5GTF measurement results and the tasks required to obtain them. The following topics are included:

- **Welcome to the V5GTF application**
  Introduction to and getting familiar with the application
- **Measurements and result displays**
  Details on supported V5GTF measurements and their result types
- **Configuration and analysis**
  A concise description of all functions and settings available to configure and analyze V5GTF measurements with their corresponding remote control command
- **Remote commands for V5GTF measurements**
  Remote commands required to configure and perform V5GTF measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FPS User Manual)
- **List of remote commands**
  Alpahabetical list of all remote commands described in the manual
- **Index**

1.2 Typographical Conventions

The following text markers are used throughout this documentation:

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

2 Welcome to the V5GTF Measurement Application

The R&S FPS-K118 is a firmware application that adds functionality to measure signals according to the Verizon 5G technical forum (TS V5G.211 standard) on the downlink to the R&S FPS.

Bandwidth of V5GTF signals

V5GTF signals have a bandwidth of 100 MHz.

Therefore, measuring these signals requires an R&S FPS with the optional bandwidth extension (160 MHz).

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

http://www.rohde-schwarz.com/product/fps.html

2.1 Installation

Find detailed installation instructions in the getting started or the release notes of the R&S FPS.

2.2 Starting the V5GTF Measurement Application

The V5GTF measurement application adds a new application to the R&S FPS.

Manual operation via an external monitor and mouse

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

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

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

To activate the application

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

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

2. Select the "V5GTF" item.

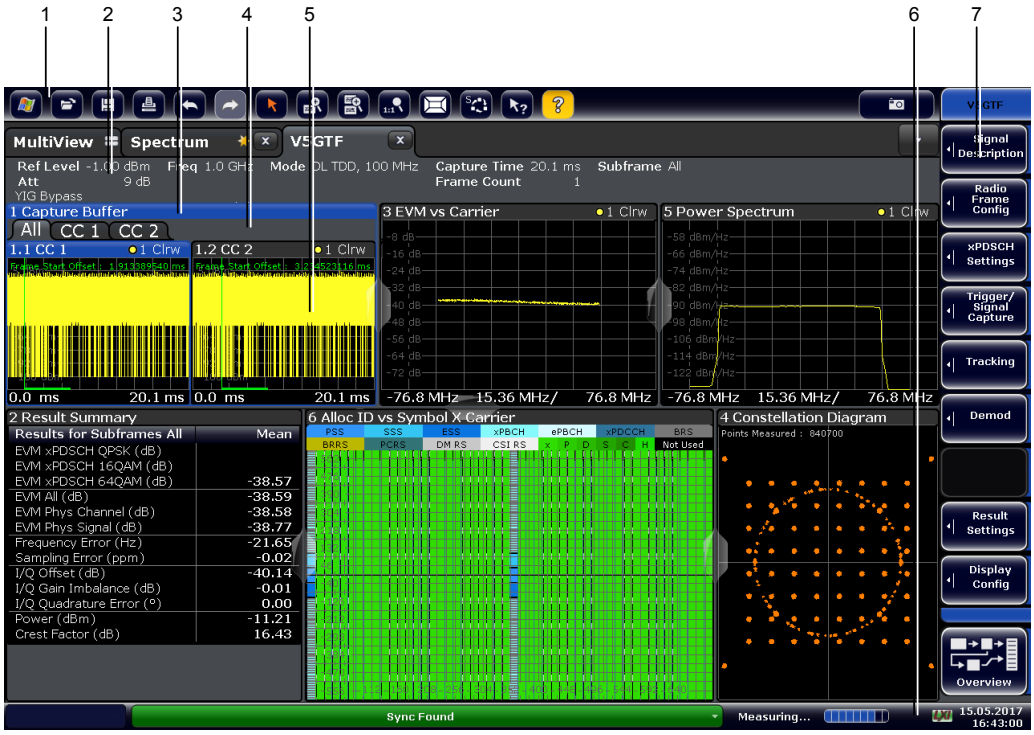
   

   The R&S FPS opens a new measurement channel for the V5GTF measurement application.

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

2.3 Understanding the Display Information

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



1 = Toolbar
2 = Channel bar
3 = Diagram header
4 = Result display

5 = Subwindows (if more than one component carrier is displayed at the same time)
6 = Status bar
7 = Softkeys

MSRA operating mode

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

For details on the MSRA operating mode, see the R&S FPS MSRA user manual.

Channel bar information

In the V5GTF measurement application, the R&S FPS shows the following settings:

Table 2-1: Information displayed in the channel bar in the V5GTF measurement application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Freq	Frequency
Mode	V5GTF mode (link direction and duplexing)
Capture Time	Signal length that has been captured
Frame Count	Number of frames that have been captured
Selected Subframe	Subframe considered in the signal analysis
Consecutive CC Meas	Number of component carriers that are measured; the numbers in parentheses indicate the number of component carriers that are analyzed in a single capture Example: 8 (3 / 3 / 2) means that 8 component carriers are analyzed in three consecutive data captures. The first two data captures analyze the first 6 component carriers (3 CCs each), while the last data capture analyzes the last 2 component carriers.

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 transducer or trigger settings). This information is displayed only when applicable for the current measurement. For details, see the R&S FPS getting started manual.

Window title bar information

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

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

Status bar information

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

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

- "Sync OK"
  The synchronization was successful. The status bar is green.
- "Sync Failed"
  The synchronization was not successful. The status bar is red.
  If you are measuring several component carriers, the message also indicates which component carrier could not be synchronized.

3 Measurements and Result Displays

The V5GTF measurement application measures and analyzes various aspects of a V5GTF signal.

It features several result displays. Result displays are different representations of the measurement results. They are either diagrams that show the results as a graph or tables that show the results as numbers.

Remote command:

Result display selection: `LAYout:ADD[:WINDow]?` on page 70

3.1 Selecting Result Displays

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

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

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

- Capture Buffer
- EVM vs Carrier
- Power Spectrum
- Result Summary
- Alloc ID vs Symbol x Carrier
- Constellation Diagram

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

Remote command:

`LAYout:ADD[:WINDow]?` on page 70

Note that you can customize the contents of some numerical result displays. For more information, see Chapter 5.1, "Configuring Tables / Numerical Results", on page 56.

3.2 Performing Measurements

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

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

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

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 FPS.

3.3 Selecting the Operating Mode

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

The V5GTF application is supported by the Multi Standard Radio Analyzer (MSRA).

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

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

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

The analysis interval is automatically determined according to the Capture Time you have defined. The analysis interval cannot be edited directly in the V5GTF application, but is changed automatically when you change the evaluation range. The currently used analysis interval (in seconds, related to capture buffer start) is indicated in the window header for each result display.

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

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

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

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

3.4 I/Q Measurements

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

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

Remote command:

Result display selection: `LAYout:ADD[:WINDow]?` on page 70

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

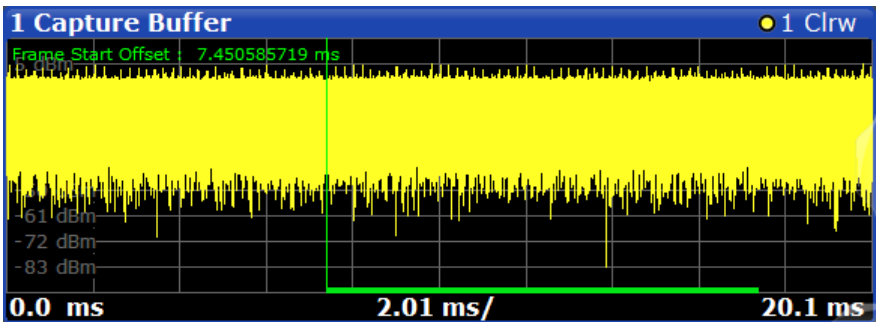


Figure 3-1: Capture buffer without zoom

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

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

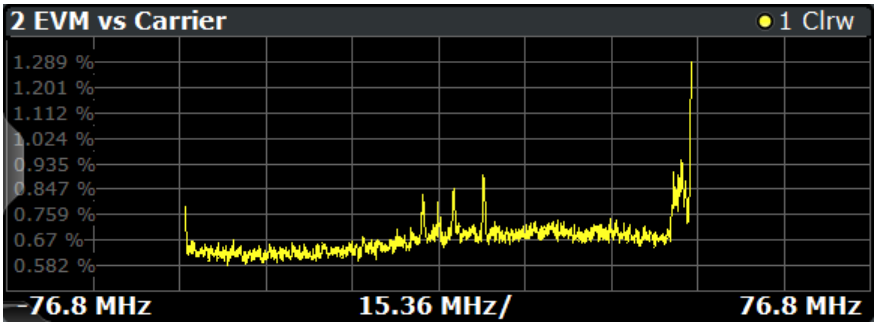
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CBUF
Querying results: TRACe:DATA?
Querying the subframe start offset: `FETCh[:CC<cc>]:SUMMary:TFRame?`
on page 93

EVM vs Carrier
Starts the EVM vs Carrier result display.

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

The results are based on an average EVM that is calculated over the resource elements for each subcarrier. The average subcarrier EVM is calculated over the complete radio frame.

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



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

EVM vs Symbol
Starts the EVM vs Symbol result display.

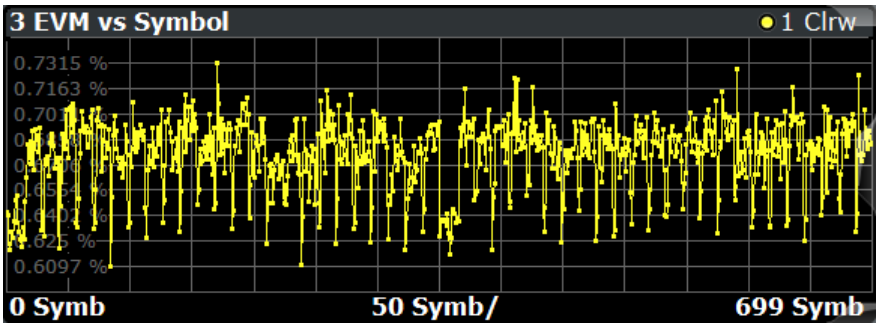
This result display shows the error vector magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a certain OFDM symbol. The average OFDM symbol EVM is calculated over the complete radio frame.

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 FPS could not determine the EVM for that symbol.

For TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

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



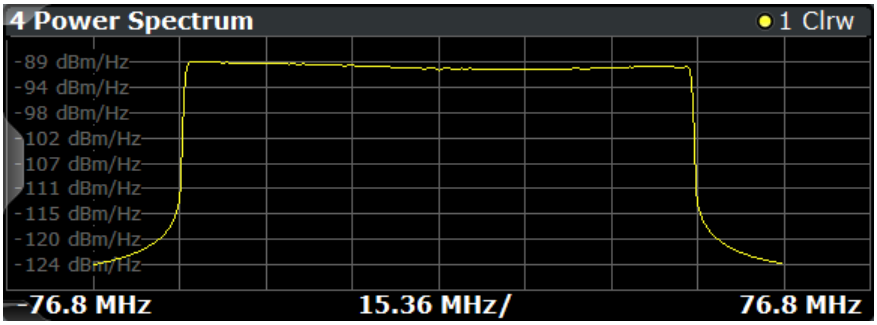
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSY
Querying results: TRACe:DATA?

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz.

The displayed bandwidth is always 153.6 MHz.

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



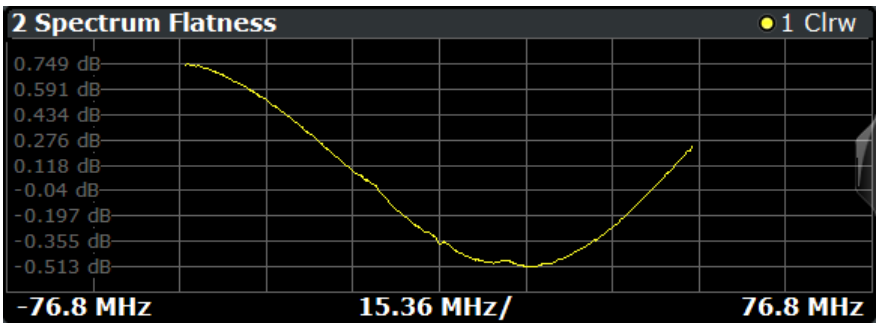
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PSPE
Querying results: TRACe:DATA?

Spectrum Flatness
Starts the Spectrum Flatness result display.

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

The measurement is evaluated for the complete radio frame.

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



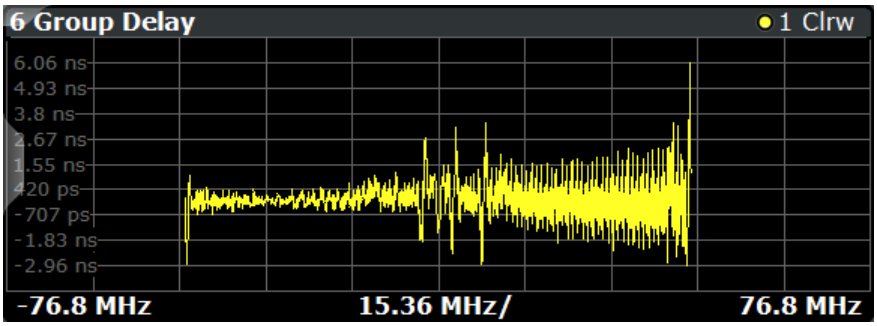
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,SFL
Querying results: TRACe:DATA?

Group Delay
Starts the Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated for the complete radio frame.

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

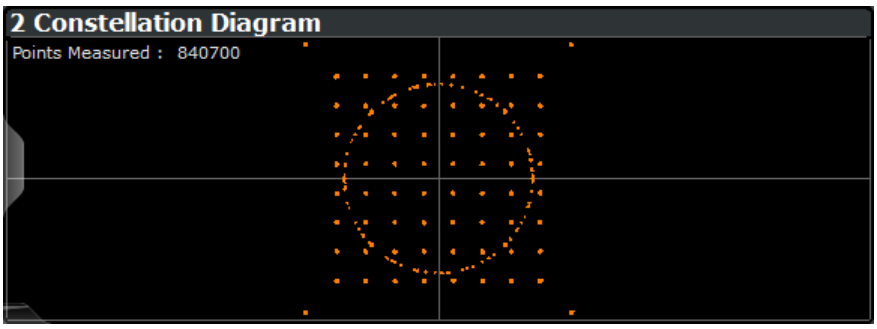


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,GDEL
Querying results: TRACe:DATA?

Constellation Diagram
Starts the Constellation Diagram result display.

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

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



The constellation diagram shows the number of points that are displayed in the diagram.

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

Allocation Summary
Starts the Allocation Summary result display.

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

5 Allocation Summary

Sub-frame	Allocation ID	No of RBs	Rel Power [dB]	Modulation	Power per RE [dBm]	EVM [%]
0	xPBCH		0.000	QPSK	-41.105	0.629
	BRS		0.000	QPSK	-41.106	0.633
	PSS		0.000	CAZAC	-41.522	0.658
	ESS		0.000	CAZAC	-41.396	0.627
	SSS		0.000	RBPSK	-41.631	0.641
	ALL	0				0.638
1	xPDSCH 0	100	0.000	64QAM	-41.188	0.680
	DM RS 0		6.000	QPSK	-35.176	0.663
	xPDCCH		0.000	QPSK	-41.185	0.631
	xPDCCH RS		0.000	QPSK	-41.179	0.615
	ALL	100				0.647

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

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the corresponding allocation.
- **Rel. Power [dB]**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.

