R&S®FSW-K192/-K193 DOCSIS® 3.1 OFDM Measurements User Manual

1175649002
Version 24

ROHDE&SCHWARZ
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This manual applies to the following FSW models with firmware version 6.10 and later:

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

The following firmware options are described:

- FSW-K192 DOCSIS 3.1 OFDM Downstream Measurements (1325.4138.02)
- FSW-K193 DOCSIS 3.1 OFDM Upstream Measurements (1325.4144.02)

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1175.6490.02 | Version 24 | R&S®FSW-K192/-K193

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

Contents

1 Documentation overview

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

www.rohde-schwarz.com/manual/FSW

Further documents are available at:

www.rohde-schwarz.com/product/FSW

1.1 Getting started manual

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

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

1.2 User manuals and help

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

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

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

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

1.3 Service manual

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

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

https://gloris.rohde-schwarz.com

1.4 Instrument security procedures

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

1.5 Printed safety instructions

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

1.6 Specifications and brochures

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

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

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

1.7 Release notes and open-source acknowledgment (OSA)

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

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

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

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

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

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

1.9 Videos

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

2 Welcome to the R&S FSW DOCSIS 3.1 applications

The R&S FSW DOCSIS 3.1 applications (FSW-K192/-K193) are firmware applications that add functionality to the FSW to perform measurements according to the DOCSIS 3.1 standard.

FSW-K192 performs measurements for DOCSIS 3.1 **downstream** signals.

FSW-K193 performs measurements for DOCSIS 3.1 **upstream** signals.

Specific bandwidth extension option required

Both R&S FSW DOCSIS 3.1 applications require one of the following bandwidth extension hardware options:

- FSW-B320 (1313.7172.02) - K192 (downstream) only
- FSW-B320+ (1325.4867.04)
- FSW-B512 (1313.4296.xx)
- FSW-B1200 (1331.6400.xx)
- FSW-B2100 (1331.6916.xx) - K192 (downstream) only

The options do not work with the optional 2 GHz / 5 GHz bandwidth extensions (FSWB2000/B5000), which require an additional oscilloscope.

If the required options are not installed, or non-supported bandwidth extension options are active, an error message is displayed and no measurements can be performed with the R&S FSW DOCSIS 3.1 applications.

The R&S FSW DOCSIS 3.1 applications feature:

- Modulation accuracy measurements
- Occupied bandwidth measurements
- Statistical measurements

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

General FSW functions

The application-independent functions for general tasks on the FSW are also available for DOCSIS 3.1 measurements and are described in the FSW user manual. In particular, this comprises the following functionality:

- Data management
- General software preferences and information
- Event-based actions

The latest version is available for download at the http://www.rohde-schwarz.com/product/FSW.html.

An application note discussing the fundamental technological advances of DOCSIS 3.1 and presenting measurement solutions from Rohde & Schwarz is available from the Rohde & Schwarz website: http://www.rohde-schwarz.com/appnote/7MH89.

Installation

You can find detailed installation instructions in the FSW Getting Started manual or in the Release Notes.

2.1 Starting the R&S FSW DOCSIS 3.1 application

Both R&S FSW DOCSIS 3.1 application options add a new application to the FSW.

To activate the R&S FSW DOCSIS 3.1 applications

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

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

2. Select the "DOCSIS 3.1" item.

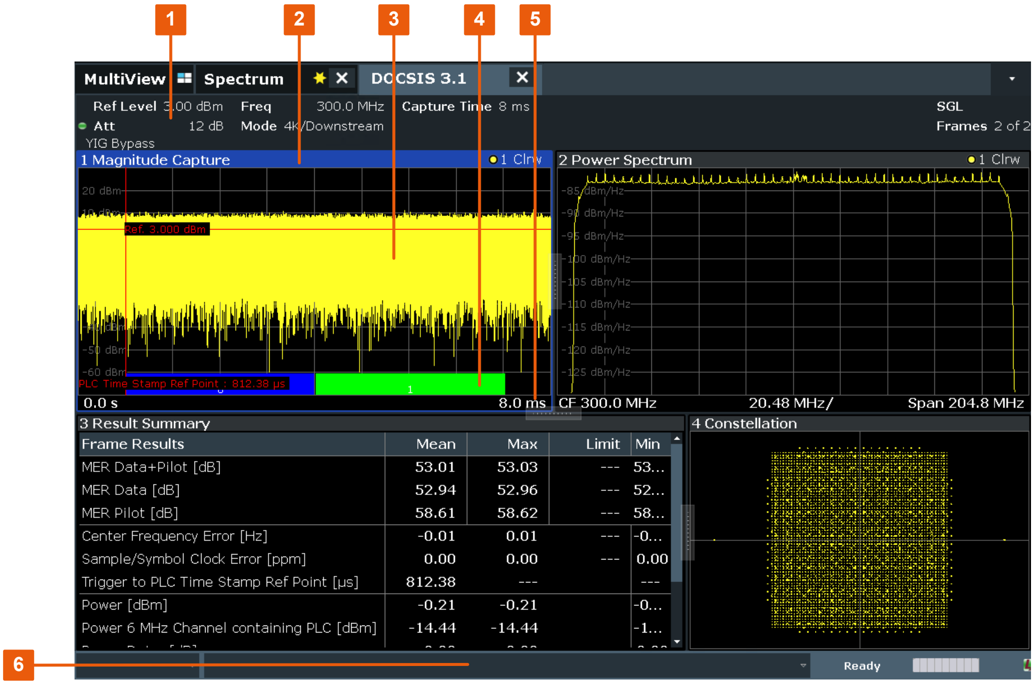
   The FSW opens a new measurement channel for the DOCSIS 3.1 (downstream) application.
   The measurement is started immediately with the default settings. It can be configured in the DOCSIS 3.1 "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see Chapter 5.3.1, "Configuration overview", on page 55).

3. To perform a measurement on a DOCSIS 3.1 uplink signal, select "Signal Description > Stream Direction: Upstream".

2.2 Understanding the display information

The following figure shows a measurement diagram during a DOCSIS 3.1 downlink measurement. All different information areas are labeled. They are explained in more detail in the following sections.

(The basic screen elements are identical for DOCSIS 3.1 uplink measurements.)



1 = Channel bar for firmware and measurement settings
2 = Window title bar with diagram-specific (trace) information
3 = Diagram area
4 = Detected symbols
5 = Diagram footer with diagram-specific information, depending on measurement application
6 = Instrument status bar with error messages, progress bar and date/time display

Channel bar information

In the R&S FSW DOCSIS 3.1 application, the FSW shows the following settings:

Table 2-1: Information displayed in the channel bar in the R&S FSW DOCSIS 3.1 application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Freq	Center frequency for the RF signal
Mode	N_{FFT} mode: 4K - 8K / Downstream - Upstream
Capture Time	Measurement time for data acquisition.
SGL	The sweep is set to single sweep mode.
Frames x of y (z)	For statistical evaluation over frames: <x> frames of totally required <y> frames have been analyzed so far <z> frames were analyzed in the most recent measurement (= current capture buffer)

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

Window title bar information

For each diagram, the header provides the following information:

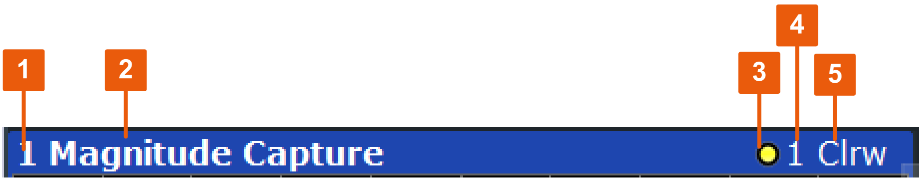


Figure 2-1: Window title bar information in the R&S FSW DOCSIS 3.1 application

1 = Window number
2 = Window type
3 = Trace color
4 = Trace number
5 = Trace mode

Diagram footer information

The diagram footer (beneath the diagram) contains the following information, depending on the evaluation:

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.

3 Measurements and result display

The R&S FSW DOCSIS 3.1 application provides several different measurements to determine the parameters described by the DOCSIS 3.1 specifications.

3.1 DOCSIS 3.1 I/Q measurement

Access: "Overview" > "Select Measurement" > "Modulation Accuracy"

Or: [MEAS] > "Select Measurement" > "Modulation Accuracy"

The default DOCSIS 3.1 I/Q measurement captures the I/Q data from the DOCSIS 3.1 signal using a (nearly rectangular) filter with a relatively large bandwidth. The I/Q data captured with this filter includes magnitude and phase information. This information allows the R&S FSW DOCSIS 3.1 application to demodulate broadband signals and determine various characteristic signal parameters in just one measurement, including:

- Modulation accuracy
- Spectrum flatness
- Center frequency tolerance
- Symbol clock tolerance

Other parameters specified in the DOCSIS 3.1 standard require a better signal-to-noise level or a smaller bandwidth filter than the I/Q measurement provides and must be determined in separate measurements (see Chapter 3.2, "Frequency sweep measurements", on page 34).

3.1.1 Modulation accuracy parameters

The default DOCSIS 3.1 I/Q measurement (Modulation Accuracy) captures the I/Q data from the DOCSIS 3.1 signal and determines all the following I/Q parameters in a single sweep.