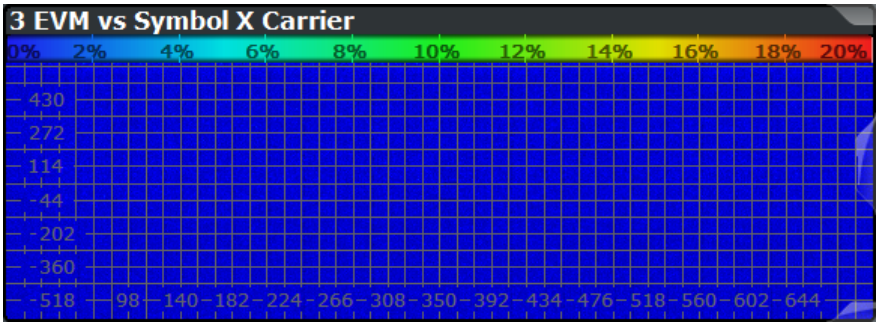
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Note: Contents of the allocation summary
The number of columns shown in the allocation summary is variable. To add or remove a column, click the header row of the table **once**. The application opens a dialog box to select the columns which you would like to display.

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

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

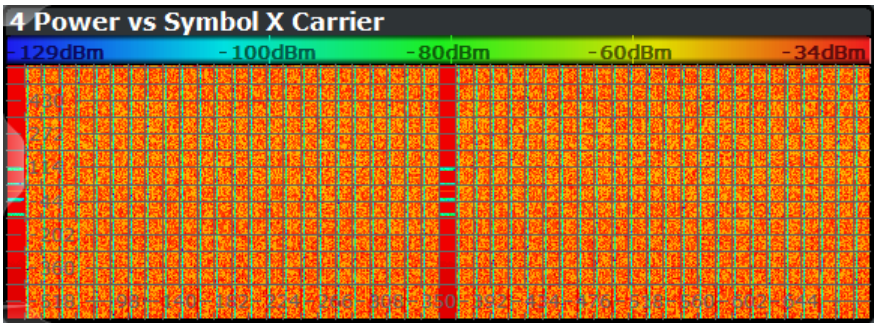
The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the EVM. The color map for the power levels is provided above the diagram area.



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

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

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

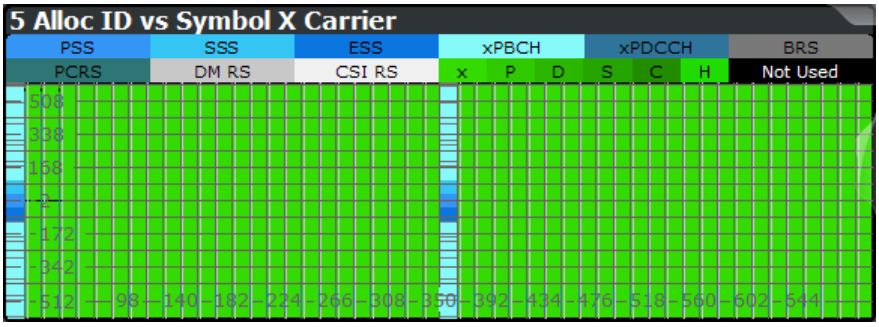


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PVSC
Querying results: TRACe:DATA?

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

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

The map above the diagram also shows the colors used for each allocation.



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

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

Remote command:

LAY:ADD ? '1',LEFT,RSUM

Contents of the result summary

6 Result Summary

Results for Subframes All	Mean
EVM xPDSCH QPSK (%)	
EVM xPDSCH 16QAM (%)	
EVM xPDSCH 64QAM (%)	0.68
EVM xPDSCH 256QAM (%)	
EVM All (%)	0.68
EVM Phys Channel (%)	0.68
EVM Phys Signal (%)	0.64
Frequency Error (Hz)	21.71
Sampling Error (ppm)	0.00
I/Q Offset (dB)	-35.48
I/Q Gain Imbalance (dB)	-0.01
I/Q Quadrature Error (°)	0.01
Power (dBm)	-10.40
Crest Factor (dB)	15.64

Figure 3-2: Result summary for the downlink

The table shows results that refer to the complete frame. For each result, the mean values are displayed.

For measurements on multiple carriers (carrier aggregation), the result summary has a tab for each carrier. In addition, the "All" tab contains a summary of the results for all component carriers. Each column of the table represents one component carrier in that case.

Results for downlink	
EVM xPDSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the xPDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSQP[:AVERage]?` on page 89
EVM xPDSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the xPDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSST[:AVERage]?` on page 90
EVM xPDSCH 64QAM	Shows the EVM for all 64QAM-modulated resource elements of the xPDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSSF[:AVERage]?` on page 89
EVM xPDSCH 256QAM	Shows the EVM for all 256QAM-modulated resource elements of the xPDSCH channel in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM:DSTS[:AVERage]?` on page 90
EVM All	Shows the EVM for all resource elements in the analyzed frame. `FETCh[:CC<cc>]:SUMMary:EVM[:ALL][:AVERage]?` on page 89
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. xPDSCH, xPUSCH, xPBCH or xPDCCH, for example, are physical channels. `FETCh[:CC<cc>]:SUMMary:EVM:PCHannel[:AVERage]?` on page 90
EVM Phys Signal	Shows the EVM for all physical signal resource elements in the analyzed frame. The reference signal, for example, is a physical signal. `FETCh[:CC<cc>]:SUMMary:EVM:PSIGnal[:AVERage]?` on page 91
Frequency Error	Shows the difference in the measured center frequency and the reference center frequency. `FETCh[:CC<cc>]:SUMMary:FERRor[:AVERage]?` on page 91
Sampling Error	Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate. `FETCh[:CC<cc>]:SUMMary:SERRor[:AVERage]?` on page 93
I/Q Offset	Shows the power at spectral line 0 normalized to the total transmitted power. `FETCh[:CC<cc>]:SUMMary:IQOFfset[:AVERage]?` on page 92
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 91
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 92

Power	Shows the average time domain power of the analyzed signal. `FETCh[:CC<cc>]:SUMMary:POWer[:AVERage]?` on page 92
Crest Factor	Shows the peak-to-average power ratio of captured signal. `FETCh[:CC<cc>]:SUMMary:CRESt[:AVERage]?` on page 88

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

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

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 70
Results:
`CALCulate<n>:MARKer<m>:X` on page 94
`CALCulate<n>:MARKer<m>:Y?` on page 95

4 Configuration

V5GTF measurements require a special application on the R&S FPS, which you activate using the MODE key on the front panel.

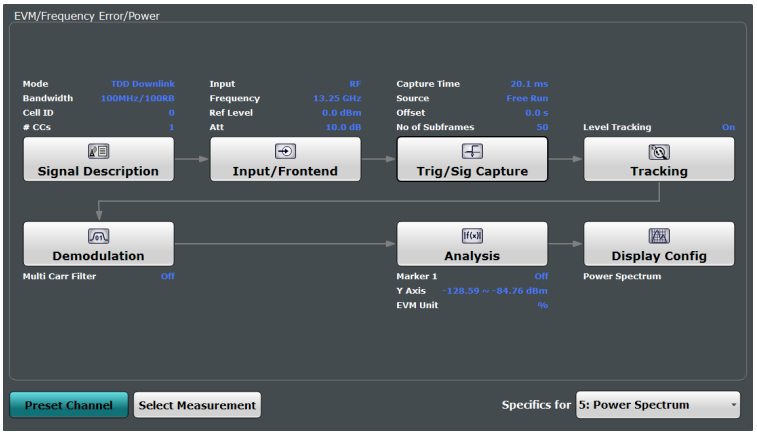
When you start the V5GTF application, the R&S FPS starts to measure the input signal with the default configuration or the configuration of the last measurement (when you have not performed a preset since then). After you have started an instance of the V5G application, the application displays the "Meas Config" menu which contains functions to define the characteristics of the signal you are measuring.

Unavailable hardkeys

Note that the SPAN, BW, TRACE, LINES and MKR FUNC keys have no contents and no function in the V5GTF 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, "Physical Signal Characteristics", on page 25.
2. Input / Frontend
   See Chapter 4.9, "Selecting the Input Source", on page 48.
3. Trigger / Signal Capture
   See Chapter 4.13, "Triggering Measurements", on page 53
   See Chapter 4.12, "Configuring the Data Capture", on page 52
4. Tracking
   See Chapter 4.14, "Tracking", on page 54.
5. Demodulation
   See Chapter 4.15, "Demodulation", on page 54.
6. Analysis
   See Chapter 5, "Analysis", on page 56.
7. Display Configuration
   See Chapter 3, "Measurements and Result Displays", on page 12

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

Do not confuse the "Preset Channel" button with the PRESET *key*, which restores the entire instrument to its default values and thus closes **all channels** on the R&S FPS (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 96

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

Remote command:
n/a

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

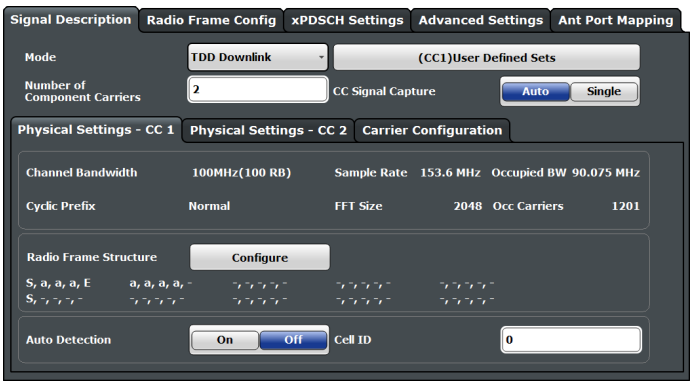
Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

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

4.2 Physical Signal Characteristics

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

The "Signal Description" dialog box contains general signal characteristics.



Configuring component carriers

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

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

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

The remote commands required to configure the physical signal characteristics are described in Chapter 6.9.2, "Physical Signal Characteristics", on page 97.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Selecting the V5GTF mode

The "Mode" selects the V5GTF 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 V5GTF standard only supports TDD mode.

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

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

The application shows the currently selected V5GTF mode (including the bandwidth) in the channel bar.

Remote command:
Link direction: `CONFigure[:V5G]:LDIRection` on page 98

Carrier Aggregation

Carrier aggregation has been introduced in the V5GTF standard to increase the bandwidth. In those systems, several carriers can be used to transmit a signal.

You can configure up to 8 component carriers for measurements on contiguous and non-contiguous intra-band carrier aggregation (the carriers are in the same frequency band). Each carrier has the same bandwidth of 100 MHz.

The application provides the following capture modes.

- "Single": Each configured component carrier is captured consecutively by an individual data capture buffer.
- "Auto": The R&S FPS determines how many component carriers it can capture in a single measurement

If you select "Auto" mode, the R&S FPS captures as many component carriers as it can in a single measurement and captures the rest in subsequent measurements. The maximum number of component carriers it can analyze in a single capture depends on the available bandwidth (with the optional 500 MHz bandwidth, for example, it can analyze up to 5 carriers in a single capture).

When all required measurements are done, the R&S FPS shows the results for all component carriers.

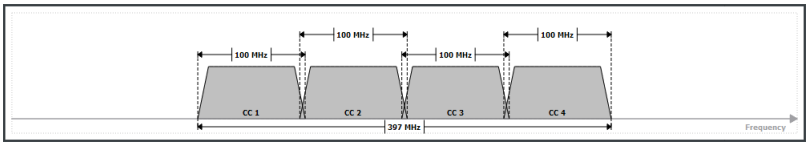
Basic component carrier configuration ← Carrier Aggregation

You can define the characteristics of the CCs in the table in the "Carrier Configuration" panel (in the "Signal Characteristics" dialog box). Depending on the "Number of Component Carriers", the application adjusts the size of the table. Each line corresponds to a component carrier.

- The "Center Frequency" defines the carrier frequency of the carriers.
- Each carrier has a bandwidth of 100 MHz.
- For all component carriers, the R&S FPS also shows the "Frequency Offset" relative to the center frequency of the first carrier.
  If you define a different frequency offset, the application adjusts the center frequency accordingly.

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

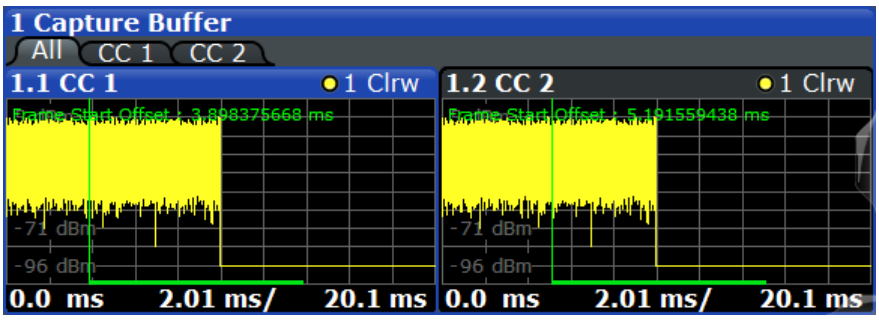
The R&S FPS shows a preview of the current carrier configuration in a diagram at the bottom of the dialog.



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

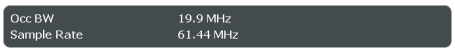
Features of the I/Q measurements ← Carrier Aggregation

For measurements on component carriers, results are shown for each component carrier separately. The layout of the diagrams is adjusted like this:



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

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



Remote commands to configure carrier aggregation ← Carrier Aggregation

Remote command:
Number of carriers: `CONFigure[:LTE]:NOCC` on page 97
Capture mode: `CONFigure[:V5G]:CSCapture` on page 97
Carrier frequency: `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 100
Measurement frequency: `SENSe:FREQuency:CENTer?`
Offset: `[SENSe]:FREQuency:CENTer[:CC<cc>]:OFFSet` on page 101

Physical settings of the signal
Physical settings describe the basic structure of the signal you are measuring.

The "Channel Bandwidth" of a V5GTF signal is always 100 MHz with a normal "Cyclic Prefix".

The physical settings also show the sample rate, FFT size, the occupied bandwidth and number of occupied subcarriers in the signal.

The dialog box also provides an overview of the current structure of the radio frame as a comma-separated list. Each character corresponds to a subframe, "S,a,a,a,a", for example means that the first subframe is a synchronization subframe, and all other subframes are subframe type a.

Selecting the "Configure" button opens the radio frame configuration tab where you can customize the radio frame structure according to your needs.

The physical layer cell ID is responsible for synchronization between network and user equipment. It identifies a particular radio cell in the V5GTF network. The cell ID is a value between 0 and 503. For automatic detection of the cell ID, turn on the "Auto" function.

Remote command:
Cell ID (DL): `CONFigure[:V5G]:DL[:CC<cc>]:PLC:CID` on page 98

Using Test Scenarios
Test scenarios are descriptions of specific V5GTF signals.

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

- "User Defined"
  The "User Defined" tab contains functionality to manage custom test scenarios.
  To create a custom test scenario, describe a signal as required and then save it with the corresponding button.
  Here, you can also restore custom test scenarios and delete ones you do not need anymore.

Test scenarios for carrier aggregation

When you measure component carriers, you can describe each component carrier separately and save or restore the scenario for each carrier in the corresponding tab ("CC<x>"). Single carrier scenarios are stored in `.allocation` files.

For easier handling of multiple carriers, however, you can also store the descriptions of all carriers in a single file. To do so, configure all component carriers as required and save the test scenario in "All CCs" tab. Multiple carrier test scenarios are stored in `.ccallocation` files. The advantage of this method is, that you do not have to restore a scenario for each component carrier, but can do so in a single step.

The `ccallocation` files contain the frequency information of the signal.

Remote command:
Single carrier (save): `MMEMory:STORe<n>:DEModsetting[:CC<cc>]` on page 100
Multiple carriers (save): `MMEMory:STORe<n>:DEModsetting:ALL` on page 99
Single carrier (restore): `MMEMory:LOAD:DEModsetting[:CC<cc>]` on page 99
Multiple carriers (restore): `MMEMory:LOAD:DEModsetting:ALL` on page 99

4.3 Radio Frame Configuration

Access: "Overview" > "Signal Description" > "Radio Frame Config"

A radio frame in the V5GTF standard has a length of 10 ms (same as in LTE). It consists of 50 subframes, each with a length of 0.2 ms. A subframe contains 14 OFDM symbols.

Figure 4-1: Radio frame as defined by the V5GTF standard

Each subframe has one of four predefined structures. Two structures are defined for the downlink (a and b), and two for the uplink (c and d).

Each subframe type contains and transmits control information (xPDCCH or xPUCCH) as well as the user data (xPDSCH or xPUSCH).

The subframes that carry uplink and downlink information also contain a guard period. The guard period has the length of one symbol in the transition between uplink and downlink. You can also include optional reference signals (CSI).

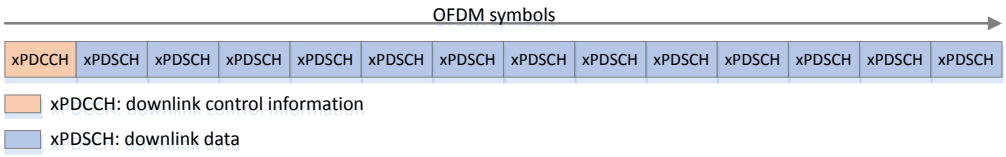


Figure 4-2: Subframe type a (downlink)

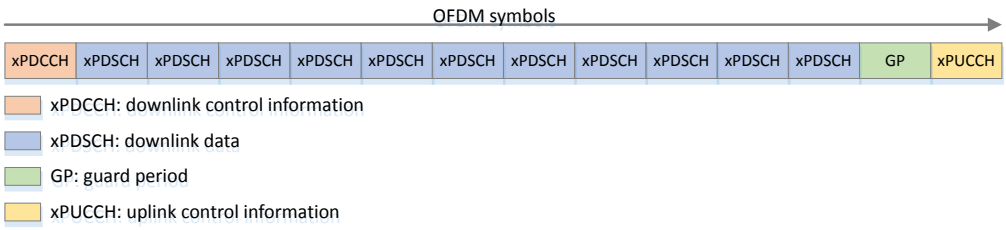


Figure 4-3: Subframe type b (downlink)

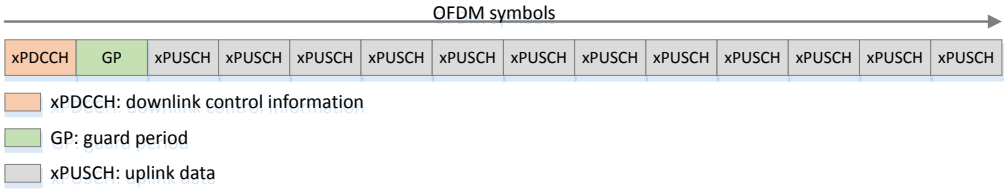


Figure 4-4: Subframe type c (uplink)

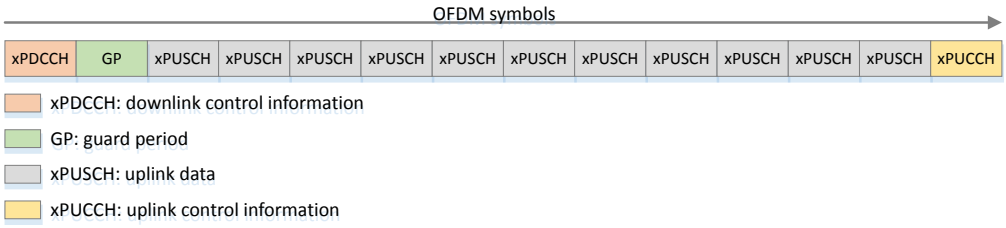
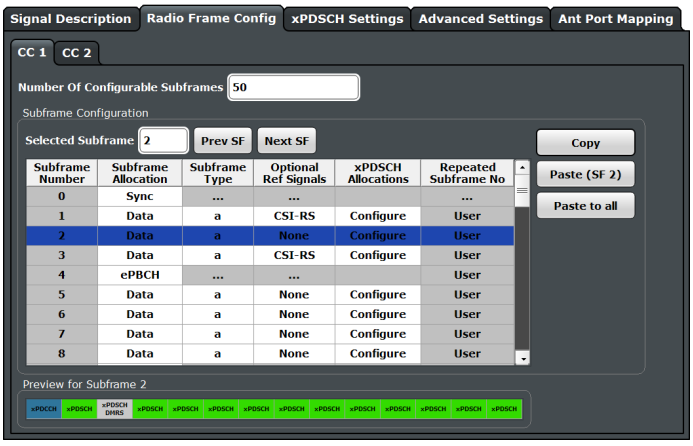


Figure 4-5: Subframe type d (uplink)

Special subframes:

- On the downlink, subframes 0 and 25 are reserved exclusively for the synchronization signals, xPBCH and the beamforming reference signal (BRS).
- On the uplink, subframes 0 and 25 are always unused.
- Subframes 4 and 29 can carry ePBCH information.
- Subframes 15 and 40 can carry xRACH information.

The V5GTF application allows you to configure and customize the subframes you are using in your signal.



Configuring component carriers

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

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

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

The remote commands required to configure the radio frame are described in Chapter 6.9.3, "Radio Frame Configuration", on page 101.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Number of Configurable Subframes

Before you start to configure each subframe, define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 50 subframes.

If you enter a number smaller than 50 subframes, you can configure only the first few subframes (depending on the number you have entered). The other subframes are configured automatically based on the subframes you have configured manually. For the other subframes, the R&S FPS repeats the pattern of the subframes you have configured, including the xPDSCH allocation configuration.

Note that you can always apply a special configuration to subframes 0, 4, 15, 25, 29, 40.

After you have selected the number of configurable subframes, you can define the characteristics of each subframe in the subframe configuration table. Each row in that table shows the characteristics of one subframe.

The last column in the table ("Repeated Subframe No.") shows the number of the subframe which the subframe configuration is based on.

Example:

You have entered "5" in the "Configurable Subframes" field. Thus, you can edit the first 5 subframes in the table (the others are grayed out and unavailable for editing). The configuration of the first subframe (0) is fix (sync or unused). You configure the other four subframes to carry data. This would result in the following pattern:

sync - 1 - 2 - 3 - 4

This pattern is repeated in the other subframes: sync - 1 - 2 - 3 - 4 - 1 - 2 - 3 - 4 - 1 - 2 - 3 - 4 etc. (exception: subframe 25).

If you configure subframe 4 to carry the ePBCH, the pattern would look like this: sync - 1 - 2 - 3 - ePBCH - 1 - 2 - 3 - 1 - 2 - 3 etc.

Copying subframes

If several subframes in the radio frame have the same configuration, the easiest way is to configure one subframe and "Copy" that configuration (including the allocation configuration) to other subframes.

When you copy a subframe, the "Copy" button indicates which subframe is in the clipboard (for example: "Paste (SF 1)". You can then apply that configuration either to a selected subframe or all subframes:

- "Paste" applies the copied configuration to the selected subframe.
  A selected subframe is highlighted in blue.
- "Paste to All" applies the copied configuration to all other subframes.

Remote command:
Downlink: `CONFigure[:V5G]:DL[:CC<cc>]:CSUBframes`
Copy subframe (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:COPY` on page 103
Paste subframe (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:PASTe[:ITEM]` on page 104
Paste subframe (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:PASTe:ALL` on page 104

Reset Frame Config
Restores the default frame configuration.

Remote command:
Downlink: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:RESet` on page 105

Selecting a subframe for configuration
You can jump to a specific subframe (= row in the subframe configuration table) by entering a number between 0 and 49 in the "Selected Subframe" input field. The currently selected subframe is highlighted blue.

The "Prev SF" and "Next SF" buttons select the subframes directly above or below the currently selected subframe.

Note that the R&S FPS shows the current symbol usage of the selected subframe in a diagram at the bottom of the dialog box.

Figure 4-6: Overview of symbol usage in the currently selected subframe

Remote command:
Downlink: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:SELect` on page 105

Subframe Number
Shows the number of a subframe.

Subframe Allocation
Selects the type of data that the subframe carries.

- "Sync" (supported for subframe 0 and 25)
  The subframe carries synchronization data. The standard defines subframes 0 and 25 as the subframe that carries the synchronization channels. The structure and usage of the resource elements in a synchronization subframe is fix.
- "ePBCH" (supported for subframe 4 and 29)
  The subframe carries ePBCH data.
  Note that analysis of the ePBCH is not supported.
- "xRACH" (supported for subframe 15 and 40)
  The subframe carries xRACH data.
  Note that analysis of the xRACH is not supported.
- "Data" (supported for all subframes except 0 and 25)
  The subframe carries user and control data.
- "Unused" (supported for all subframes)
  The subframe is not used in the signal you are measuring.
  Note that on the uplink, subframes 0 and 25 are always unused.

Remote command:
Downlink: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation` on page 102

Subframe Type
Selects the subframe type for subframes that carry user data.

- Subframe type "a"
  Available for downlink measurements.
- Subframe type "b"
  Available for downlink measurements.

For a graphical overview of the different subframe types and their structure, see Chapter 4.3, "Radio Frame Configuration", on page 29.

You can only select the subframe type for subframes that carry user data (subframe allocation = data).

Remote command:
Downlink: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:TYPE` on page 105

Optional Ref Signals
Selects one of several optional reference signals that you can transmit in a subframe.

- "None"
  No optional reference signal is transmitted in the corresponding subframe.
- "CSI-RS"
  Transmits the CSI reference signal in the corresponding subframe.

You can only define optional reference signals for subframes that carry user data (subframe allocation = data).

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ORSignals` on page 103

Allocations
"xPDSCH Allocations": Opens the xPDSCH Settings tab to configure the allocations used by xPDSCH in the corresponding subframe.

Repeated Subframe No
Shows the way that you have configured the subframe.

If the cell shows "User", it means that you have configured that subframe manually.

If the cell shows a number, it means that the subframe was configured automatically based on the configuration of another subframe. The number indicates the subframe number the configuration is based on. For example, if the cell shows a "2", it means that that subframe is identical to the configuration of subframe number 2.

Note that such a pattern is only applied if the number of configurable subframes is smaller than 50. Otherwise, all subframes are user configured subframes.

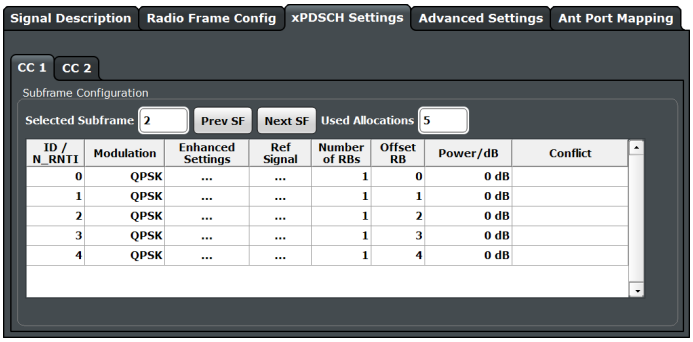
Remote command:
not supported

4.4 xPDSCH Configuration (Downlink)

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

The xPDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore occupies most of the resource elements in a radio frame and is present in most of the subframes used for downlink transmission.

Each downlink subframe consists of one or more (user) allocations. Each allocation, in turn, can have a different size and transmission characteristics (modulation, power etc.). The subframe configuration table provides an overview of all allocations used in the corresponding subframe and allows you to configure each allocation individually. Each row in the configuration table corresponds to one allocation.



If there are any errors or conflicts between allocations in one or more subframes, the application shows the corrupt subframe in the "Conflict" column of the table. Conflicts are highlighted red if an error occurs. In addition, it shows the conflicting rows of the configuration table.

ID / N_RNTI	Modulation	Enhanced Settings	Ref Signal	Number of RBs	Offset RB	Power/dB	Conflict
0	QPSK	...	...	2	0	0 dB	Collision : 1
1	QPSK	...	...	1	1	0 dB	Collision : 0
2	QPSK	...	...	1	2	0 dB	
3	QPSK	...	...	1	3	0 dB	

Before you start to customize the allocations of a subframe, you should define the number of subframes you want to have in the radio frame. The application supports the configuration of up to 50 subframes.

Configuring component carriers

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

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

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

The remote commands required to configure the xPDSCH are described in Chapter 6.9.4, "xPDSCH Configuration", on page 106.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

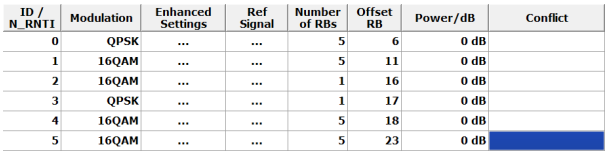
Selecting the subframe to configure

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

You can also select the subframe that comes after or before the currently selected subframe with the "Prev SF" or "next SF" buttons.

4.4.1 xPDSCH Configuration Table

The xPDSCH configuration table contains functionality to configure the allocations used in the currently selected subframe.



ID / N_RNTI	Modulation	Enhanced Settings	Ref Signal	Number of RBs	Offset RB	Power/dB	Conflict
0	QPSK	...	...	5	6	0 dB	
1	16QAM	...	...	5	11	0 dB	
2	16QAM	...	...	1	16	0 dB	
3	QPSK	...	...	1	17	0 dB	
4	16QAM	...	...	5	18	0 dB	
5	16QAM	...	...	5	23	0 dB	

The remote commands required to configure the xPDSCH are described in Chapter 6.9.4, "xPDSCH Configuration", on page 106.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Defining the number of allocations in a subframe

In the default state, a subframe contains no allocation.

Each subframe can have a different number of allocations. You can define the number of allocations in the selected subframe with the "Used Allocations" setting. When you add allocations, the R&S FPS expands the table accordingly. Each row in the table represents one allocation.

You can configure up to 16 allocations in every subframe.

Remote command:

`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount` on page 106

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

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

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:UEID`
on page 116

Modulation
Selects the modulation scheme for the corresponding allocation.

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:MODulation`
on page 108

Enhanced Settings / Ref Signal
Opens a dialog box to configure advanced characteristics of the xPDSCH and advanced reference signals.

For more information, see Chapter 4.4.2, "Enhanced Settings for xPDSCH Allocations", on page 38.

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

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:RBCount`
on page 114

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

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:RBOFfset`
on page 114

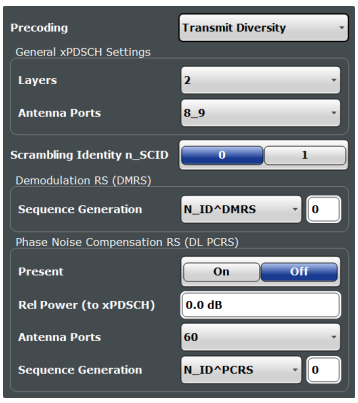
Power
Sets the boosting of the allocation.

Boosting is the power of the allocation (xPDSCH and its reference signal) relative to the BRS.

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:POWer`
on page 112

4.4.2 Enhanced Settings for xPDSCH Allocations

The "Enhanced Settings" and "Ref Signal" settings contain advanced settings like the precoding scheme and advanced reference signals settings that you can apply to an allocation.



The remote commands required to configure the xPDSCH are described in Chapter 6.9.4, "xPDSCH Configuration", on page 106.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Precoding

The precoding scheme selects the method by which the data is mapped to antenna ports.

The following precoding schemes are supported.