Table 3-1: DOCSIS 3.1 Modulation Accuracy Parameters

Parameter	Keyword for remote command	Unit	Description
MER Data+Pilot	MER	dB	Modulation error ratio for data and pilot carriers
MER Data	MERD	dB	Modulation error ratio for data carriers only

Parameter	Keyword for remote command	Unit	Description
MER Pilot	MERP	dB	Modulation error ratio for pilot carriers only
Center Frequency Error	FERR	Hz	Not available if the sample clock error is normalized (upstream only).
Sample/Symbol Clock Error	CERR	ppm	
Trigger to PLC Time Stamp Ref point	TPLC	µs	Downstream only Time offset of the PLC Timestamp Reference Point (as defined in the standard in 7.5.13.10 "PLC Timestamp Reference Point") to the beginning of the capture buffer (Useful only with an (external) trigger at frame start; if no trigger is used, value is very unsteady)
Trigger to Frame	TFR	µs	Upstream only
Power	POW	dBm/ dBmV / dBuV	Absolute total power of OFDM channel (all subcarriers) Unit depends on Unit setting.
Power 6 MHz Channel containing PLC	POW:SPLC	dBm/ dBmV / dBuV	Absolute power in the 6-MHz channel containing the PLC Unit depends on Unit setting.
Power of Analyzed Minislots	POW:AMIN	dBm	Upstream only Total power of all minislots analyzed during a Synchronous Band Power (upstream only) measurement. The results for the individual bands in the Synchronous Band Power table use this value as a reference.
Power Data	POW:DATA	dB , dBm	Power in the data subcarriers Unit depends on Power Unit and Unit settings. For relative results, this value is always 0 (data power relative to itself).
Power Pilots	POW:PIL	dB , dBm	Power in all (normal and complementary) pilot channels (upstream only) Unit depends on Power Unit and Unit settings.
Power Scattered Pilots	POW:SPIL	dB , dBm	Power in the scattered pilot channels (downstream only) Unit depends on Power Unit and Unit settings.
Power Continuous Pilots	POW:CONP	dB , dBm	Power in the continuous pilot channels (downstream only) Unit depends on Power Unit and Unit settings.
Zero Bit Loaded Carrier Ratio	ZBIT	-	Downstream only Average ratio of the zero bit loaded subcarriers to the total number of carriers available for the codewords

Remote commands

When you query all results of the result summary using the FETCh:SUMMary:ALL? command, the values are returned in the order the parameters are described in table Table 3-1.

For each parameter, several evaluations are calculated for the entire input signal. The remote commands required to retrieve the results are indicated in the following table.

Table 3-2: Calculated summary results

Result type	Description	Remote command
Mean	Mean measured value	FETCh:SUMMary:<parameter>:AVERage
Max	Maximum measured value	FETCh:SUMMary:<parameter>:MAXimum
Min	Minimum measured value	FETCh:SUMMary:<parameter>:MINimum

3.1.2 Signal content information

In addition to the modulation accuracy parameters that are calculated from the input signal, detailed signal content information is available for analysis in the R&S FSW DOCSIS 3.1 application.

The Signal Content Detailed result display shows the serialized information from the list of NCPs and codewords (downstream) or minislot sets (upstream) contained in the input signal.

In the first rows, the information is provided for the following objects in the specified order:

Downstream:

- Scattered Pilots
- Continuous Pilots
- PLC preamble
- PLC data
- Excluded subcarriers

Upstream:

- Pilots
- Excluded subcarriers

Then, the information for each symbol in the order of the logical subcarriers is provided, with one row each for:

Downstream:

- NCPs
- Codewords

Upstream:

- Minislot sets

The Signal Content Summary (downstream only) result display shows the summarized information for the NCPs and codewords contained in the downstream input signal.

Table 3-3: DOCSIS 3.1 Signal Content Parameters

Column	Description
CW Index	Codeword index (0..1535) Not available for PLC, pilots and excluded subcarriers
Symbol Start	OFDM symbol (0..127) Not available for PLC, pilots and excluded subcarriers
Object	Information type: • Invalid data (-1) • Pilots (0) • PLC Preamble (1) • PLC Data (2) • Excluded subcarrier (3) • NCP CW (4) • NCP CRC-24 (5) • NCP Null (6) • Codeword / Minislot set (7) • NCP All (8) • Profile (9) • Compl. Pilots (10) • Scattered pilots (11) - downstream only • Continuous pilots (12) - downstream only (The value in parentheses is returned for `FETCh:SCDetailed:ALL?` on page 314)
Modulation	Modulation (see "Modulation" on page 71)
MER (dB)	Modulation error ratio in dB
Power	Power (unit depends on Power Unit setting.)
Upstream only:	
# Minislots	Number of minislots
Downstream only:	
# [count]	(Signal Content **Summary** only) For the PLC preamble and PLC data: the number of detected objects of this type (since one of these types is always in each frame, the count equals the number of analyzed frames) For the NCPs: the number of NCPs evaluated for the results For the profiles: the number of codewords of that profile
#sc	Number of subcarriers
LDPC Iterations	Low density parity check Number of iterations Note that PLC and NCP decoding may need up to 2 iterations even if no bit errors occurred since parts of the codewords are not transmitted (puncturing).
LDPC BitErr.Pre BER Pre	Low density parity check Absolute number of bit errors before decoding Bit error ratio before decoding (the ratio of errored bits to the total number of transmitted bits)

Column	Description
LDPC BitErr.Post BER Post	Low density parity check Absolute number of bit errors after decoding Bit error rate after decoding (the ratio of falsely decoded bits to the total number of transmitted bits)
LDPC CWErr.Post BLER Post	Low density parity check Absolute number of codeword errors after decoding Block error rate after decoding (the ratio of falsely decoded codewords to the total number of transmitted codewords)

3.1.3 PLC information

The *Physical Link Channel (PLC)* contains general transmission information. The information in the PLC can be used by the R&S FSW DOCSIS 3.1 application to determine several of the signal description parameters automatically.

The PLC Messages (downstream only) result display shows the serialized information from the individual OFDM symbols contained in the input signal.

The PLC information can only be provided for downstream DOCSIS 3.1 signals.

Table 3-4: PLC information

Item	Description	Query Command
Timestamp	Time the PLC was created; used as a reference point	`FETCh:PLCMessages:TIMestamp?`FETCh:
OFDM channel (OCD) information		
Downstream Channel ID		`FETCh:PLCMessages:OCD:DCID?` on page 286FETCh:
Configuration Change Count		`FETCh:PLCMessages:OCD:CCCount?` on page 285
Discrete Fourier Transform Size	Length of the FFT defining the OFDM transmission; corresponds to the number of physical subcarriers See "N_{FFT} (FFT length)" on page 59	`FETCh:PLCMessages:OCD:DFTSize?` on page 286
Cyclic Prefix	Length of the configurable cyclic prefix See "Cyclic Prefix CP" on page 59	`FETCh:PLCMessages:OCD:CP?` on page 285
Roll Off	Roll-off period for the Tukey raised-cosine window which is applied at the beginning (and end) of an OFDM symbol. The roll-off period defines the steepness of the filter. See "Roll-off" on page 60	`FETCh:PLCMessages:OCD:ROFF?` on page 287

Item	Description	Query Command
Spectrum Location	Center frequency in Hz of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum See "OFDM Spectrum Location" on page 59	FETCh:PLCMessages:OCD:SLOCation? on page 288
PLC Start Index	Starting subcarrier index of the physical link channel (PLC) See "PLC Start Index L" on page 61	FETCh:PLCMessages:OCD:PLC:INDex? on page 287
Time Interleaving Depth	Maximum number of delay lines used for time interleaving See "Time-Interleaving Depth" on page 60	FETCh:PLCMessages:OCD:TIDepth? on page 288
Excluded Subcarriers	Subcarriers not used to transmit data in a DOCSIS 3.1 channel See "Continuous pilots and excluded sub-carrier assignment" on page 62	FETCh:PLCMessages:OCD:ESUBcarriers? on page 287
Continuous Pilots	Subcarriers used to synchronize time and phase information between symbols See "Continuous pilots and excluded sub-carrier assignment" on page 62	FETCh:PLCMessages:OCD:CPILots? on page 286
Codeword (NCP) information		
Downstream Channel ID		FETCh:PLCMessages:NCP:DCID? on page 284
Configuration Change Count		FETCh:PLCMessages:NCP:CCCount? on page 284
Modulation	Modulation used by the Next Codeword Pointer (NCP) See "NCP Modulation" on page 61	FETCh:PLCMessages:NCP:MODulation? on page 285
Assignment	Subcarrier assigned to the codeword See "Codeword / frame configuration" on page 65	FETCh:PLCMessages:NCP:ASSignment? on page 284
Profile information		
Downstream Channel ID		FETCh:PLCMessages:PROFile<i>:DCID? on page 289
Configuration Change Count		FETCh:PLCMessages:PROFile<i>:CCCount? on page 289
Modulation and assignment	Assignment of the modulation used by each subcarrier See "Profile settings: modulation subcarrier assignment" on page 70	FETCh:PLCMessages:PROFile<i>:ASSignment? on page 289