- "None"
  Turns off precoding.
- "Transmit Diversity"
  Turns on precoding for transmit diversity (several antennas transmit a single layer data stream to reduce transmission errors).
- "Spatial Multiplexing"
  Turns on precoding for spatial multiplexing (several antennas transmit different data streams to increase data rate).

For precoding schemes "Transmit Diversity" and "Spatial Multiplexing", the xPDSCH is always transmitted on two layers. If you apply no precoding, you can select the number of "Layers" on which the xPDSCH is transmitted.

For all precoding schmes (including no precoding), you can select the antenna ports on which the xPDSCH is transmitted. The antenna ports available for xPDSCH transmission is fix. In case of a two layer transmission, the xPDSCH is transmitted on a combination of two (predefined) antenna ports.

Remote command:
Precoding: CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PRECoding on page 113
Layers: CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:XPDSch:NOLayer on page 117
Antenna ports: CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:XPDSch:AP on page 116

UE Specific Reference Signals
Each xPDSCH or xPUSCH allocation can carry reference signals specific to the user equipment: the demodulation reference signal (DMRS) and the phase noise compensation reference signal (PCRS).

Both reference signals are affected by the parameter "Scrambling Identity" n_{scid}. This parameter has an effect on the sequence generation of the reference signals as defined in V5G.211. The value is either 0 or 1.

Remote command:
Scrambling identity (DL): CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:SCID on page 115

DMRS configuration ← UE Specific Reference Signals
The V5G standard (V5G.211) defines two methods by which the DMRS sequence can be calculated. You can select the method with the "Sequence Generation" parameter. The sequence is either calculated with the "n_ID^DMRS" variable (a pseudo-random seed value). Or, if the higher layers provide no value for n_ID^DMRS, the sequence is generated based on the cell ID with the "n_ID^Cell". n_ID^Cell has the same value as the cell ID.

Note: The sequence generation method is always the same for both the DMRS and the PCRS. If you select "n_ID^Cell" for either, the R&S FPS automatically selects the method for the other, and vice versa.

Remote command:
DMRS sequence generation (DL): CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:SGENeration on page 108
DMRS ID (DL): CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:NID on page 107

PCRS configuration ← UE Specific Reference Signals
The PCRS is a reference signal for phase noise compensation that you can transmit in a xPDSCH or xPUSCH allocation.

If the PCRS is present (turned on), you can define various properties of that reference signal.

- The "Rel Power (to xPDSCH)" defines the power with which the PCRS is transmitted. The value is a power level in dB relative to the power of the xPDSCH allocation it is transmitted on.
- The "Antenna Ports" selects the antenna port it is transmitted on (60 or 61, or 60 and 61).
  Antenna port assignment is only possible on the downlink.

- The "Sequence Generation" selects the method by which the PCRS sequence is calculated. The standard (V5G.211) defines two methods: "n_ID^DMRS" and "n_ID^Cell". In the latter case, the value is the cell ID.

Note: The sequence generation method is always the same for both the DMRS and the PCRS. If you select "n_ID^Cell" for either, the R&S FPS automatically selects the method for the other, and vice versa.

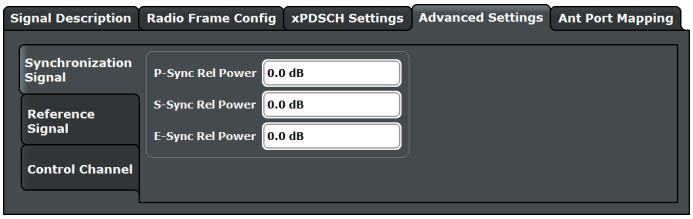
Remote command:
PCRS state (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:STATe` on page 112
PCRS Power (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:POWer` on page 112
PCRS AP (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:AP` on page 109
PCRS sequence generation (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:SGENeration` on page 111
PCRS ID (DL): `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:NID` on page 110

4.5 Synchronization Signal Configuration (Downlink)

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

The synchronization signals in a V5GTF radio frame are always transmitted on subframes 0 and 25. The V5GTF standard specifies three synchronization signals, which are always present in the radio frame. The location of the synchronization signals within the subframe and the allocated resource elements are fix.

- Primary synchronization signal (P-Sync)
  The P-Sync is used for radio frame synchronization.
- Secondary synchronization signal (S-Sync)
  The S-Sync is used for radio frame synchronization.
- Extended synchronization signal (E-Sync)
  The E-Sync to identify the OFDM symbol index.



Configuring component carriers

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

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

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

The remote commands required to configure the synchronization signal are described in Chapter 6.9.5, "Synchronization Signal Configuration", on page 118.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>]:SYNC:PPOWer` on page 118

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

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>]:SYNC:SPOWer` on page 118

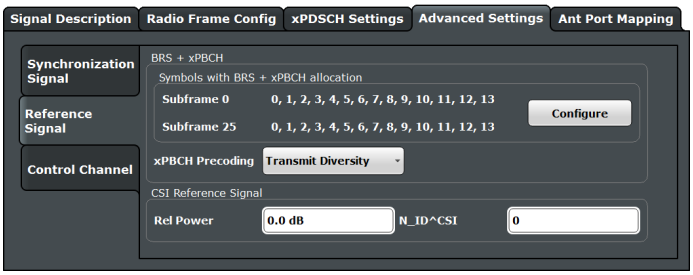
E-Sync Relative Power
Defines the relative power of the extended synchronization signal (E-Sync).

Remote command:
`CONFigure[:V5G]:DL[:CC<cc>]:SYNC:EPOWer` on page 118

4.6 Reference Signal Configuration (Downlink)

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

V5GTF specifies several reference signals for various purposes. You can configure them in the "Reference Signal" dialog box.



Configuring component carriers

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

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

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

The remote commands required to configure the reference signals are described in Chapter 6.9.6, "Reference Signal Configuration", on page 119.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

xPBCH and BRS Configuration

The physical broadcast channel (xPBCH) carries the broadcasting message. It always shares the symbol it is transmitted in with the beam reference signal (BRS), which serves two purposes.

- It is the demodulation reference signal for the xPBCH.
- It contains information for the UE about which beam that the base station transmits.

The xPBCH and BRS are always transmitted on subframes 0 and 25. The symbol(s) you can use for the transmission of the BRS and the xPBCH is arbitrary. Select the "Configure" button to open another dialog box that allows you to assign the BRS and xPBCH to any symbol of subframe 0 and 25 ("On" = xPBCH uses the corresponding symbol, "Off" = corresponding symbol is unused.

The list in the "Reference Signal" dialog box shows which symbols are currently occupied by the BRS and xPBCH.

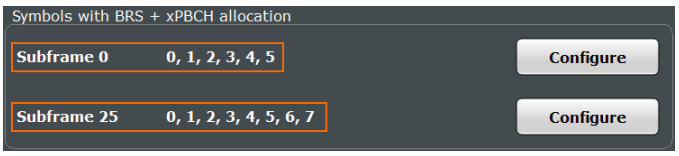


Figure 4-7: Symbol assignment for xPBCH

The xPBCH and BRS use the transmit diversity "Precoding" scheme (several antennas transmit a single layer data stream). You can also turn off precoding ("None").

Remote command:
Symbol usage: `CONFigure[:V5G]:DL[:CC<cc>]:BRS:SUBFrame<sf>:SYMBol<sym>[:STATe]` on page 119
Precoding: `CONFigure[:V5G]:DL[:CC<cc>]:XPBCh:PRECoding` on page 122

CSI Reference Signal Configuration
The channel state information (CSI) reference signal is used to estimate the properties of the signal propagation channel from the base station to the user equipment. This information is quantized and fed back to the base station.

It can be transmitted in OFDM symbol 12 (antenna ports 16 to 23) and in the last OFDM symbol 13 (antenna ports 16 to 31).

You can define the "Power" of a CSI reference signal resource element relative to the power of the BRS.

The "N_ID^CSI" parameter defines the initial (seed) value by which the reference signal sequence is generated.

Remote command:
Power: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:CSIRs:POWer` on page 121
N_ID^CSI: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:CSIRs:NCID` on page 120

ePBCH DMRS Configuration
The extended physical broadcast channel (ePBCH) is a channel that carries system information for initial cell attachment and radio resource configuration. If present, it is transmitted either in subframe 4 or 29 (the complete subframe is reserved for ePBCH in that case) and is mapped to antenna port 500 or 501.

In addition to the ePBCH information, several resource elements are reserved for the ePBCH demodulation reference signal (DMRS) which is used to demodulate the ePBCH.

The ePBCH uses the transmit diversity "Precoding" scheme (several antennas transmit a single layer data stream). You can also turn off precoding ("None").

The "Power" of a ePBCH resource element is a value relative to the power of the BRS.

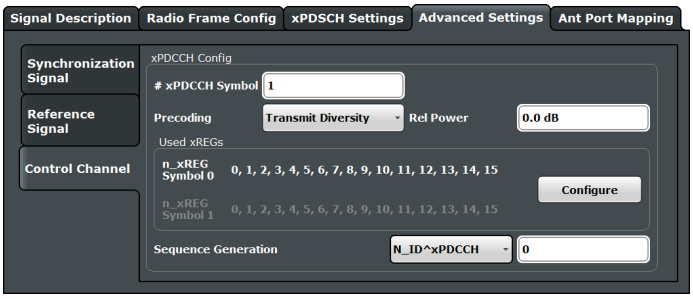
Remote command:
Precoding: `CONFigure[:V5G]:DL[:CC<cc>]:EPBCh:PRECoding` on page 121
Power: `CONFigure[:V5G]:DL[:CC<cc>]:EPBCh:POWer` on page 121

4.7 Control Channel Configuration (Downlink)

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

The physical downlink control channel (xPDCCH) carries scheduling assignments like the control information (DCI) required by the UE to receive and demodulate data successfully. The xPDCCH demodulation reference signal (DMRS) allows the UE to demodulate the xPDCCH successfully.

The xPDCCH is transmitted in the first or the first two OFDM symbols of a subframe. There are several resource element groups (xREG) reserved for the reference signal and the xPDCCH control information. An xREG is a group of resource elements within an OFDM symbol that indicates a specific location in that symbol. Each OFDM symbol has 16 xREGs.



Configuring component carriers

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

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

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

The remote commands required to configure the control channel are described in Chapter 6.9.7, "Control Channel Configuration", on page 122.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

xPDCCH Configuration

The xPDCCH is located either on the first or the first two OFDM symbols in a data subframe. In both cases you can allocate a xPDCCH to any of the 16 xREGs in that symbol: When you select the "Configure" button, the R&S FPS opens another dialog box that allows you to select the xREGs you would like to allocate the xPDCCH to ("On" = xPDCCH occupies the corresponding xREG, "Off" = xREG is unused).

You can define the "Power" of xPDCCH resource elements relative to the power of a common resource element.

As defined by the V5GTF standard, the xPDCCH uses the transmit diversity "Precoding" scheme (several antennas transmit a single layer data stream). You can also turn off precoding ("None").

The V5GTF standard (V5G.211) defines two methods by which the DMRS sequence can be calculated. You can select the method with the "Sequence Generation" parameter. The sequence is either calculated with the "n_ID^DMRS" variable (a pseudo-random seed value). Or, if the higher layers provide no value for n_ID^DMRS, the sequence is generated based on the cell ID with the "n_ID^Cell". n_ID^Cell has the same value as the cell ID.

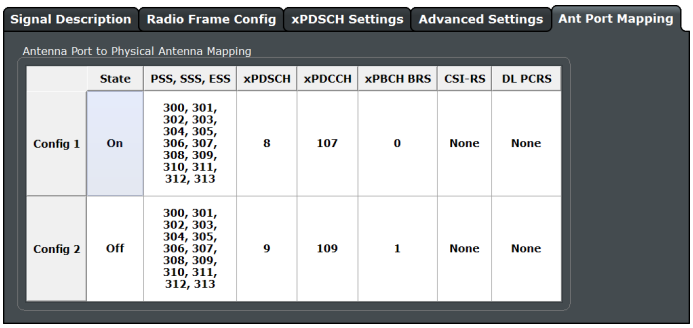
Remote command:
Symbol number: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SYMBol<sym>[:COUNt]` on page 125
Precoding: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:PRECoding` on page 123
Power: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:POWer` on page 123
Sequence generation: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SGENeration` on page 124
Sequence ID: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:NID` on page 123
XREG usage: `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SYMBol<sym>:XREG<xr>[:STATe]` on page 124

4.8 Antenna Port Mapping (Downlink)

Access: "Overview" > "Signal Description" > "Ant Port Mapping"

Antenna ports are not physical antennas, but rather are a logical concept. Each antenna port carries certain signal components (= physical channels) that should be transmitted under the same conditions. Physical channels can be transmitted on a single antenna port, or on several antenna ports. Each antenna port in turn can be mapped to one of the physical antennas. Typically, one physical antenna combines several antenna ports. However, one specific antenna port can also be transmitted on more than one physical antenna.

The "Ant Port Mapping" dialog box allows you to map the antenna ports used by the various physical channels defined in the V5GTF standard to one or two layer configurations.



	State	PSS, SSS, ESS	xPDSCH	xPDCCH	xPBCH BRS	CSI-RS	DL PCRS
Config 1	On	300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313	8	107	0	None	None
Config 2	Off	300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313	9	109	1	None	None

The remote commands required to configure the antenna ports are described in Chapter 6.9.8, "Antenna Port Configuration", on page 126.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

The dialog is designed as a table with two rows representing the physical antennas ("Config 1" and "Config 2"). The columns represent the physical channels.

State	Applies the configuration to the measurement. Note that you can currently measure only one of the two configurations (physical antenna). If you turn on one configuration, the other is automatically turned off.
PSS, SSS, ESS	The synchronization signals can be transmitted on multiple antenna ports (300 to 313). When you select the cell, the R&S FPS opens another dialog box in which you can turn the transmission of the synchronization signals on certain antenna ports on and off. By default, the synchronization signals are transmitted on all antenna ports.
xPDSCH	The xPDSCH can be transmitted on multiple antenna ports (8 to 15). When you select the cell, the R&S FPS opens another dialog box in which you can turn the transmission of the xPDSCH on certain antenna ports on and off. By default, the xPDSCH is transmitted on antenna port 8 only.
xPDCCH	The xPDCCH can be transmitted on a single antenna port (107 or 109). Select on which antenna port you would like to transmit the xPDCCH on from the dropdown menu. When you transmit the xPDCCH on the first antenna on antenna port 107, the R&S FPS automatically selects antenna port 109 on the second physical antenna and vice versa.
xPBCH BRS	The xPBCH BRS can be transmitted on a single antenna port (0 to 7). Select on which antenna port you would like to transmit the xPBCH BRS on from the dropdown menu.
ePBCH	The ePBCH can be transmitted on a single antenna port (500 or 501). Select on which antenna port you would like to transmit the ePBCH on from the dropdown menu. By default, the ePBCH is transmitted on no antenna ports.
CSI RS	The CSI RS can be transmitted on multiple antenna ports (16 to 31). Antenna ports 16 to 23 are reserved for the first CSI RS symbol (symbol 12 in a subframe). Antenna ports 24 to 31 are reserved for the second CSI RS symbol (symbol 13 in a subframe). By default, the CSI RS is transmitted on no antenna ports.
PCRS	The PCRS can be transmitted on a single antenna port or on two antenna ports simultaneously (60 to 61). Select on which antenna port you would like to transmit the PCRS on from the dropdown menu.

Remote commands to map antenna ports to physical antennas

Remote command:
Configuration state: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:STATe` on page 129
Synchronization signal: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:SSIGnal:AP<ap>` on page 129
xPDSCH: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:XPDSch:AP<ant>` on page 131
xPDCCH: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:XPDCch:AP<ap>` on page 130
xPBCH: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:BRS:AP<ap>` on page 126
ePBCH: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:EPBCh:AP<ap>` on page 127
CSI RS: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:CSIRs:AP<ap>` on page 127
PCRS: `CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:PCRS:AP<ap>` on page 128

4.9 Selecting the Input Source

The application supports several input sources and outputs.

For a comprehensive description of the supported inputs and outputs, refer to the documentation of the R&S FPS base unit.

4.9.1 RF Input

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

Functions to configure the RF input described elsewhere:

- " Input Coupling " on page 51
- " Impedance " on page 52

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

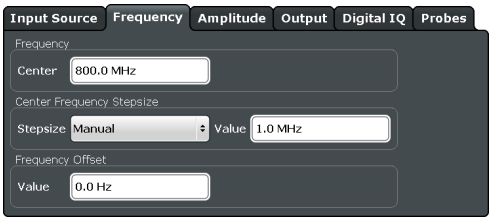
Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 132

4.10 Defining the Frequency

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 6.9.10, "Frequency Configuration", on page 132.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Defining the Signal Frequency

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

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

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

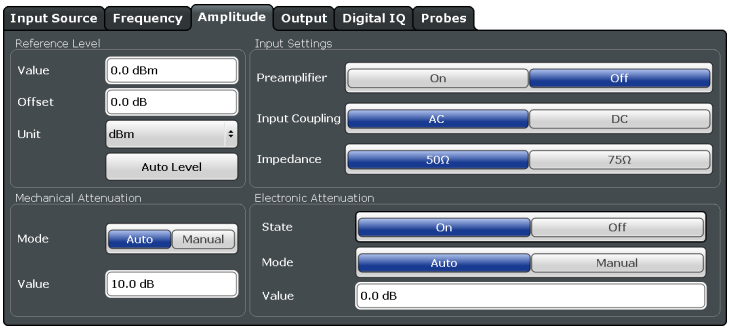
- = Center
  One frequency step corresponds to the current center frequency.
- Manual
  Define any stepsize you need.

Remote command:
Center frequency: `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 100
Frequency stepsize: `[SENSe:]FREQuency:CENTer:STEP` on page 132
Frequency offset: `[SENSe]:FREQuency:CENTer[:CC<cc>]:OFFSet` on page 101

4.11 Defining Level Characteristics

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

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



The remote commands required to configure the amplitude are described in Chapter 6.9.11, "Amplitude Characteristics", on page 133.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power for signals with a high crest factor like V5GTF.

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

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

You can define an arithmetic **level offset**. A level offset is useful if the signal is attenuated or amplified before it is fed into the analyzer. All displayed power level results 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.

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

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

Automatic level detection also optimizes RF attenuation.

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

Remote command:
Manual: DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel on page 133
Automatic: [SENSe:]ADJust:LEVel on page 137
Offset: DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 134

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

The V5GTF measurement application provides several attenuation modes.

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

For more information on attenuating the signal, see the manual of the connected instrument.

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

Remote command:
RF attenuation: INPut:ATTenuation on page 134
RF attenuation: INPut:ATTenuation:AUTO on page 134
Electronic attenuation: INPut<n>:EATT:STATe on page 136
Electronic attenuation: INPut<n>:EATT:AUTO on page 136
Electronic attenuation: INPut<n>:EATT on page 136

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

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

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

Remote command:
INPut:COUPling on page 135

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

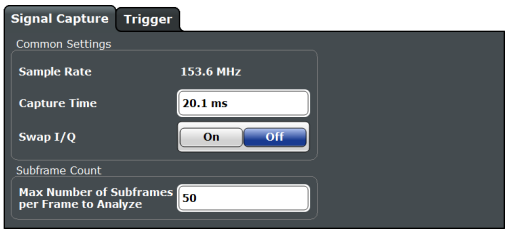
Select 75 Ω if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type. (That corresponds to 25Ω in series to the input impedance of the instrument.) The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Remote command:
`INPut:IMPedance` on page 135

4.12 Configuring the Data Capture

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

The data capture settings contain settings that control various aspects of the data capture.



The remote commands required to configure the data capture are described in Chapter 6.9.12, "Data Capture", on page 137.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Capture Time
Defines the capture time.

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

By default, the application captures 20.1 ms of data to make sure that at least one complete V5GTF frame is captured in the measurement.

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

Note that if you are using the multi-standard radio analyzer, only the MSRA master channel actually captures the data. The capture time only defines the V5GTF analysis interval.

More information

Remote command:
[SENSe:]SWEep:TIME on page 138

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

Remote command:
[SENSe:]SWAPiq on page 138

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

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

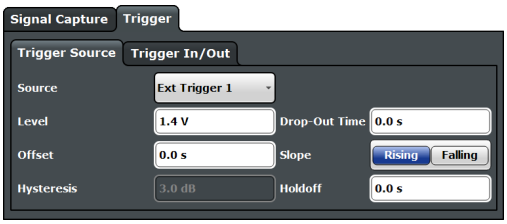
Remote command:
[SENSe<n>:][V5G:]FRAMe:SCOunt on page 137

4.13 Triggering Measurements

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

The trigger functionality of the V5GTF measurement application is the same as that of the R&S FPS. For a comprehensive description of the available trigger settings see the documentation of the R&S FPS.

Note that some trigger sources available in the spectrum application are not available in the V5GTF application.

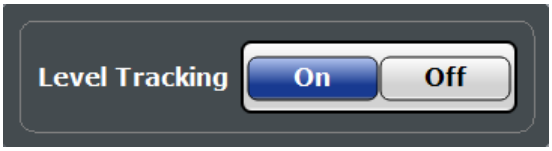


For more information on triggering measurements see the documentation of the R&S FPS.

4.14 Tracking

Access: "Overview" > "Tracking"

Tracking settings contain settings that compensate various errors.



The remote commands required to configure error tracking are described in Chapter 6.9.13, "Tracking", on page 138.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

Level Tracking
Turns level tracking on and off.

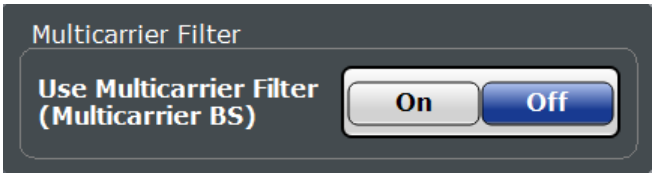
When you turn on level tracking, the R&S FPS compensates the measurement results for power level deviations for each symbol.

Remote command:
`[SENSe<n>:][V5G:]TRACking:LEVel` on page 138

4.15 Demodulation

Access: "Overview" > "Demodulation"

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



The remote commands required to configure the demodulation are described in Chapter 6.9.14, "Demodulation", on page 139.

The remote commands required to query measurement results are decribed in:

- Chapter 6.7, "Remote Commands to Retrieve Trace Data", on page 81
- Chapter 6.8, "Remote Commands to Retrieve Numeric Results", on page 88

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

Remote command:
`[SENSe<n>:][V5G:]DEMod:MCFilter` on page 139

4.16 Automatic Configuration

Access: AUTO SET

The application features several automatic configuration routines. When you use one of those, the R&S FPS 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 V5GTF input signal.

For more information see the user manual of the R&S FPS.

Auto EVM

Adjusts the amplitude settings to achieve the optimal EVM using the maximum dynamic range.

This routine measures the signal several times at various levels to achieve the best results. Therefore, this routine can take several minutes to finish (depending on the number of component carriers).

Auto scaling

Scales the y-axis for best viewing results. Also see "Y-Axis Scale" on page 57.

5 Analysis

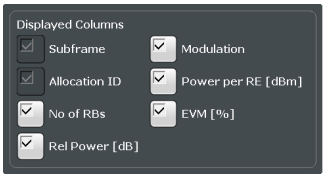
The application provides several tools to analyze the measurement results in more detail.

5.1 Configuring Tables / Numerical Results

The application allows you to customize the number of columns for some numeric result displays, for example the allocation summary.

► Select somewhere 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 Exporting Measurement Results

Access: TRACE > "Trace Export Config"

In case you want to evaluate the data with external applications (for example in a Microsoft Excel spreadsheet), you can export the measurement data to an ASCII file.

The data export is available for:

- I/Q measurements
- Time Alignment Error measurements

1. Select the "Trace Export Config" dialog box via the TRACE key.
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).

As the basic principle is the same as in the spectrum application, refer to the R&S FPS user manual for more information.

5.3 Analyzing I/Q Measurements

5.3.1 Scale

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

Scaling settings define the diagram scale.

The remote commands required to configure the y-axis acale are described in Chapter 6.10.1, "Y-Axis Scale", on page 140.

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

Usually, the best way to view the results is if they fit ideally in the diagram area and display the complete trace. This is the way the application scales the y-axis if you are using the **automatic scale** function.

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

You can restore the default scale at any time with "Restore Scale".

Tip:

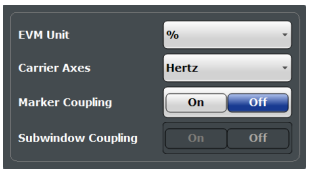
Alternatively, you can scale the windows in the "Auto Set" menu. In addition to scaling the window currently in focus ("Auto Scale Window"), there you can scale **all windows** at the same time ("Auto Scale All").

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO`
on page 140
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum`
on page 141
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum`
on page 141

5.3.2 Result Settings

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

Result settings define the way certain measurement results are displayed.



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

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 142

Carrier Axes
Selects the scale of the x-axis for result displays that show results of OFDM subcarriers.

Remote command:
`UNIT:CAXes` on page 142

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:MARKer:COUPling` on page 141

Subwindow Coupling
Couples or decouples result display tabs (subwindows).

If the coupling is on and you select another tab in a result display, the application automatically selects the same tab for all result displays.

Subwindow coupling is available for measurements with multiple data streams (for example carrier aggregation).

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:COUPling` on page 142

5.3.3 Markers

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

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

Markers in result displays with a third aspect

In result displays that have a third dimension ("EVM vs Symbol x Carrier" etc.), you can position a marker on a particular symbol in a particular carrier.

When you activate a marker, you can select the symbol and carrier you want to position the marker on. Alternatively, you can define the marker position in the "Marker Configuration" dialog box, which is expanded accordingly.

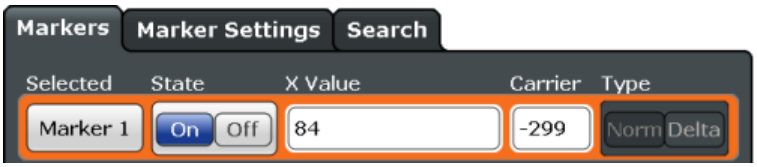


Figure 5-1: Marker configuration dialog, the Carrier field is only available for result displays with a third dimension.

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

6 Remote Control

The following remote control commands are required to configure and perform V5GTF measurements in a remote environment. The R&S FPS must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FPS User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data.
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation.
- Using the common status registers.

6.1 Common Suffixes

In the V5GTF measurement application, the following common suffixes are used in remote commands:

Table 6-1: Common suffixes used in remote commands in the V5GTF measurement application

Suffix	Value range	Description
<m>	1..4	Marker
<n>	1..16	Window (**in the currently selected channel**)
<t>	1..6	Trace
<a>	DL: 0..16 UL: 0..1	Selects a subframe allocation.
<ap>	depends on channel	Selects an antenna port.
<cc>	1..8	Selects a component carrier. The actual number of supported component carriers depends on the selected measurement
<cf>	1..2	Selects a physical antenna (for antenna port mapping).

Suffix	Value range	Description
<k>	---	Selects a limit line. Irrelevant for the V5GTF application.
<sf>	0..49	Selects a subframe.
<sym>	0..13	Selects an OFDM symbol
<xr>	0..15	Selects an xREG.

6.2 Introduction

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

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

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

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

Remote command examples

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

6.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

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

Parameters that are only returned as the result of a query are indicated as **Return values**.

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

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

Example:

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

6.2.3 Numeric Suffixes

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

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

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

Example:

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

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

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.

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

6.2.5 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, these are separated by a comma.

Example:

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

Parameters may 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. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

6.2.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

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 62.

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

6.3 Remote Commands to Select the V5GTF Application

INSTrument:CREate:DUPLicate

This command duplicates the currently selected channel, i.e creates a new channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer 2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

Example:
```
INST:SEL 'IQAnalyzer'
INST:CRE:DUPL
```
Duplicates the channel named 'IQAnalyzer' and creates a new channel named 'IQAnalyzer2'.

Usage: Event

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

This command adds an additional channel.

The number of channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 67.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 67).

Example:
```
INST:CRE IQ, 'IQAnalyzer2'
```
Adds an additional I/Q Analyzer channel named "IQAnalyzer2".

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

This command replaces a channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 67.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 67).

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named "IQAnalyzer2" by a new channel of type "IQ Analyzer" named "IQAnalyzer".

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a channel.

If you delete the last channel, the default "Spectrum" channel is activated.

Parameters:

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

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Event

INSTrument:LIST?

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

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a channel.

Parameters:

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

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

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

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

Parameters:

<ChannelType> **V5GTf**
V5GTF measurement channel

Example: //Select V5GTF application
`INST V5GT`

6.4 General Window Commands

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 channel* (see `INSTrument[:SELect]` on page 68).

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format> **SPLit**
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 73).

Suffix:
<n> Window

Parameters:
<Size>
LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example:
```
DISP:WIND2:SIZE LARG
```

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

This command 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

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

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

Usage: Event

6.5 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a 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 channel.

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

This command adds a window to the display in the active channel.

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

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

Query parameters:

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

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

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

Return values:

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

Usage: Query only

Manual operation: See "Capture Buffer" on page 14
See "EVM vs Carrier" on page 15
See "EVM vs Symbol" on page 16
See "Power Spectrum" on page 16
See "Spectrum Flatness" on page 17
See "Group Delay" on page 17
See "Constellation Diagram" on page 17
See "Allocation Summary" on page 18
See "EVM vs Symbol x Carrier" on page 19
See "Power vs Symbol x Carrier" on page 19
See "Allocation ID vs Symbol x Carrier" on page 20
See "Result Summary" on page 20
See " Marker Table " on page 22

Table 6-2: <WindowType> parameter values for V5GTF measurement application

Parameter value	Window type
I/Q measurements	
AISC	Allocation ID vs. Symbol X Carrier
ASUM	Allocation Summary
CBUF	Capture Buffer
FLAT	Channel Flatness
CONS	Constellation Diagram
EVCA	EVM vs. Carrier
EVSC	EVM vs. Symbol X Carrier
EVSY	EVM vs. Symbol
GDEL	Group Delay
MTAB	Marker Table
PSPE	Power Spectrum
PVSC	Power vs. Symbol X Carrier
RSUM	Result Summary

LAYout:CATalog[:WINDow]?

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

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

Return values:

<WindowName> string

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

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

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

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active channel.

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

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

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

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

Usage: Query only

LAYout:MOVE[:WINDow] <arg0>, <arg1>, <arg2>

Setting parameters:
<arg0> String containing the name of an existing window that is to be moved.
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.

<arg1> String containing the name of an existing window the selected window is placed next to or replaces.
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.

<arg2> LEFT | RIGHt | ABOVe | BELow | REPLace

Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

This command 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: Event

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

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active 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 70 for a list of available window types.