3.1.4 Evaluation methods for DOCSIS 3.1 I/Q measurements

Access: "Overview" > "Display Config"

Or: [MEAS] > "Display Config"

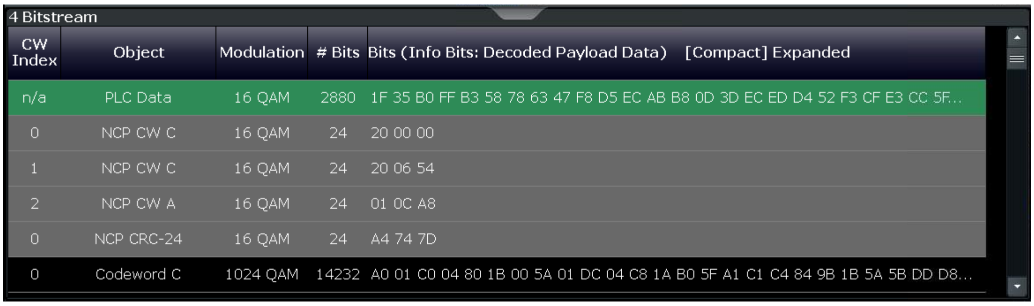
The captured I/Q data from the DOCSIS 3.1 signal can be evaluated using various different methods without having to start a new measurement or sweep. Which results are displayed depends on the selected evaluation.

The following evaluation methods can be selected for the default DOCSIS 3.1 I/Q measurement.

Bitstream (downstream only)
This result display shows the decoded data stream for each detected OFDM symbol in the currently Selected Frame as indicated in the "Magnitude Capture" display. Which bits exactly are decoded is configurable, for example the decoded payload data (default), the raw bits or the input or output bits of the parity check. By default, the byte values are displayed. Alternatively, the individual bit values can be displayed.

The bitstream can only be provided for downstream DOCSIS 3.1 signals.

The bitstream can be displayed in a compact or an expanded format. In the compact format, only the first (max.) 25 bytes are displayed for each codeword, so that one row per codeword is displayed in the table.



4 Bitstream

CW Index	Object	Modulation	# Bits	Bits (Info Bits: Decoded Payload Data) [Compact] Expanded
n/a	PLC Data	16 QAM	2880	1F 35 B0 FF B3 58 78 63 47 F8 D5 EC AB B8 0D 3D EC ED D4 52 F3 CF E3 CC 5F...
0	NCP CW C	16 QAM	24	20 00 00
1	NCP CW C	16 QAM	24	20 06 54
2	NCP CW A	16 QAM	24	01 0C A8
0	NCP CRC-24	16 QAM	24	A4 74 7D
0	Codeword C	1024 QAM	14232	A0 01 C0 04 80 1B 00 5A 01 DC 04 C8 1A B0 5F A1 C1 C4 84 9B 1B 5A 5B DD D8...

Figure 3-1: Bitstream result display for DOCSIS 3.1 standard (compact display)

In expanded format, all bytes for each codeword are displayed, where each row displays a maximum of 20 bytes. Thus, a single codeword can require multiple rows. In this case, the object for subsequent rows is indicated as "Codeword <X> Cont". A byte index indicates which bytes are displayed in each row.

4 Bitstream

CW Index	Object	Modulation	# Bits	Byte Index	Bits (Info Bits: Decoded Payload Data) Compact [Expanded]
n/a	PLC Data	16 QAM	2880	0	1F 35 B0 FF B3 58 78 63 47 F8 D5 EC AB B8 0D 3D EC ED D4 52
n/a	PLC Data Cont	16 QAM	2880	20	F3 CF E3 CC 5F 29 A8 48 E2 5B 3B 3F A0 56 9C 33 00 00 00 00
n/a	PLC Data Cont	16 QAM	2880	40	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
n/a	PLC Data Cont	16 QAM	2880	60	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
n/a	PLC Data Cont	16 QAM	2880	80	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
n/a	PLC Data Cont	16 QAM	2880	100	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

Figure 3-2: Bitstream result display for DOCSIS 3.1 standard (expanded display)

Which information is displayed is configurable (see "Selected Frame" on page 114). If enabled, the Bitstream table includes the following information:

- Object
- Modulation
- Total number of bits in object
- Byte index (graphical display only, not in remote command output)
- Bit/byte values in hexadecimal format for max. 100 bytes

For details on individual parameters, see Chapter 3.1.2, "Signal content information", on page 16.

Remote command:
`LAY:ADD? '1',RIGH, BITS`, see `LAYout:ADD[:WINDow]?` on page 241
`UNIT:BITStream` on page 268
Querying results:
`FETCh:BITStream:ALL?` on page 276
`[SENSe:]FRAMe:SELect` on page 236

Constellation
This result display shows the in-phase and quadrature phase results for the currently Selected Frame as indicated in the "Magnitude Capture" display. The Tracking/Channel Estimation according to the user settings is applied.

The inphase results (I) are displayed on the x-axis, the quadrature phase (Q) results on the y-axis.

The results can be restricted to the following:

- One or all information types
- One or more modulation types
- One or all symbols
- One or all subcarriers

Multiple (or all) modulations can be selected simultaneously. By default, all objects and all modulations are displayed (in yellow).

If a single modulation type is selected, the ideal constellation is also indicated in the display.

If multiple modulation types are selected, the constellation can be displayed in multiple colors, one for each modulation type, using the following color map:

All	BPSK	QPSK	16-QAM	64-QAM	128-QAM	256-QAM
512-QAM	1024-QAM	2048-QAM	4096-QAM	8192-QAM	16384-QAM	Ideal

Figure 3-3: Color map for constellation points for different modulations

Example:

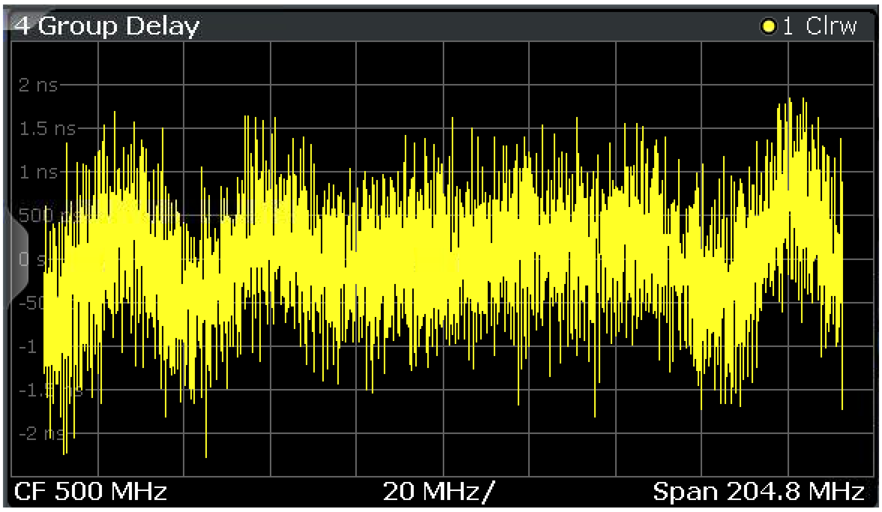
If the object is restricted to "Profile A" and all modulation types are selected, all modulation types found for profile A are displayed in multiple colors.

If the object is restricted to "Profile A" and the modulation is restricted to QPSK, any constellation points with QPSK modulation found for profile A are displayed in green. Additionally, the ideal QPSK constellation is displayed in gray in the same diagram.

To activate this color mapping, see "Fast Mode (Single Color)" on page 119.

Remote command:
LAY:ADD? '1',RIGH,CONS, see LAYout:ADD[:WINDow]? on page 241
[SENSe:]MODulation:SELect on page 252
[SENSe:]OBJect:SELect on page 252
[SENSe:]SUBCarrier:SELect on page 253
[SENSe:]SYMBol:SELect on page 253
[SENSe:]FRAMe:SELect on page 236
Results:
TRACe<n>[:DATA]? on page 296

Group Delay
Displays the time deviations of the signal versus carrier for the currently Selected Frame as indicated in the "Magnitude Capture" display.



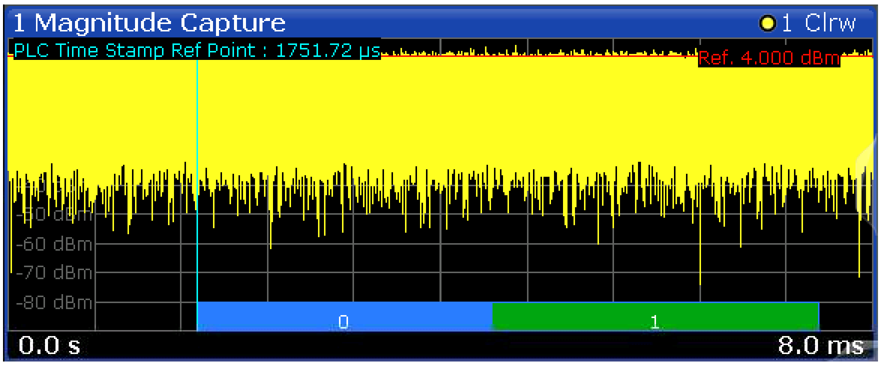
The carrier values can be provided as carrier numbers or carrier frequencies, see Selected Frame.