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

Usage: Setting only

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 69 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

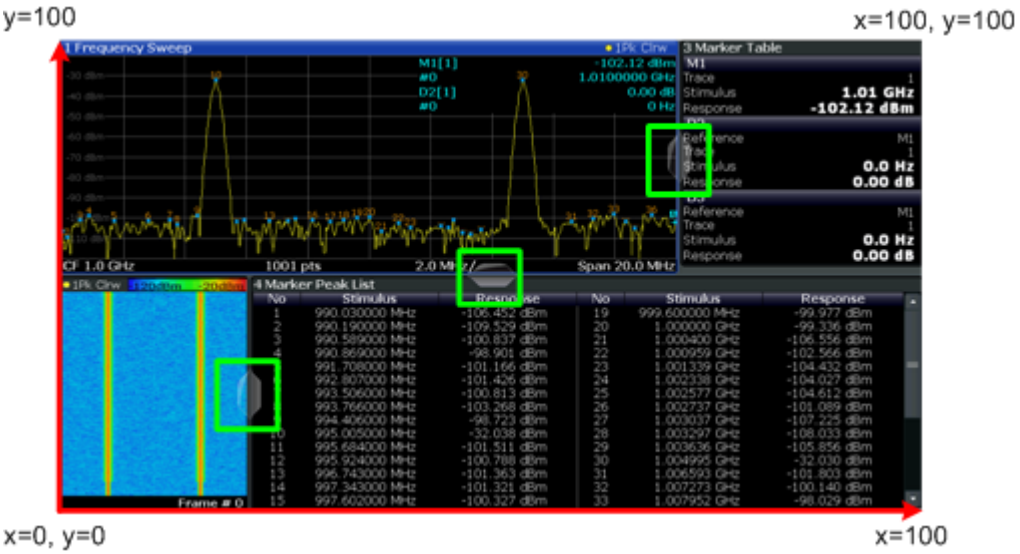


Figure 6-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 6-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

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

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

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

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

Suffix:
<n> Window

Parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 70 for a list of available window types.

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

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

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active 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

This command removes the window specified by the suffix <n> from the display in the active channel.

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

Suffix:
<n> Window

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

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command 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 70 for a list of available window types.

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

Usage: Setting only

6.6 Performing Measurements

6.6.1 Measurements

ABORt

This command aborts the measurement in the current channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FPS is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FPS on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

Suffix:
<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 0

Example: `INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

Suffix:

<n> irrelevant

Usage: Event

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

This command queries the current synchronization state.

Suffix:

<cc> Component Carrier

Return values:

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

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

Usage: Query only

6.6.2 Measurement Sequences

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 79.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 80.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 80).

Suffix:
<n> irrelevant

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FPS application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 80).

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

Suffix:
<n> irrelevant

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single sequence mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.
```
SYST:SEQ OFF
```

6.7 Remote Commands to Retrieve Trace Data

6.7.1 Using the TRACe[:DATA] Command

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

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

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.

For measurements on aggregated carriers, where each measurement window has subwindows, you have to select the subwindow first with `DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect`.

6.7.1.1 Capture Buffer

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

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

The unit is always dBm.

The following parameters are supported.

- TRACE1

6.7.1.2 EVM vs Carrier

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

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

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes

6.7.1.3 EVM vs Carrier

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

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

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes

6.7.1.4 EVM vs Symbol

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

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

The measurement always analyzes the symbol EVM over all subframes.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.7.1.5 Power Spectrum

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

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

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

6.7.1.6 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.

- TRACE1
  Returns the average power over all subframes.

6.7.1.7 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 V5GTF bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

6.7.1.8 Constellation Diagram

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

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

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

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

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

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

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

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

The I and Q values have no unit.

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

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

6.7.1.9 Allocation Summary

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

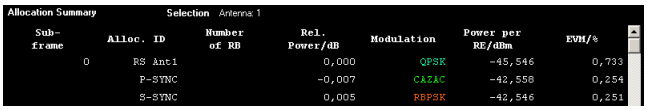
`<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...`

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

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see Chapter 6.7.1.13, "Return Value Codes", on page 86.

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

Example:



`TRAC:DATA? TRACE1` would return:

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

6.7.1.10 EVM vs Symbol x Carrier

For the EVM vs Symbol x Carrier, the command returns one value for each resource element.

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

The unit depends on `UNIT:EVM`.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

6.7.1.11 Power vs Symbol x Carrier

For the Power vs Symbol x Carrier, the command returns one value for each resource element.

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

with P = Power of a resource element.

The unit is always dBm.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

6.7.1.12 Allocation ID vs Symbol x Carrier

For the Allocation ID vs Symbol x Carrier, the command returns one value for each resource element.

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

The `<allocation ID>` is encoded.

For the code assignment see Chapter 6.7.1.13, "Return Value Codes", on page 86.

The following parameters are supported.

- TRACE1

6.7.1.13 Return Value Codes

<number of symbols or bits>

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

<ACK/NACK>

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

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

<allocation ID>

Represents the allocation ID. The range is as follows.

- **-3** = P-Sync
- **-4** = S-Sync
- **-5** = ESS
- **-10** = BRS
- **-11** = BRRS
- **-12** = CSI RS
- **-20** = xPDCCH
- **-21** = xPDCCH RS
- **-22** = xPBCH
- **-23** = ePBCH
- **-24** = ePBCH RS
- **-1xxxxx** = xPDSCH (Port 8 to 11)
- **-2xxxxx** = xPDSCH (Port 12 to 15)
- **-3xxxxx** = xPDSCH PCRS
- **-4xxxxx** = xPUSCH RS
- **-5xxxxx** = xPUSCH PCRS
  Note. **xxxxx** is a placeholder for the ID of the channel.
  If the channel has, for example, the ID 22, the return value would be -100022, -200022 or -300022 (depending on the configuration)

<channel type>

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

<codeword>

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

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

<modulation>

Represents the modulation scheme.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **6** = CAZAC
- **14** = 256QAM

FORMat[:DATA] <Format>

This command specifies the data format for the data transmission between the V5GTF measurement application and the remote client. Supported formats are ASCII or REAL32.

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

- Allocation summary

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: `FORM REAL`

The software will send binary data in Real32 data format.

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

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

For more information, see Chapter 6.7.1, "Using the TRACe[:DATA] Command", on page 81.

Suffix:
<n> Window

Query parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

Example: `TRAC2? TRACE1`
Queries results of the second measurement window. The type of data that is returned by the parameter (`TRACE1`) depends on the result display shown in measurement window 2.

Usage: Query only

6.8 Remote Commands to Retrieve Numeric Results

6.8.1 Result Summary

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

This command 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

Manual operation: See "Result Summary" on page 20

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

This command queries the EVM of all resource elements.

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>
The unit is % or dB, depending on your selection.

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

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

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

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

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

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

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the EVM of all xPDSCH resource elements with a 256QAM modulation.

Suffix:
<cc> Component Carrier

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

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command 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

Manual operation: See "Result Summary" on page 20

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

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

Suffix:
<cc> Component Carrier

Return values:
<EVM> <numeric value>

The unit is % or dB, depending on your selection.

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the frequency error.

Suffix:
<cc> Component Carrier

Return values:
<FreqError> <numeric value>

Default unit: Hz

Example: //Query average frequency error
`FETC:SUMM:FERR?`

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the I/Q gain imbalance.

Suffix:
<cc> Component Carrier

Return values:
<GainImbalance> <numeric value>

Default unit: dB

Example: //Query average gain imbalance
`FETC:SUMM:GIMB?`

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the I/Q offset.

Suffix:
<cc> Component Carrier

Return values:
<IQOffset> <numeric value>

Default unit: dB

Example: //Query average IQ offset
`FETC:SUMM:IQOF?`

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the total power.

Suffix:
<cc> Component Carrier

Return values:
<Power> <numeric value>

Default unit: dBm

Example: //Query average total power
`FETC:SUMM:POW?`

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the quadrature error.

Suffix:
<cc> Component Carrier

Return values:
<QuadError> <numeric value>

Default unit: deg

Example: //Query average quadrature error
`FETC:SUMM:QUAD?`

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

This command queries the sampling error.

Suffix:
<cc> Component Carrier

Return values:
<SamplingError> <numeric value>

Default unit: ppm

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

Usage: Query only

Manual operation: See "Result Summary" on page 20

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

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

Suffix:
<cc> Component Carrier

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

Default unit: s

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

Usage: Query only

Manual operation: See "Capture Buffer" on page 14

6.8.2 Marker Table

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

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

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

Suffix:
<m> Marker
<n> Window

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

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

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

If necessary, the command activates the delta marker first.

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

See also `INITiate<n>:CONTinuous` on page 77.

The unit depends on the application of the command.

Suffix:
<m> Marker
<n> Window

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

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

Usage: Query only

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

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

If necessary, the command activates the marker.

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

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

Parameters:

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

Range: The range depends on the current x-axis range.

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

Manual operation: See " Marker Table " on page 22

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

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

If necessary, the command activates the marker first.

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

See also `INITiate<n>:CONTinuous` on page 77.

Suffix:

<n> Window

<m> Marker

Return values:

<Result> Result at the marker position.

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

Usage: Query only

Manual operation: See " Marker Table " on page 22

6.9 Remote Commands to Configure the V5GTF Measurements

6.9.1 General Configuration

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

The remote control commands to select the result displays for I/Q measurements are described in Chapter 6.5, "Working with Windows in the Display", on page 69.

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Setting parameters:

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

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

Usage: Setting only

MMEMory:STORe:IQ:STATe <Path>

This command saves I/Q data to a file.

Setting parameters:

<Path> 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.

Usage: Setting only

SYSTem:PRESet:CHANnel[:EXEC]

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

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual operation: See "Preset Channel" on page 25

6.9.2 Physical Signal Characteristics

CONFigure[:LTE]:NOCC <Carriers>

This command selects the number of component carriers analyzed in the measurement.

Parameters:

<Carriers> Number of the component carriers that you would like to measure. The range depends on the measurement.
For more information see "Carrier Aggregation" on page 26.
*RST: 1

Example: //Select number of component carriers
`CONF:NOCC 2`

Manual operation: See "Remote commands to configure carrier aggregation" on page 28

CONFigure[:V5G]:CSCapture <Mode>

This command selects the capture mode for measurements on multiple component carriers.

Setting parameters:

<Mode>

AUTO
Automatically selects the number of component carriers that can be analyzed in a single capture. If there are more carriers than can be analyzed in a single measurement, the other carriers are analyzed in subsequent measurements.

SINGle
Capture each component carrier subsequently in individual measurements.

*RST: AUTO

Example:

```
//Select component carrier capture mode
CONF:CSC AUTO
```

Manual operation: See "Remote commands to configure carrier aggregation" on page 28

CONFigure[:V5G]:DL[:CC<cc>]:PLC:CID <CellID>

This command defines the cell ID.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

Parameters:

<CellID>

AUTO
Automatically defines the cell ID.

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

Range: 0 to 503

Example:

```
//Define cell ID
CONF:LDIR DL
CONF:DL:PLC:CID 12
```

Manual operation: See "Physical settings of the signal" on page 28

CONFigure[:V5G]:LDIRection <Direction>

This command selects the link direction of the signal (V5GTF measurement mode).

Prerequisites for this command

- Measuring downlink signals required option R&S FPS-K118.
- Measuring uplink signals required option R&S FPS-K119.

Parameters:

<Direction>
DL
Selects downlink measurements.
UL
Selects uplink measurements.

Example:
//Select link direction
```
CONF:LDIR DL
```

Manual operation: See "Selecting the V5GTF mode" on page 26

MMEMory:LOAD:DEModsetting:ALL <Path>

This command restores the signal description of multiple carriers from a single file.

Parameters:

<Path>
String containing the path and name of the file.
The file extension is `.ccallocation`.

Example:
//Restore signal description for multiple carriers in a single files
```
CONF:NOCC 2
MMEM:LOAD:DEM:ALL 'c:\TestSignal.ccallocation'
```

Manual operation: See "Using Test Scenarios" on page 28

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

This command restores the signal description.

Suffix:

<cc>
Component Carrier

Parameters:

<Path>
String containing the path and name of the file.
The file extension is `.allocation`.

Example:
//Restore signal description for a single component carrier
```
MMEM:LOAD:DEM 'c:\TestSignal.allocation'
```
//restore signal description for multiple carriers in individual files
```
CONF:NOCC 2
MMEM:LOAD:DEM:CC1 'c:\TestSignalCC1.allocation'
MMEM:LOAD:DEM:CC2 'c:\TestSignalCC2.allocation'
```

Manual operation: See "Using Test Scenarios" on page 28

MMEMory:STORe<n>:DEModsetting:ALL <Path>

This command saves the signal description of multiple carriers in a single file.

Suffix:

<n>
irrelevant

Parameters:

<Path> String containing the path and name of the file.
The file extension is `.ccallocation`.

Example: //Save signal description for multiple carriers in a single files
```
CONF:NOCC 2
MMEM:STOR:DEM:ALL 'c:\TestSignal.ccallocation'
```

Manual operation: See "Using Test Scenarios" on page 28

MMEMory:STORe<n>:DEModsetting[:CC<cc>] <Path>

This command saves the signal description.

Suffix:

<n> irrelevant

<cc> Component Carrier

Parameters:

<Path> String containing the path and name of the file.
The file extension is `.allocation`.

Example: //Save signal description for a single component carrier
```
MMEM:STOR:DEM 'c:\TestSignal.allocation'
```
//Save signal description for multiple carriers in individual files
```
CONF:NOCC 2
MMEM:STOR:DEM:CC1 'c:\TestSignalCC1.allocation'
MMEM:STOR:DEM:CC2 'c:\TestSignalCC2.allocation'
```

Manual operation: See "Using Test Scenarios" on page 28

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

This command sets the center frequency for RF measurements.

Component carrier measurements

- Defining or querying the frequency of the first carrier is possible with `FREQ:CENT:CC1`. The `CC1` part of the syntax is mandatory in that case.
- `FREQ:CENT?` queries the measurement frequency (center of the two carriers).

Suffix:

<cc> Component Carrier

Parameters:

<Frequency> <numeric value>

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

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

Example: //Define frequency for measurement on aggregated carriers:
`FREQ:CENT:CC1 850MHZ`

Manual operation: See "Remote commands to configure carrier aggregation" on page 28
See "Defining the Signal Frequency" on page 49

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

This command defines the general frequency offset or the frequency offset for a component carrier.

The effect of the command depends on the syntax:

- When you omit the `[CC<cc>]` syntax element, the command defines the overall frequency offset.
  In that case, the value is added to the measurement frequency and, in case of measurements with component carriers, the center frequency of the component carriers.
- When you include the `[CC<cc>]` syntax element, the command defines the offset of the component carrier relative the first component carrier.
  In that case, the command is not available for the first component carrier - thus, `...:CC1:...` is not possible.

Suffix:
<cc> Component Carrier

Parameters:
<Frequency> • General frequency offset: frequency offset in Hz.
• Component carrier offset: frequency offset relative to the first component carrier in Hz.

Example: //Add a frequency offset of 50 Hz to the measurement frequency.
//If you are measuring component carriers, the value is also added to the center frequencies of those carriers.
`FREQ:CENT:OFFS 50HZ`
//Define a frequency offset of 15 MHz for the second component carrier relative to the first component carrier.
`FREQ:CENT:CC2:OFFS 15MHZ`

Manual operation: See "Remote commands to configure carrier aggregation" on page 28
See "Defining the Signal Frequency" on page 49

6.9.3 Radio Frame Configuration

CONFigure[:V5G]:DL[:CC<cc>]:CSUBframes <Subframes>

This command defines the number of configurable subframes.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Subframes> <numeric value> (integer only)
Range: 0 to 50
*RST: 50

Example: //Define number of configurable subframes
```
CONF:LDIR DL
CONF:DL:CSUB 10
```

Manual operation: See "Number of Configurable Subframes" on page 32

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation <Allocations>

This command selects the subframe allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Parameters:
<Allocations>

EPBCh
Subframe is used for transmission of the ePBCH.
This allocation is only supported by subframes 4 and 29.

DATA
Subframe is used for data transmission (xPDSCH).

SYNC
Subframe is used for tranmission of the synchronization data.
This allocation is only supported by subframes 0 and 25.