Remote command:
LAY:ADD? '1',RIGH,GDEL, see LAYout:ADD[:WINDow]? on page 241
Results:
[SENSe:]FRAMe:SELect on page 236
TRACe<n>[:DATA]? on page 296

Magnitude Capture
The "Magnitude Capture" display shows the magnitude vs time data captured in the last measurement. Green bars at the bottom of the "Magnitude Capture" display indicate the individual detected frames with their frame number. The blue bar indicates the currently Selected Frame which is evaluated for graphical result displays.

A vertical blue line indicates the frame start (upstream) or the position of the PLC timestamp reference point (downstream, see Table 3-1).

(The position of the PLC timestamp reference point moves frequently if no trigger is used; only with an (external) trigger at frame start it remains steady.)



Remote command:
`LAY:ADD? '1',RIGH,RFM`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`TRACe<n>[:DATA]?` on page 296

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

This table is displayed automatically if configured accordingly.

For 3-dimensional result displays (MER vs Symbol X Carrier, Power vs Symbol X Carrier), the value of a marker consists of the carrier (x), the symbol (y) and the parameter value (z).

1 Marker Table

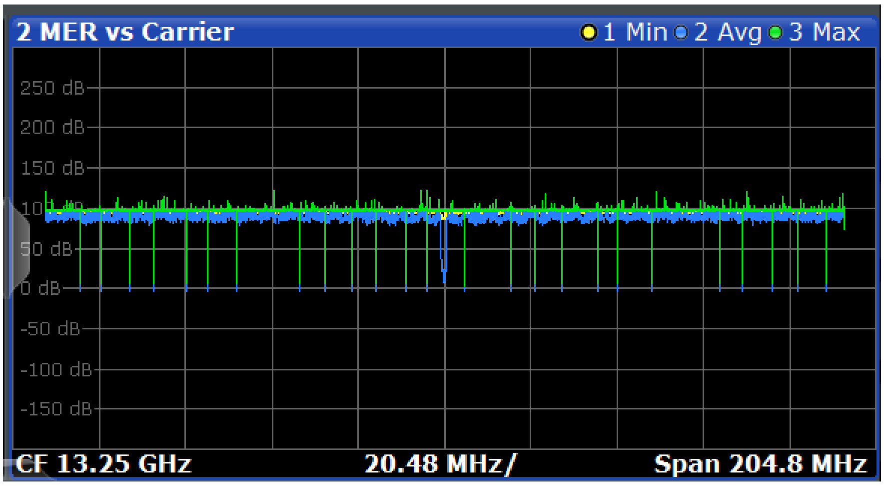
Wnd	Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
2	M1		1	2.1725 ms	-6.80 dBm		
2	D2	M1	1	13.859 ms	-0.00 dB		
2	D3	M1	1	4.6259 ms	-0.00 dB		
2	D4	M1	1	9.2331 ms	-0.00 dB		

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

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`CALCulate<n>:MARKer<m>:X` on page 294
`CALCulate<n>:MARKer<m>:Y?` on page 306

MER vs Carrier
Displays the modulation error ratio per carrier for the currently Selected Frame as indicated in the "Magnitude Capture" display, or the statistical evaluation, if enabled (see "Frame Statistic Count / Number of Frames to Analyze" on page 114).

The Minhold, Average and Maxhold traces are displayed. Define the number of frames on which the statistical evaluation is based using "Evaluation Range" > Frame Statistic Count / Number of Frames to Analyze.



The carrier values can be provided as carrier numbers or carrier frequencies, see "Carrier Axes Unit" on page 120.

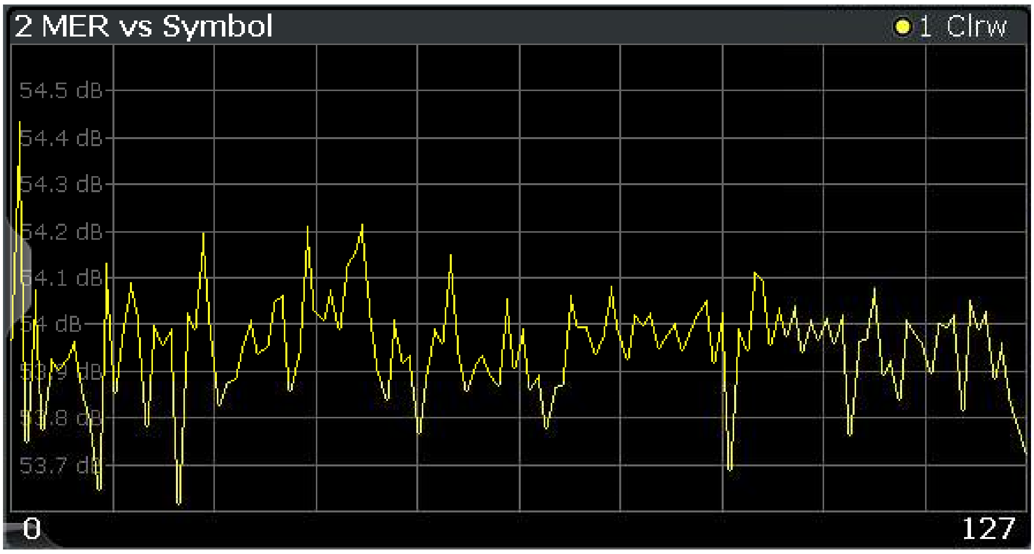
Remote command:
`LAY:ADD? '1',RIGH,MERC`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRAC:DATA? <TRACEx>`, see `TRACe<n>[:DATA]?` on page 296

MER vs Minislot (upstream only)
Displays the modulation error ratio per minislot for the currently Selected Frame as indicated in the "Magnitude Capture" display. Values are only displayed for minislots that are configured for the upstream signal (see "Profile configuration (upstream)" on page 80).

Remote command:
`LAY:ADD? '1',RIGH,MERM`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

MER vs Symbol

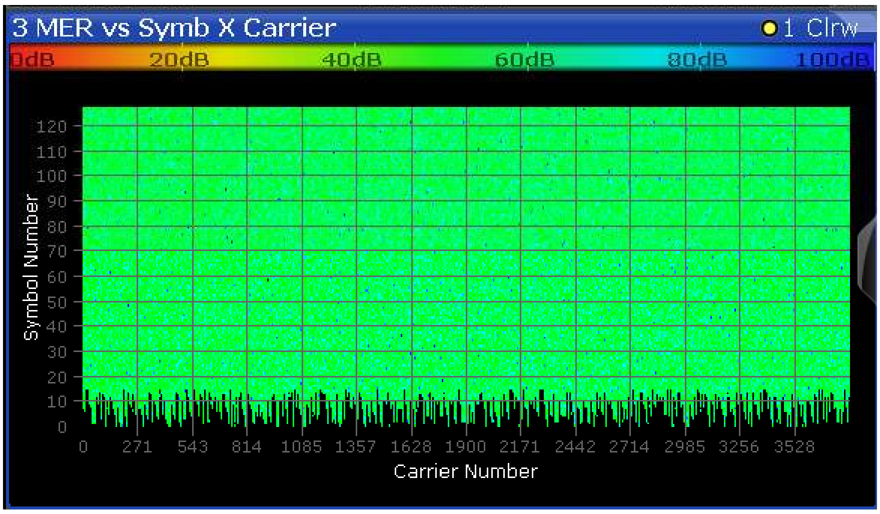
Displays the modulation error ratio per symbol for the currently Selected Frame as indicated in the "Magnitude Capture" display.



Remote command:
`LAY:ADD? '1',RIGH,MERS`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`TRACe<n>[:DATA]?` on page 296
`[SENSe:]FRAMe:SELect` on page 236

MER vs Symbol X Carrier

Displays the modulation error ratio per carrier and symbol for the currently Selected Frame as indicated in the "Magnitude Capture" display. The symbols are displayed on the x-axis, the carriers are displayed on the y-axis. The MER is color-coded according to its level and is indicated as a colored dot for each symbol and carrier. The legend for the color coding is provided by a color bar at the top of the diagram.



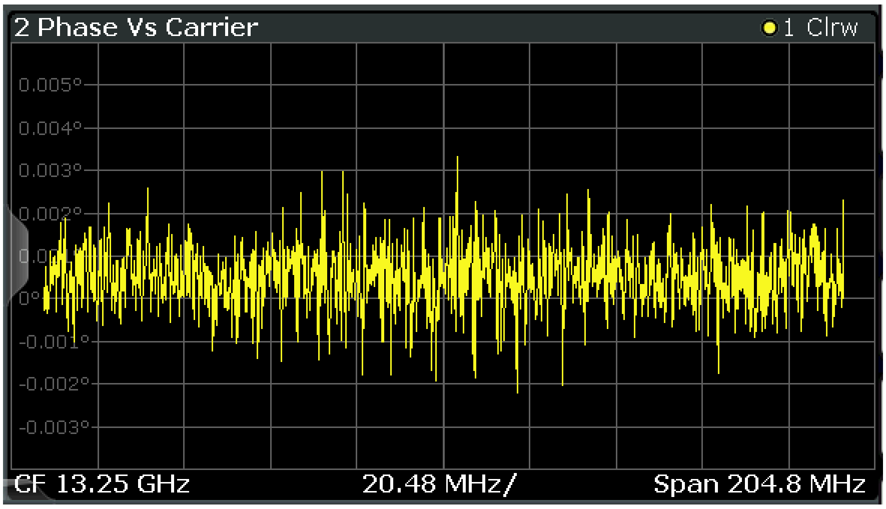
Note:

In 3-dimensional result displays the marker position is defined by its value on the x-axis (carrier) and y-axis (symbol). The parameter value (MER) is queried as the third dimension (z).

In this result display, only a single (normal) marker is available.

Remote command:
`LAY:ADD? '1',RIGH,MSC`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

Phase vs Carrier
Displays the phase per carrier for the currently Selected Frame as indicated in the "Magnitude Capture" display.

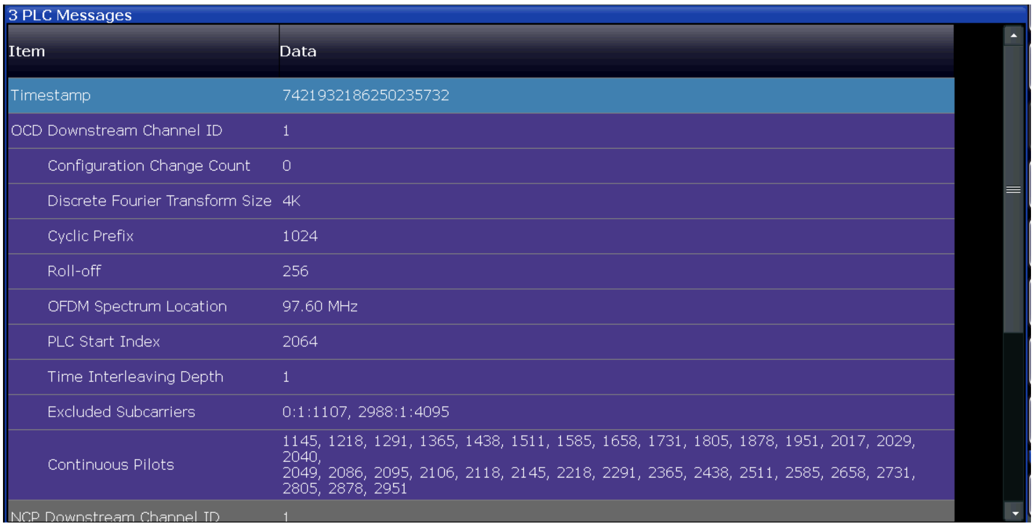


The carrier values can be provided as carrier numbers or carrier frequencies, see Selected Frame.

Remote command:
`LAY:ADD? '1',RIGH,PHAC`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

PLC Messages (downstream only)
The *Physical Link Channel (PLC)* contains general transmission information. The information in the PLC can be used by the R&S FSW DOCSIS 3.1 application to determine several of the signal description parameters automatically. The "PLC Messages" table displays the PLC information provided by the measured signal.

The PLC information can only be provided for downstream DOCSIS 3.1 signals.



3 PLC Messages

Item	Data
Timestamp	7421932186250235732
OCD Downstream Channel ID	1
Configuration Change Count	0
Discrete Fourier Transform Size	4K
Cyclic Prefix	1024
Roll-off	256
OFDM Spectrum Location	97.60 MHz
PLC Start Index	2064
Time Interleaving Depth	1
Excluded Subcarriers	0:1:1107, 2988:1:4095
Continuous Pilots	1145, 1218, 1291, 1365, 1438, 1511, 1585, 1658, 1731, 1805, 1878, 1951, 2017, 2029, 2040, 2049, 2086, 2095, 2106, 2118, 2145, 2218, 2291, 2365, 2438, 2511, 2585, 2658, 2731, 2805, 2878, 2951
NCP Downstream Channel ID	1

For details on the individual types of information, see Chapter 3.1.3, "PLC information", on page 18.

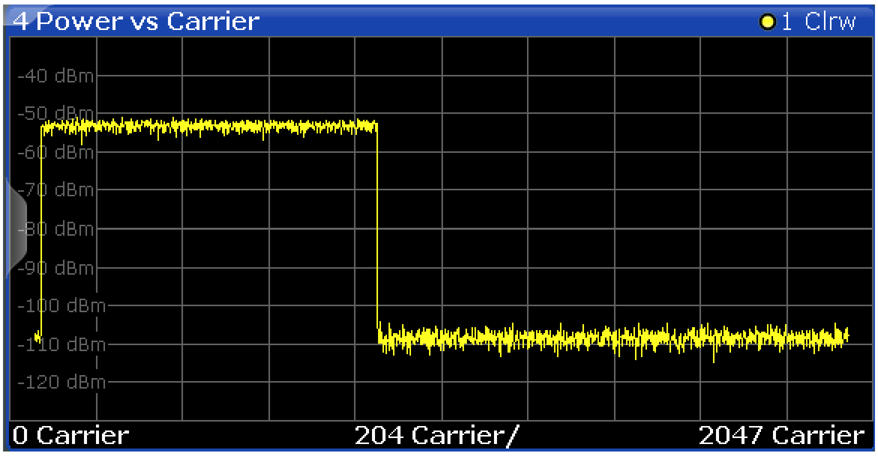
Remote command:
`LAY:ADD? '1',RIGH,PLCM`, see `LAYout:ADD[:WINDow]?` on page 241
Querying results:
See Chapter 10.9.1.3, "Querying PLC information", on page 283

Power vs Carrier (upstream only)
Displays the power level per carrier for the currently Selected Frame as indicated in the "Magnitude Capture" display. The carriers are displayed on the x-axis, the power is displayed on the y-axis.

The power unit depends on the Unit setting.

The carrier unit depends on the Carrier Axes Unit setting.

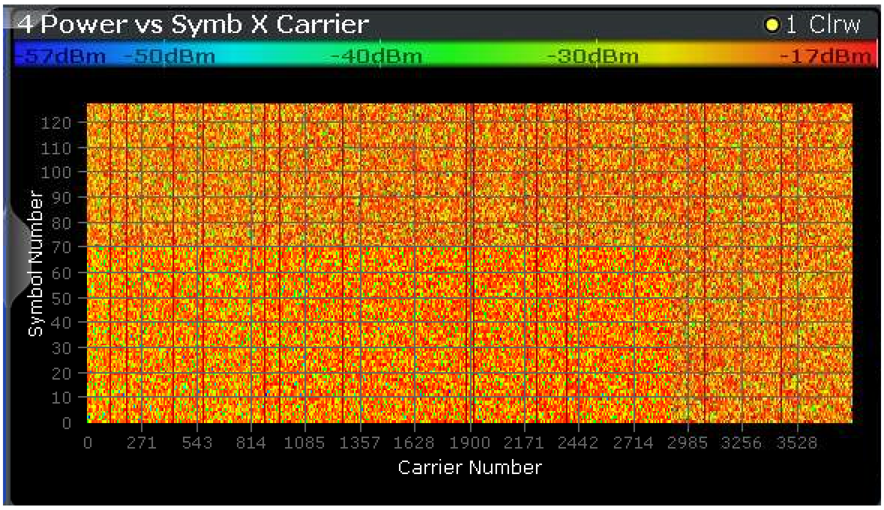
Bands configured for a Synchronous Band Power measurement are indicated by blue lines in the Power vs. Carrier result display, and are labeled according to the configuration.



Remote command:
`LAY:ADD? '1',RIGH,PCAR`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

Power vs Symbol X Carrier
Displays the power level per carrier and symbol for the currently Selected Frame as indicated in the "Magnitude Capture" display. The symbols are displayed on the x-axis, the carriers are displayed on the y-axis. The power level is color-coded and is indicated as a colored dot for each symbol and carrier. The legend for the color coding is provided by a color bar at the top of the diagram.

The power unit depends on the Unit setting.



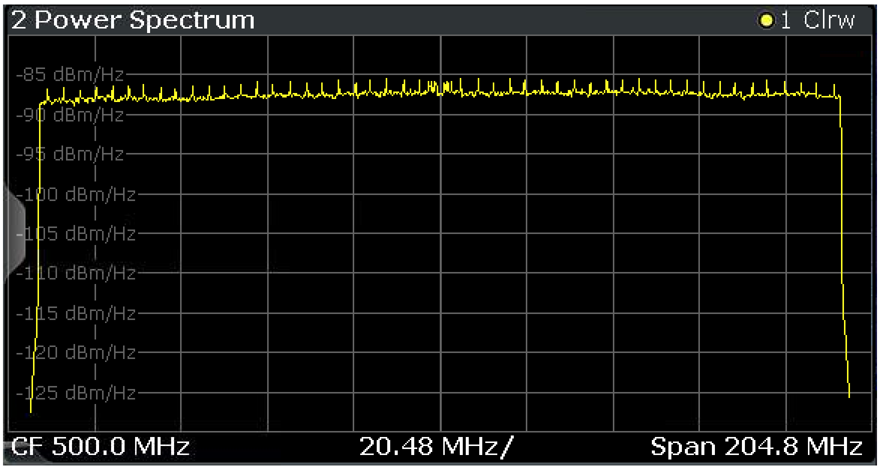
Note:
In 3-dimensional result displays the marker position is defined by its value on the x-axis (carrier) and y-axis (symbol). The parameter value (Power) is queried as the third dimension (z).