UNUSed
Subframe is not used in the transmission.

XRACh
Subframe is used for transmission of the xRACH.
This allocation is only supported by subframes 15 and 40.

Example: //Select allocation for subframes
```
CONF:LDIR DL
CONF:DL:SUBF0:ALL SYNC
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF2:ALL UNUS
CONF:DL:SUBF3:ALL DATA
CONF:DL:SUBF4:ALL EPBC
```

Manual operation: See "Subframe Allocation" on page 34

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:COPY

This command copies a specific subframe configuration to the clipboard.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Example: //Copy a subframe to the clipboard
```
CONF:LDIR DL
CONF:DL:SUBF1:COPY
```

Usage: Setting only

Manual operation: See "Number of Configurable Subframes" on page 32

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ORSignals <SignalType>

This command selects an optional reference signal that is transmitted in a subframe.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Select subframe type a (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:TYPE`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Parameters:
<SignalType>

CSIRs
Includes the CSI reference signal in the subframe.

NONE
No optional reference signal is included in the subframe.

*RST: NONE

Example: //Select optional reference signal
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:TYPE A
CONF:DL:SUBF1:ORS CSIR
CONF:DL:SUBF2:ALL DATA
CONF:DL:SUBF2:TYPE A
CONF:DL:SUBF2:ORS NONE
```

Manual operation: See "Optional Ref Signals" on page 35

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:PASTe:ALL

This command applies a previously copied subframe configuration to all other subframes.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Copy a subframe configuration to the clipboard (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:COPY`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Example: //Apply copied subframe configuration to all other subframes
```
CONF:LDIR DL
CONF:DL:SUBF1:COPY
CONF:DL:SUBF:PAST:ALL
```

Usage: Setting only

Manual operation: See "Number of Configurable Subframes" on page 32

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:PASTe[:ITEM]

This command applies a previously copied subframe configuration to another subframe.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Copy a subframe configuration to the clipboard (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:COPY`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Example: //Apply copied subframe configuration to subframe 2
```
CONF:LDIR DL
CONF:DL:SUBF1:COPY
CONF:DL:SUBF2:PAST
```

Usage: Setting only

Manual operation: See "Number of Configurable Subframes" on page 32

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:RESet

This command resets the radio frame configuration to its default state.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Example: //Reset subframe configuration
```
CONF:LDIR DL
CONF:DL:RES
```

Manual operation: See "Reset Frame Config" on page 33

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:SELect <Subframe>

This command selects a specific subframe.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Parameters:
<Subframe> <numeric value> (integer only)
Range: 0 to 49

Example: //Select subframe number two
```
CONF:LDIR DL
CONF:DL:SEL 2
```

Manual operation: See "Selecting a subframe for configuration" on page 33

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:TYPE <Type>

This command selects the subframe type.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).
- Select subframe allocation "data" for the subframe (CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation).

Suffix:

<cc> Component Carrier

<sf> Subframe

Parameters:

<Type>

A
Selects subframe type a.

B
Selects subframe type b.

Example:

```
//Select subframe type
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:TYPE A
CONF:DL:SUBF2:ALL DATA
CONF:DL:SUBF2:TYPE B
```

Manual operation: See "Subframe Type" on page 34

6.9.4 xPDSCH Configuration

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount <Allocations>

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

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).

Suffix:
<cc> Component Carrier

<sf> Subframe

Parameters:
<Allocations>

Example:
```
//Define number of allocations for subframe
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
```

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:NID <ID>

This command defines the value that the DMRS sequence is based on.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).
- Select manual definition of DMRS sequence generation (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:SGENeration`).

Suffix:
<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:
<ID> <numeric value> (integer only)

Range: 0 to 13
*RST: 0

Example:
```
//Select DMRS sequence generation for the first allocation in subframe 1
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 1
CONF:DL:SUBF1:ALL0:DMRS:SGEN NIPC
CONF:DL:SUBF1:ALL0:DMRS:NID 5
```

Manual operation: See "DMRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:SGENeration
<Method>

This command selects the method with which the DMRS sequence is calculated.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Effects of this command

- If you change the sequence generation method for the DMRS, the R&S FPS automatically selects the same method for the PCRS (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:SGENeration`).

Suffix:

<cc> Component Carrier

<sf> irrelevant

<a> Allocation

Parameters:

<Method>

NICell
The DMRS sequence is based on the cell ID.

NIDMrs
You can select the value that the sequence is based on manually with `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:NID`.

*RST: NICell

Example:

```
//Select DMRS sequence generation for the first allocation in subframe 1
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 1
CONF:DL:SUBF1:ALL0:DMRS:SGEN NIC
```

Manual operation: See "DMRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:MODulation
<Modulation>

This command selects the modulation of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).

- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier
<sf> Subframe
<a> Allocation

Parameters:
<Modulation> QPSK | QAM16 | QAM64 | QAM256

Example: //Select modulation for the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:MOD QPSK
```

Manual operation: See "Modulation" on page 37

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:AP
<AntennaPort>

This command selects the antenna port on which the PCRS is transmitted.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier
<sf> Subframe
<a> Allocation

Parameters:
<AntennaPort> AP60 | AP61 | AP60_61
*RST: AP60

Example: //Select antenna port for PCRS tranmission in the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PCRS:STAT ON
CONF:DL:SUBF1:ALL0:PCRS:AP AP60
```

Manual operation: See "PCRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:NID <ID>

This command defines the value that the PCRS sequence is based on.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).
- Select manual definition of PCRS sequence generation (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:SGENeration`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<ID> <numeric value> (integer only)

Range: 0 to 1
*RST: 0

Example: //Select PCRS sequence generation for the first allocation in subframe 1

```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PCRS:STAT ON
CONF:DL:SUBF1:ALL0:PCRS:SGEN NIPC
CONF:DL:SUBF1:ALL0:PCRS:NID 1
```

Manual operation: See "PCRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:POWer <Power>

This command defines the power of the PCRS relative to the xPDSCH allocation it is transmitted on.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define power of the PCRS in the first allocation in subframe 1

```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PCRS:STAT ON
CONF:DL:SUBF1:ALL0:PCRS:POW 3
```

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:SGENeration <Method>

This command selects the method with which the PCRS sequence is calculated.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Effects of this command

- If you change the sequence generation method for the PCRS, the R&S FPS automatically selects the same method for the DMRS (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:SGENeration`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<Method>

NICell
The PCRS sequence is based on the cell ID.

NIPCrs
You can select the value that the sequence is based on manually with `CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:NID`.

*RST: NICell

Example: //Select PCRS sequence generation for the first allocation in subframe 1

```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PCRS:STAT ON
CONF:DL:SUBF1:ALL0:PCRS:SGEN NIC
```

Manual operation: See "PCRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PCRS:STATe <State>

This command turns the PCRS in a xPDSCH allocation on and off.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on PCRS in the first allocation in subframe 1

```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL:PCRS:STAT ON
```

Manual operation: See "PCRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:POWer <Power>

This command defines the relative power of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define UE ID for the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:POW 3
```

Manual operation: See "Power" on page 38
See "PCRS configuration" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:PRECoding
<Scheme>

This command selects the precoding scheme of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:
<Scheme>

NONE
Selects no precoding for an allocation.

SPM
Selects spatial multiplexing for an allocation.

TXD
Selects transmit diversity for an allocation.

*RST: NONE

Example: //Select precoding scheme for the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PREC TXD
```

Manual operation: See "Precoding" on page 39

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:RBCount <ResourceBlocks>

This command defines the number of resource blocks occupied by a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<ResourceBlocks> <numeric value> (integer only)

Range: 1 to 100

Example: //Define resource blocks occupied by the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:RBC 5
```

Manual operation: See "Number of RB" on page 38

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:RBOFfset <Offset>

This command defines a resource block offset of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier
<sf> Subframe
<a> Allocation

Parameters:
<Offset> <numeric value> (integer only)
Range: 0 to 99

Example: //Define resource block offset for the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:RBOF 10
```

Manual operation: See "Offset RB" on page 38

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:SCID <ID>

This command selects the scrambling ID for the reference signals transmitted in a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:
<cc> Component Carrier
<sf> Subframe
<a> Allocation

Parameters:
<Scrambling ID> 0 | 1
*RST: 0

Example: //Select the scrambling ID in the first allocation in subframe 1
```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:SCID 1
```

Manual operation: See "UE Specific Reference Signals" on page 40

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:UEID <ID>

This command defines the ID or N_RNTI of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<ID> <numeric value> (integer only)

Range: 0 to 65535

Example: //Define UE ID for the first allocation in subframe 1

```
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:UEID 10
```

Manual operation: See "ID/N_RNTI" on page 37

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:XPDSch:AP <AntennaPorts>

This command selects the antenna ports on which a xPDSCH allocation is transmitted.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<AntennaPorts> AP8 | AP9 | AP10 | AP11 | AP8_9 | AP10_11 | AP8_12 | AP9_13 | AP10_14 | AP11_15

The availability of antenna ports depends on the selected precoding scheme.
• AP8, AP9, AP10 and AP11 are available for xPDSCH transmission on a single layer. Single layer transmission is supported if no precoding has been selected.
• The combinations of two antenna ports are available for xPDSCH transmission on two layers. Dual layer transmission is supported by all precoding schemes. For no precoding, you have to select dual layer transmission first.

Example:

```
//Select antenna ports for the first allocation in subframe 1
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PREC TXD
CONF:DL:SUBF1:ALL0:XPDS:AP AP8_12
```

Manual operation: See "Precoding" on page 39

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:XPDSch:NOLayer <Layers>

This command selects the number of layers used by a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select subframe allocation "data" for the subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLocation`).
- Assign one or more allocations to that subframe (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALCount`).

Suffix:

<cc> Component Carrier

<sf> Subframe

<a> Allocation

Parameters:

<Layers> 1 | 2

Example:

```
//Select antenna ports for the first allocation in subframe 1
CONF:LDIR DL
CONF:DL:SUBF1:ALL DATA
CONF:DL:SUBF1:ALC 10
CONF:DL:SUBF1:ALL0:PREC NONE
CONF:DL:SUBF1:ALL0:XPDS:NOL 2
CONF:DL:SUBF1:ALL0:XPDS:AP AP8_12
```

Manual operation: See "Precoding" on page 39

6.9.5 Synchronization Signal Configuration

CONFigure[:V5G]:DL[:CC<cc>]:SYNC:EPOWer <Power>

This command defines the relative power of the extended synchronization signal (E-SYNC).

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define relative power of E-SYNC

```
CONF:LDIR DL
CONF:DL:SYNC:EPOW 3
```

Manual operation: See "E-Sync Relative Power" on page 42

CONFigure[:V5G]:DL[:CC<cc>]:SYNC:PPOWer <Power>

This command defines the relative power of the primary synchronization signal (PSS).

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define relative power of PSS

```
CONF:LDIR DL
CONF:DL:SYNC:PPOW 3
```

Manual operation: See "P-Sync Relative Power" on page 42

CONFigure[:V5G]:DL[:CC<cc>]:SYNC:SPOWer <Power>

This command defines the relative power of the secondary synchronization signal (SSS).

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define relative power of SSS
```
CONF:LDIR DL
CONF:DL:SYNC:SPOW 3
```

Manual operation: See "S-Sync Relative Power" on page 42

6.9.6 Reference Signal Configuration

CONFigure[:V5G]:DL[:CC<cc>]:BRS:SUBFrame<sf>:SYMBol<sym>[:STATe]
<State>

This command turns the transmission of the xPBCH and BRS on specific OFDM symbols in subframes 0 and 25 on and off.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:
<cc> Component Carrier

<sf> Subframe
Only subframes 0 and 25 are supported for the transmission of the xPBCH and BRS.

<sym> OFDM symbol

Parameters:

<State>

ALL
Turns on the transmission of the xPBCH and BRS on all OFDM resource elements in the corresponding subframe.
(Suffix <sym> is irrelevant in this case.)

NONE
Turns off the transmission of the xPBCH and BRS on all OFDM resource elements in the corresponding subframe.
(Suffix <sym> is irrelevant in this case.)

ON | 1
Turns on the transmission of the xPBCH and BRS on a specific OFDM symbol in the corresponding subframe.

OFF | 0
Turns off the transmission of the xPBCH and BRS on a specific OFDM symbol in the corresponding subframe.

*RST: ON

Example:

//Configure xPBCH and BRS transmission
```
CONF:LDIR DL
CONF:DL:BRS:SUBF0:SYMB0 ON
CONF:DL:BRS:SUBF0:SYMB1 ON
CONF:DL:BRS:SUBF0:SYMB2 OFF
CONF:DL:BRS:SUBF0:SYMB3 OFF
```
etc.
```
CONF:DL:BRS:SUBF25:SYMB0 ON
CONF:DL:BRS:SUBF25:SYMB1 ON
```
etc.

Manual operation: See "xPBCH and BRS Configuration" on page 43

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:CSIRs:NCID <ID>

This command defines the initial (seed) value by which the reference signal sequence is generated ("N_ID^CSI").

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

<sf> irrelevant

Parameters:

<ID> <numeric value> (integer only)

Range: 0 to 65535
*RST: 0

Example:

//Define N_ID_CSI
```
CONF:LDIR DL
CONF:DL:CSIR:NCID 365
```

Manual operation: See "CSI Reference Signal Configuration" on page 44

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:CSIRs:POWer <Power>

This command defines the relative power of the CSI reference signal.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

<sf> irrelevant

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define CSI reference signal power

```
CONF:LDIR DL
CONF:DL:CSIR:POW 3
```

Manual operation: See "CSI Reference Signal Configuration" on page 44

CONFigure[:V5G]:DL[:CC<cc>]:EPBCh:POWer <Power>

This command defines the relative power of the ePBCH.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define ePBCH power

```
CONF:LDIR DL
CONF:DL:EPBC:POW 3
```

Manual operation: See "ePBCH DMRS Configuration" on page 44

CONFigure[:V5G]:DL[:CC<cc>]:EPBCh:PRECoding <Scheme>

This command selects the precoding scheme of a ePBCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Scheme> **NONE**
Selects no precoding for the ePBCH.
TXD
Selects transmit diversity for the ePBCH.
*RST: NONE

Example: //Select precoding scheme for the ePBCH
```
CONF:LDIR DL
CONF:DL:EPBC:PREC TXD
```

Manual operation: See "ePBCH DMRS Configuration" on page 44

CONFigure[:V5G]:DL[:CC<cc>]:XPBCh:PRECoding <Scheme>

This command selects the precoding scheme of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:
<cc> Component Carrier

Parameters:
<Scheme> **NONE**
Selects no precoding for the xPBCH.
TXD
Selects transmit diversity for the xPBCH.
*RST: NONE

Example: //Select precoding scheme for the xPBCH
```
CONF:LDIR DL
CONF:DL:XPBC:PREC TXD
```

Manual operation: See "xPBCH and BRS Configuration" on page 43

6.9.7 Control Channel Configuration

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:NID <ID>

This command defines the value that the xPDCCH sequence is based on.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).
- Select manual definition of xPDCCH sequence generation (`CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:ALLoc<a>:DMRS:SGENeration`).

Suffix:

<cc> Component Carrier

<sf> irrelevant

Parameters:

<ID> <numeric value> (integer only)

Range: 0 to 65536
*RST: 0

Example: //Select xPDCCH sequence generation

```
CONF:LDIR DL
CONF:DL:XPDC:SGEN NXP
CONF:DL:XPDC:NID 365
```

Manual operation: See "xPDCCH Configuration" on page 45

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:POWer <Power>

This command defines the relative power of the xPDCCH.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

<sf> irrelevant

Parameters:

<Power> <numeric value>

*RST: 0
Default unit: dB

Example: //Define xPDCCH power