In this result display, only a single (normal) marker is available.

Remote command:
`LAY:ADD? '1',RIGH,PSC`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

Power Spectrum
This result display shows the power density (power/Hz) vs frequency values obtained using an FFT. The evaluation is performed over the complete data in the current capture buffer, without any correction or compensation.

The power unit depends on the Unit setting.



Remote command:
`LAY:ADD? '1',RIGH,PSP`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

Result Summary
The result summary provides the numerical results for the main DOCSIS 3.1 parameters summarized over a specified number of frames or for a single frame. This is the currently Selected Frame as indicated in the "Magnitude Capture" display.

If more than one frame is evaluated (that is, Analyzing a single frame (Specified Frame) is not enabled), a statistical evaluation of the specified "Frame Statistic Count / Number of Frames to Analyze" on page 114 or for all detected frames in the capture buffer is also performed. In this case, the minimum, maximum and mean values are displayed, as well as the defined limit, if available.

For details on the evaluation basis, see "Basis of (Statistical) Evaluation" on page 45.

For details on individual parameters, see Chapter 3.1.1, "Modulation accuracy parameters", on page 14.

3 Result Summary

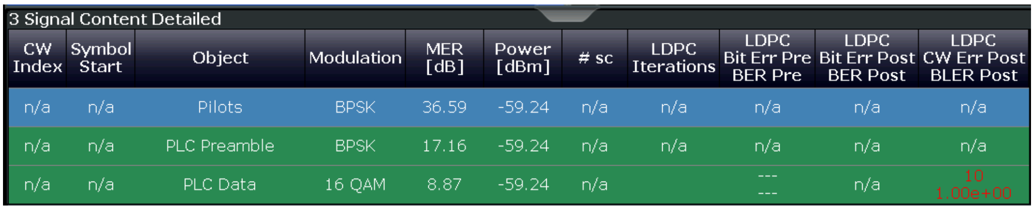
Frame Results	Mean	Max	Limit	Min
MER Data+Pilot [dB]	17.08	17.08	---	17.08
MER Data [dB]	9.27	9.27	---	9.27
MER Pilot [dB]	37.68	37.68	---	37.68
Center Frequency Error [Hz]	0.00	0.00	---	0.00
Sample/Symbol Clock Error [ppm]	0.00	0.00	---	0.00
Trigger to PLC Time Stamp Ref Point [µs]	171.25	---		---
Power [dBm]	-23.44	-23.44		-23.44
Power 6 MHz Channel containing PLC [dBm]	-38.45	-38.45		-38.45
Power Data [dB]	0.00	0.00		0.00
Power Scattered Pilots [dB]	0.00	0.00		0.00
Power Continuous Pilots [dB]	0.00	0.00		0.00
Zero Bit Loaded Carriers Ratio [%]	---	---		---

Remote command:
`LAY:ADD? '1',RIGH,RSUM`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`FETCh:SUMMary:ALL?` on page 281
`FETCh:FRAMe:COUNt?` on page 274
`FETCh:FRAMe:COUNt:ALL?` on page 275

Signal Content Detailed

This result display shows the serialized information from the list of NCPs and code-words (downstream) or minislot sets (upstream) for the currently Selected Frame as indicated in the "Magnitude Capture" display.

For details on individual entries, see Chapter 3.1.2, "Signal content information", on page 16.



3 Signal Content Detailed

CW Index	Symbol Start	Object	Modulation	MER [dB]	Power [dBm]	# sc	LDPC Iterations	LDPC Bit Err Pre BER Pre	LDPC Bit Err Post BER Post	LDPC CW Err Post BLER Post
n/a	n/a	Pilots	BPSK	36.59	-59.24	n/a	n/a	n/a	n/a	n/a
n/a	n/a	PLC Preamble	BPSK	17.16	-59.24	n/a	n/a	n/a	n/a	n/a
n/a	n/a	PLC Data	16 QAM	8.87	-59.24	n/a		--- ---	n/a	10 1.00e+00

Note: If the low density parity check (LDPC) results indicate no errors (= 0), the value is displayed green, otherwise the value is red. This allows you to detect errors at a glance.

Remote command:
`LAY:ADD? '1',RIGH,SCD`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`FETCh:SCDetailed:ALL:FORMatted?` on page 279
`[SENSe:]FRAMe:SELect` on page 236

Signal Content Summary (downstream only)

This result display shows the summarized information for the NCPs and codewords in a specified number of frames or for a single frame. This is the currently Selected Frame as indicated in the "Magnitude Capture" display.

Note: This result display is **not** available for **upstream** measurements!

If more than one frame is evaluated (that is, Analyzing a single frame (Specified Frame) is not enabled), a statistical evaluation of the specified Frame Statistic Count / Number of Frames to Analyze or for all detected frames in the capture buffer is also performed. In this case, the minimum, maximum and mean values are displayed, as well as the defined limit, if available.

For details on the evaluation basis, see "Basis of (Statistical) Evaluation" on page 45.

For details on individual entries, see Chapter 3.1.2, "Signal content information", on page 16.

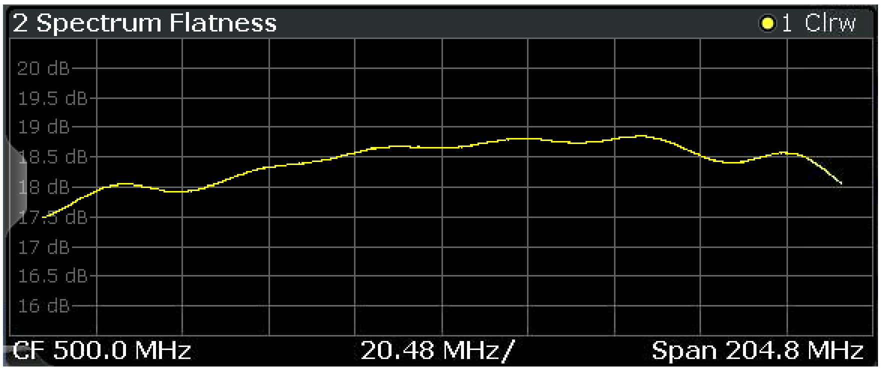
3 Signal Content Summary

Name	Modulation	MER [dB]	# [count]	LDPC Bit Err Pre BER Pre	LDPC Bit Err Post BER Post	LDPC CW Err Post BLER Post
Pilots	BPSK	84.07	n/a	n/a	n/a	n/a
PLC Preamble	BPSK	90.81	10	n/a	n/a	n/a
PLC Data	16 QAM	90.88	10	--- ---	n/a	100 1.00e+00
NCP All	None	---	0	--- ---	n/a	--- ---

Remote command:
`LAY:ADD? '1',RIGH,SCS`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`FETCh:SCSummary:ALL?` on page 280
`FETCh:FRAMe:COUNt?` on page 274
`FETCh:FRAMe:COUNt:ALL?` on page 275

Spectrum Flatness

This result display shows the relative power offset per carrier caused by the transmit channel for the currently Selected Frame as indicated in the "Magnitude Capture" display.



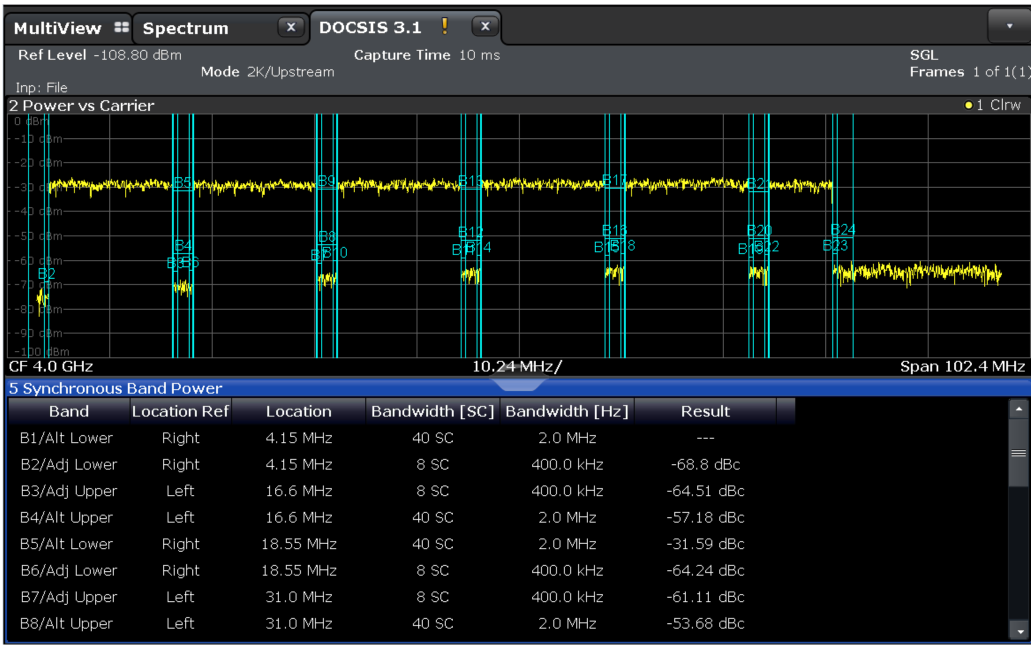
The carrier values can be provided as carrier numbers or carrier frequencies, see "Carrier Axes Unit" on page 120.

Remote command:
`LAY:ADD? '1',RIGH,SFL`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`[SENSe:]FRAMe:SELect` on page 236
`TRACe<n>[:DATA]?` on page 296

Synchronous Band Power (upstream only)
For upstream transmission, the DOCSIS 3.1 standard requires a power measurement in specified bands adjacent to the signal channels. The R&S FSW DOCSIS 3.1 application provides such power results in the "Synchronous Band Power" table, together with the Power vs. Carrier result display. The power for configured bands is calculated synchronously with the modulation accuracy results in the default I/Q measurement, rather than in a separate sweep measurement.

The R&S FSW DOCSIS 3.1 application can determine the bands for the power measurement automatically as required by the standard, or it can apply a user-defined configuration (see Chapter 5.3.11.4, "Synchronous band power settings", on page 127). The bands for which the power is calculated are indicated by blue lines in the Power vs. Carrier result display, and are labeled according to the configuration.

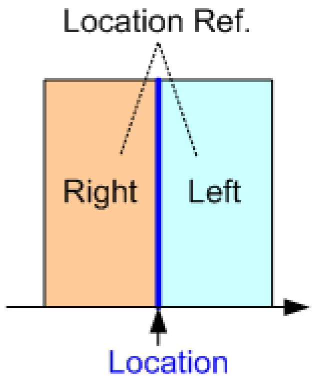
Note: Synchronous Band Power measurements require a sample rate of 204.8 MHz (see "Sample Rate" on page 105). Data from adjacent channels must be filtered out (see "Filter Out Adjacent Channels" on page 106).



The Synchronous Band Power table provides the following results for each configured band:

"Band" Label (as indicated in the Power vs Carrier display) of the power band and type (adjacent/alternate and upper/lower)

"Location Ref" Defines whether the indicated "Location" is located on the left or on the right edge of the band.



"Location" The subcarrier that marks the specified edge of the measured power band

"Bandwidth [SC]" The number of subcarriers in the measured power band

"Bandwidth [Hz]" The frequency range of the measured power band

"Result" The measured power in the band, referenced to the total power in all analyzed minislots ("Power of Analyzed Minislots" in the "Result Summary")

Remote command:
`LAY:ADD? '1',RIGH,SBP`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`CALCulate<n>:US:CHANnel:SBPower:BAND<n>:RESult?` on page 293

3.2 Frequency sweep measurements

Access: "Overview" > "Select Measurement"

Or: [MEAS] > "Select Meas"

Standard measurements that are common to several digital standards and are often required in signal and spectrum test scenarios are provided by the FSW base unit (Spectrum application). These measurements capture only the power level (magnitude, which we refer to as *RF data*) of the signal, as opposed to the two components provided by I/Q data.

Frequency sweep measurements can tune on a constant frequency ("Zero span measurement") or sweep a frequency range ("Frequency sweep measurement")

The signal cannot be demodulated based on the captured RF data. However, the required power information can be determined much more precisely, as more noise is filtered out of the signal.

The frequency sweep measurements provided by the R&S FSW DOCSIS 3.1 application are identical to the corresponding measurements in the base unit, but are pre-configured according to the requirements of the selected DOCSIS 3.1 standard.

For details on these measurements, see the FSW User Manual.

The R&S FSW DOCSIS 3.1 application provides the following frequency sweep measurements:

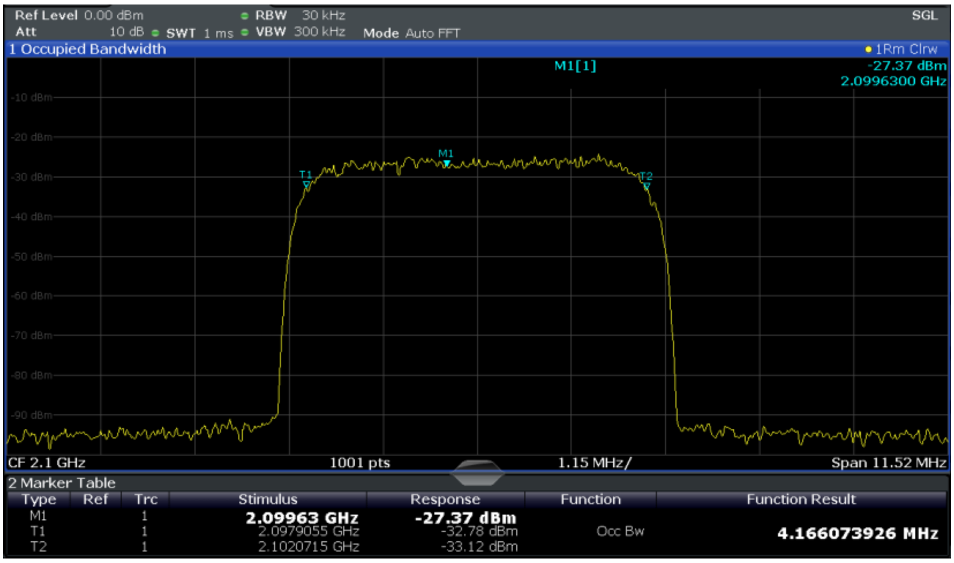
3.2.1 Measurement types and results for frequency sweep measurements

The R&S FSW DOCSIS 3.1 application provides the following pre-configured frequency sweep measurements:

Occupied Bandwidth

The "Occupied Bandwidth" (OBW) measurement determines the bandwidth in which a certain percentage of the total signal power is measured. The percentage of the signal power to be included in the bandwidth measurement can be changed; by default settings it is 99 %.

The occupied bandwidth is indicated as the "Occ BW" function result in the marker table; the frequency markers used to determine it are also displayed.



For details, see Chapter 5.4.1, "Occupied bandwidth", on page 134.

Remote command:
`CALC:MARK:FUNC:POW:SEL OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 161
Querying results:
`CALC:MARK:FUNC:POW:RES? OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult?` on page 293

CCDF

The "CCDF" (complementary cumulative distribution function) measurement determines the distribution of the signal amplitudes. The measurement captures a user-definable number of samples and calculates their mean power. As a result, the probability that a sample's power is higher than the calculated mean power + x dB is displayed. The crest factor is displayed in the "Result Summary".

For details see Chapter 5.4.2, "CCDF", on page 134.

Figure 3-4: CCDF measurement results

Remote command:
`CALCulate<n>:STATistics:CCDF[:STATe]` on page 161
Querying results:
`CALCulate<n>:MARKer<m>:Y?` on page 306
`CALCulate<n>:STATistics:RESult<res>?` on page 294

3.2.2 Evaluation methods for frequency sweep measurements

The evaluation methods for frequency sweep measurements in the R&S FSW DOCSIS 3.1 application are identical to those in the FSW base unit (Spectrum application).

Diagram

Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the "Trace" settings. Scaling for the y-axis can be configured.

Remote command:
`LAY:ADD? '1',RIGH, DIAG`, see `LAYout:ADD[:WINDow]?` on page 241
Results:

Result Summary
Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.

2 Result Summary

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	1.229 MHz		-0.86 dBm	
Tx Total			-0.86 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	30.000 kHz	750.000 kHz	-79.59 dB	-80.34 dB
Alt1	30.000 kHz	1.980 MHz	-85.04 dB	-83.85 dB

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

Remote command:
`LAY:ADD? '1',RIGH, RSUM`, see `LAYout:ADD[:WINDow]?` on page 241

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

This table is displayed automatically if configured accordingly.

For 3-dimensional result displays (MER vs Symbol X Carrier, Power vs Symbol X Carrier), the value of a marker consists of the carrier (x), the symbol (y) and the parameter value (z).

1 Marker Table

Wnd	Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
2	M1		1	2.1725 ms	-6.80 dBm		
2	D2	M1	1	13.859 ms	-0.00 dB		
2	D3	M1	1	4.6259 ms	-0.00 dB		
2	D4	M1	1	9.2331 ms	-0.00 dB		

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

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`CALCulate<n>:MARKer<m>:X` on page 294
`CALCulate<n>:MARKer<m>:Y?` on page 306

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

3 Marker Peak List

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

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

Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 241
Results:
`CALCulate<n>:MARKer<m>:X` on page 294
`CALCulate<n>:MARKer<m>:Y?` on page 306

4 Measurement basics

Some background knowledge on basic terms and principles used in DOCSIS 3.1 measurements is provided here for a better understanding of the required configuration settings.

4.1 DOCSIS 3.1 characteristics

A cable network based on the Data-Over-Cable Service Interface Specifications (DOCSIS® 3.1, see References) allows for very high data rates due to its large number of carriers and very high modulation rates.