```
CONF:LDIR DL
CONF:DL:XPDC:POW 3
```

Manual operation: See "xPDCCH Configuration" on page 45

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:PRECoding <Scheme>

This command selects the precoding scheme of a xPDSCH allocation.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<sf> Subframe

Parameters:

<Scheme>

NONE
Selects no precoding for an allocation.

TXD
Selects transmit diversity for an allocation.

*RST: NONE

Example:

```
//Select xPDCCH precoding
CONF:LDIR DL
CONF:DL:XPDC:PREC TXD
```

Manual operation: See "xPDCCH Configuration" on page 45

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SGENeration <Method>

This command selects the method with which the xPDCCH sequence is calculated.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<sf> Subframe

Parameters:

<Method>

NCID
The xPDCCH sequence is based on the cell ID.

NXPid
You can select the value that the sequence is based on manually with CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:NID.

Example:

```
//Select method for sequence generation
CONF:LDIR DL
CONF:DL:XPDC:SGEN NCID
```

Manual operation: See "xPDCCH Configuration" on page 45

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SYMBol<sym>:XREG<xr>[:STATe] <State>

This command turns the transmission of the xPDCCH on specific XREG resource elements on and off.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<sf> irrelevant

<sym> 0..1
Selects the XREG symbol.
Transmission on symbol 2 is only available if you transmit the xPDCCH on 2 XREG symbols (CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SYMBol<sym>[:COUNt] on page 125).

<xr> XREG

Parameters:

<State> **ALL**
Turns on the transmission of the xPDCCH on all xREG resource elements.
(Suffix <xr> is irrelevant in this case.)

NONE
Turns off the transmission of the xPDCCH for all XREG resource elements.
(Suffix <xr> is irrelevant in this case.)

ON | 1
Turns on the transmission of the xPDCCH on a specific XREG.

OFF | 0
Turns off the transmission of the xPDCCH on a specific XREG.

*RST: ON

Example:

```
//Configure xPDCCH transmission
CONF:LDIR DL
CONF:DL:XPDC:SYMB 2
CONF:DL:XPDC:SYMB0:XREG0 ON
CONF:DL:XPDC:SYMB0:XREG1 ON
CONF:DL:XPDC:SYMB0:XREG2 OFF
CONF:DL:XPDC:SYMB0:XREG3 OFF
etc.
CONF:DL:XPDC:SYMB1:XREG0 ON
CONF:DL:XPDC:SYMB1:XREG1 ON
etc.
```

Manual operation: See "xPDCCH Configuration" on page 45

CONFigure[:V5G]:DL[:CC<cc>][:SUBFrame<sf>]:XPDCch:SYMBol<sym>[:COUNt] <Symbols>

This command defines the number of xREG symbols on which the xPDCCH is transmitted.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<sf> irrelevant

<sym> irrelevant

Parameters:

<Symbols> <numeric value> (integer only)

Range: 1 to 2
*RST: 1

Example: //Define number of xREG symbols for PDCCH transmission
CONF:LDIR DL
CONF:DL:XPDC:SYMB 2

Manual operation: See "xPDCCH Configuration" on page 45

6.9.8 Antenna Port Configuration

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:BRS:AP<ap> <State>

This command maps antenna ports on which the xPBCH BRS is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 0..7
Antenna Port

Parameters:

<State> ON | OFF | 1 | 0

*RST: depends on antenna port

Example: //Transmit xPBCH BRS on antenna port 5 and map it to physical antenna 2
```
CONF:LDIR DL
CONF:DL:PAM2:BRS:AP5 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:CSIRs:AP<ap> <State>

This command maps antenna ports on which the CSI RS is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 16..31
Antenna Port

Parameters:

<State>

ALL
Turns on the transmission of the CSI RS on all antenna ports. (Suffix <ap> is irrelevant in this case.)

NONE
Turns off the transmission of the CSI RS on all antenna ports. (Suffix <ap> is irrelevant in this case.)

ON | 1
Turns on the transmission of the CSI RS on a specific antenna port.

OFF | 0
Turns off the transmission of the CSI RS on a specific antenna port.

*RST: depends on antenna port

Example: //Transmit CSI RS on antenna port 30 and 31 and map it to physical antenna 1
```
CONF:LDIR DL
CONF:DL:PAM1:CSIR:AP30 ON
CONF:DL:PAM1:CSIR:AP31 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:EPBCh:AP<ap> <State>

This command maps antenna ports on which the ePBCH is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 500 | 501
Antenna Port

Parameters:

<State> ON | OFF | 1 | 0

*RST: depends on physical antenna

Example: //Transmit ePBCH on antenna port 500 and map it to physical antenna 2

```
CONF:LDIR DL
CONF:DL:PAM2:EPDC:AP500 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:PCRS:AP<ap> <State>

This command maps antenna ports on which the PCRS is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (CONFigure[:V5G]:LDIRection).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 60..61 | 6061
Antenna Port

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Transmit PCRS on antenna port 60 and 61 and map it to physical antenna 2

```
CONF:LDIR DL
CONF:DL:PAM2:PCRS:AP6061 ON
```

Example: //Transmit PCRS on antenna port 60only and map it to physical antenna 2

```
CONF:LDIR DL
CONF:DL:PAM2:PCRS:AP60 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:SSIGnal:AP<ap> <State>

This command maps antenna ports on which the synchronization signals (PSS, SSS, ESS) are transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 300..313
Antenna Port

Parameters:

<State>

ALL
Turns on the transmission of the synchronization signal on all antenna ports.
(Suffix <ap> is irrelevant in this case.)

NONE
Turns off the transmission of the synchronization signal on all antenna ports.
(Suffix <ap> is irrelevant in this case.)

ON | 1
Turns on the transmission of the synchronization signal on a specific antenna port.

OFF | 0
Turns off the transmission of the synchronization signal on a specific antenna port.

*RST: depends on antenna port

Example: //Transmit synchronization signal on antenna port 303 and map it to physical antenna 1

```
CONF:LDIR DL
CONF:DL:PAM1:XPDS:AP303 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:STATe <State>

This command turns the antenna port configuration of a physical antenna on and off.

The configuration you turn on is the one considered in the measurement. Note that only one configuration can be measured at the same time.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Effects of this command

- When you turn on the configuration of one physical antenna, the R&S FPS automatically turn off the other one.

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

Parameters:

<State> ON | OFF | 1 | 0

*RST: depends on antenna

Example: //Turn on configuration for second physical antenna

```
CONF:LDIR DL
CONF:DL:PAM2:STAT ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:XPDCch:AP<ap> <State>

This command maps antenna ports on which the xPDCCH is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Effects of this command

- When you transmit the xPDCCH on the first antenna on antenna port 107, the R&S FPS automatically selects antenna port 109 on the second physical antenna and vice versa.

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 107 | 109
Antenna Port

Parameters:

<State> ON | OFF | 1 | 0

*RST: depends on physical antenna

Example: //Transmit xPDCCH on antenna port 107 and map it to physical antenna 2

```
CONF:LDIR DL
CONF:DL:PAM2:XPDC:AP107 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

CONFigure[:V5G]:DL[:CC<cc>]:PAMapping<cf>:XPDSch:AP<ant> <State>

This command maps antenna ports on which the xPDSCH is transmitted to a physical antenna.

Prerequisites for this command

- Select downlink mode (`CONFigure[:V5G]:LDIRection`).

Suffix:

<cc> Component Carrier

<cf> Physical Antenna

<ap> 8..15
Antenna Port

Parameters:

<State>

ALL
Turns on the transmission of the xPDSCH on all antenna ports. (Suffix <ap> is irrelevant in this case.)

NONE
Turns off the transmission of the xPDSCH on all antenna ports. (Suffix <ap> is irrelevant in this case.)

ON | 1
Turns on the transmission of the xPDSCH on a specific antenna port.

OFF | 0
Turns off the transmission of the xPDSCH on a specific antenna port.

*RST: depends on antenna port

Example:

//Transmit xPDSCH on antenna port 10 and map it to physical antenna 2

```
CONF:LDIR DL
CONF:DL:PAM2:XPDS:AP10 ON
```

Manual operation: See "Remote commands to map antenna ports to physical antennas" on page 48

6.9.9 Input Configuration

Remote commands to configure the input described elsewhere:

- `INPut:COUPling` on page 135
- `INPut:IMPedance` on page 135
- `[SENSe:]SWAPiq` on page 138

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

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG-preselector described in " YIG-Preselector " on page 48.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA, Pulse, Amplifier measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See " YIG-Preselector " on page 48

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FPS.

Parameters:

<Source> **RF**
Radio Frequency ("RF INPUT" connector)

*RST: RF

6.9.10 Frequency Configuration

Commands to configure the frequency described elsewhere.

- `[SENSe:]FREQuency:CENTer[:CC<cc>]` on page 100
- `[SENSe]:FREQuency:CENTer[:CC<cc>]:OFFSet` on page 101

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

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 "Defining the Signal Frequency" on page 49

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>
SPAN
Couples the step size to the span. Available for measurements in the frequency domain.
OFF
Decouples the step size.
*RST: SPAN

Example: //Couple step size to span
```
FREQ:CENT:STEP:LINK SPAN
```

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Parameters:

<Factor>
1 to 100 PCT
*RST: 10

Example: //Couple frequency step size to span and define a step size factor
```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 20PCT
```

6.9.11 Amplitude Characteristics

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

This command defines the reference level (for all traces in all windows).

Suffix:
<n>, <t> irrelevant

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See "Defining a Reference Level" on page 50

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

This command defines a reference level offset (for all traces in all windows).

Suffix:
<n>, <t> irrelevant

Parameters:
<Offset>
Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Defining a Reference Level" on page 50

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:
<Attenuation>
Range: see data sheet
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Manual operation: See "Attenuating the Signal" on page 51

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FPS determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

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

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Manual operation: See "Attenuating the Signal" on page 51

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP DC`

Manual operation: See " Input Coupling " on page 51

INPut:GAIN[:VALue] <Gain>

This command selects the gain if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 135).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> 15 dB | 30 dB
The availability of gain levels depends on the model of the R&S FPS.
R&S FPS8/13: 15dB and 30 dB
R&S FPS26 or higher: 30 dB
All other values are rounded to the nearest of these two.
*RST: OFF

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```
Switches on 30 dB preamplification.

INPut:GAIN:STATe <State>

Parameters:

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

Example:
```
INP:GAIN:STAT ON
```
Switches on 30 dB preamplification.

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Parameters:
<Impedance> 50 | 75
*RST: 50 Ω

Example: `INP:IMP 75`

Manual operation: See " Impedance " on page 52

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command requires the optional Electronic Attenuator.

Suffix:
<n> Window

Parameters:
<Attenuation> Attenuation level in dB.
Default unit: dB

Example: `INP:EATT 10`
Defines an attenuation level of 10 dB.

Manual operation: See "Attenuating the Signal" on page 51

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command requires the optional Electronic Attenuator.

Suffix:
<n> Window

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

Example: `INP:EATT:AUTO ON`
Turns automatic selection of electronic attenuation level on.

Manual operation: See "Attenuating the Signal" on page 51

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command requires the optional Electronic Attenuator.

Suffix:
<n> Window

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

Example: INP:EATT:STAT ON
Turns on the electronic attenuator.

Manual operation: See "Attenuating the Signal" on page 51

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FPS or limiting the dynamic range by an S/N ratio that is too small.

Example: ADJ:LEV

Usage: Event

Manual operation: See "Defining a Reference Level" on page 50

6.9.12 Data Capture

[SENSe<n>:][V5G:]FRAMe:SCOunt <Subframes>

This command selects the maximum number of subframes to analyze.

Selecting a number of subframes different from the default one may become necessary if the capture time is less than 20.1 ms.

Suffix:
<n> irrelevant

Parameters:
<Subframes> **ALL**
Analyzes all subframes of a frame (50).

<numeric value>
Number of subframes that the application analyzes.

Range: 1 to 50
*RST: ALL

Example: //Analyze 3 subframes
FRAM:SCO 3

Manual operation: See "Maximum Number of Subframes per Frame to Analyze" on page 53

[SENSe:]SWAPiq <State>

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

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Swap I and Q branches

```
SWAP ON
```

Manual operation: See "Swap I/Q" on page 53

[SENSe:]SWEep:TIME <CaptLength>

This command defines the capture time.

Parameters:

<CaptLength> <numeric value>

*RST: 20.1 ms
Default unit: s

Example: //Define capture time

```
SWE:TIME 40ms
```

Manual operation: See "Capture Time" on page 52

TRACe<n>:IQ:SRATe?

This command queries the sample rate.

Suffix:

<n> irrelevant

Return values:

<SampleRate> <numeric value>

Example: //Query sample rate

```
TRAC:IQ:SRAT?
```

Usage: Query only

6.9.13 Tracking

[SENSe<n>:][V5G:]TRACking:LEVel <State>

This command turns level tracking on and off.

Suffix:
<n> irrelevant

Parameters:
<Type> ON | OFF | 0 | 1
*RST: OFF

Example: //Turn on level tracking
`TRAC:LEV ON`

Manual operation: See "Level Tracking" on page 54

6.9.14 Demodulation

[SENSe<n>:][V5G:]DEMod:MCFilter <State>

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

Suffix:
<n> irrelevant

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

Example: //Turn on interference suppression
`DEM:MCF ON`

Manual operation: See "Multicarrier Filter" on page 55

6.9.15 Automatic Configuration

[SENSe<n>:]ADJust:EVM

This command adjusts the amplitude settings, including attenuator and preamplifier, to achieve the optimal EVM using the maximum dynamic range.

Note that this process can up to several minutes, depending on the number of component carriers you are measuring.

Suffix:
<n> irrelevant

Example: //Optimize EVM
`ADJ:EVM`

Usage: Event

[SENSe<n>:]ADJust:LEVel

This command adjusts the amplitude settings, including attenuator and preamplifier, to achieve the best dynamic range.

Compared to `[SENSe<n>:]ADJust:EVM` on page 139, which achieves the best amplitude settings to optimize the EVM, you can use this command for a quick determination of preliminary amplitude settings.

Suffix:
<n> irrelevant

Example: //Adjust amplitude settings
`ADJ:LEV`

Usage: Event

6.10 Analysis

6.10.1 Y-Axis Scale

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO <ONCE>

This command automatically scales the y-axis of a diagram based on the displayed results.

Suffix:
<n> Window

<w> Subwindow

<t> irrelevant

Setting parameters:
<ONCE> **DEFault**
Restores the default scale of the y-axis.

ONCE
Scales the y-axis for ideal viewing.

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 "Y-Axis Scale" on page 57

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value displayed on the vertical diagram axis.

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 "Y-Axis Scale" on page 57

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

This command 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 "Y-Axis Scale" on page 57

6.10.2 Result Settings

CALCulate:MARKer:COUPling <State>

This command couples or decouples markers in different result displays to each other.

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 58

DISPlay[:WINDow<n>][:SUBWindow<w>]:COUPling <State>

This command couples or decouples result display tabs (subwindows).

Subwindow coupling is available for measurements with multiple data streams (like carrier aggregation).

Suffix:

<n> Window

<w> Subwindow

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on subwindow coupling

```
DISP:COUP ON
```

Manual operation: See "Subwindow Coupling" on page 58

UNIT:CAXes <Unit>

This command selects the scale of the x-axis for result displays that show subcarrier results.

Parameters:

<Unit> **CARR**
Shows the number of the subcarriers on the x-axis.

HZ
Shows the frequency of the subcarriers on the x-axis.

Example: //Display frequency on the x-axis

```
UNIT:CAX HZ
```

Manual operation: See "Carrier Axes" on page 58

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

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

Manual operation: See "EVM Unit" on page 58

List of Commands

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