For *downstream* transmission based on DOCSIS 3.1, OFDM channels with a bandwidth of up to 192 MHz are used in a spectrum from 258 MHz to 1.2 GHz. Each OFDM channel in turn consists of 7600 (active) subcarriers with a spacing of 25 kHz, or 3800 (active) subcarriers with a spacing of 50 kHz. Data is transmitted with a fixed sample rate of 204.8 MHz.

For *upstream* transmission based on DOCSIS 3.1, OFDM channels with a bandwidth of up to 96 MHz are used in a spectrum from 5 MHz to 204 MHz. Each OFDM channel in turn consists of 3800 (active) subcarriers with a spacing of 25 kHz, or 1900 (active) subcarriers with a spacing of 50 kHz. Data is transmitted with a fixed sample rate of 102.4 MHz.

OFDM channels can be configured independently, taking different channel conditions into account. Each subcarrier can use a different modulation, allowing for higher data rates where transmission conditions are good, and reliable data reception where they are poor. Time and frequency interleaving methods, as well as forward error correction (FEC) and cyclic redundancy correction bits ensure low error rates and high modulation accuracy.

Using DOCSIS 3.1, the same data is sent to multiple cable modems in data blocks containing information on which contents need to be decoded by the individual modems.

4.2 DOCSIS 3.1 downstream signal processing

Downstream DOCSIS 3.1 signals are used to transmit data from the cable modem termination system (CMTS) to numerous individual cable modems in widely spread locations. The R&S FSW DOCSIS 3.1 applications analyze both types of signals based on DOCSIS 3.1.

The following graphic illustrates the basic signal processing performed by the application for downstream signals. The individual steps are then described in more detail.

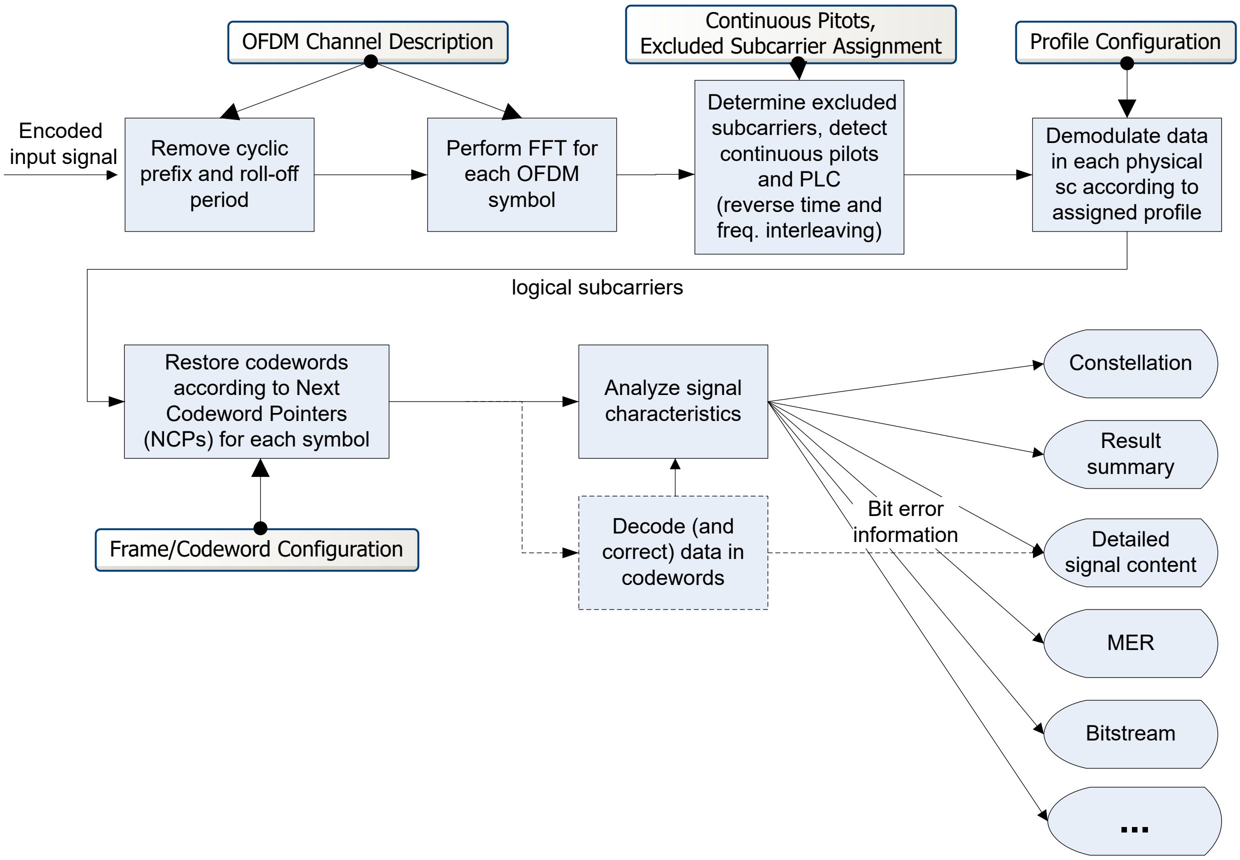


Figure 4-1: Signal processing in the R&S FSW DOCSIS 3.1 application

OFDM channel input

The encoded data input from an OFDM channel is a time domain discrete, complex-valued signal, which is sampled at a rate of 204.8 MSamples by the R&S FSW DOCSIS 3.1 application. It is then analyzed according to the configured signal description.

In the first step, the cyclic prefix and roll-off period are removed. While the cyclic prefix prevents intersymbol interference, the roll-off period determines how steep the spectrum rises and falls at its edges.

FFT

The initial data captured by the R&S FSW DOCSIS 3.1 application consists of measured values over time. In order to analyze the data for each OFDM symbol in the frequency domain, that is, the data in each subcarrier, an FFT must be performed on the captured data. Depending on the specified FFT length, which corresponds to the number of subcarriers, an FFT is performed on either 4096 samples (4K mode), or 8192 samples (8K mode) of the channel input, for each symbol.

Subcarriers and profiles

For each of the subcarriers, a different modulation may be used for transmission, depending on channel conditions.

The assignment is configured in *profiles*. For each set of modems with similar transmission conditions, a profile can then be assigned.

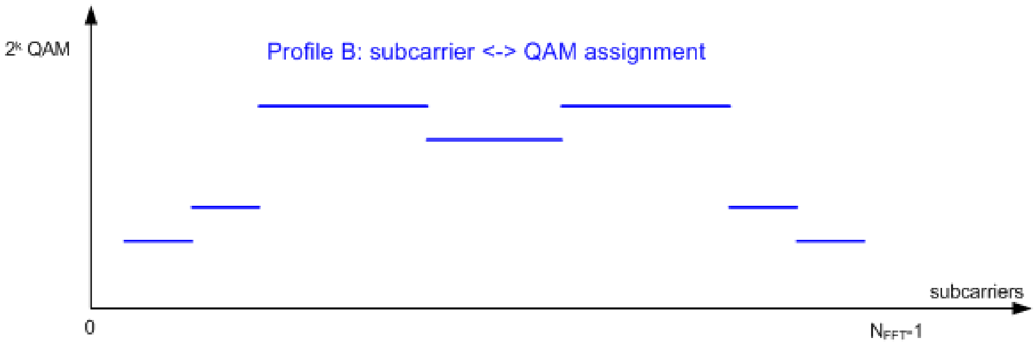


Figure 4-2: Profile: assignment of modulation to physical subcarriers

In order to demodulate the data in the subcarriers, the R&S FSW DOCSIS 3.1 application must determine the assignment of the modulation used by each subcarrier. This is configured in the signal description. Up to 16 different profiles can be configured and then assigned to each set of subcarriers sent to the same set of modems (see "Codewords, logical subcarriers, frames, and NCPs" on page 42).

Continuous pilots, excluded subcarriers, PLC

Some subcarriers have a specific function and are used identically for all symbols. Such fixed objects in the channel must be configured so that the R&S FSW DOCSIS 3.1 application can distinguish their contents from the useful data. Subcarriers with a special function are configured in the signal description in a continuous pilots and excluded subcarrier assignment table.

Continuous pilots are located at the same position in each OFDM channel and are used to synchronize time and phase information between symbols.

Excluded subcarriers are not used to transmit data in a DOCSIS 3.1 channel. This may be due to poor transmission conditions, use by other transmission channels, or for other reasons. Such carriers are blocked for all symbols of the channel.

The *Physical Link Channel (PLC)* is located at the same position in each OFDM symbol and consists of several consecutive subcarriers. It contains general transmission information, such as the FFT size, number of subcarriers, and spacing size used for transmission, as well as a preamble, which contains a defined pattern and is required to synchronize the symbols. The preamble of the PLC is BPSK-modulated, while the PLC data is always transmitted using 16-QAM modulation.

The information in the PLC can be used by the R&S FSW DOCSIS 3.1 application to determine several of the signal description parameters described above automatically. The position of the PLC itself can also be detected by the R&S FSW DOCSIS 3.1 application automatically.

Codewords, logical subcarriers, frames, and NCPs

The useful data that is to be transmitted to the same group of cable modems is summarized into blocks. The blocks are extended by additional bits for forward error correction, which allow transmission errors to be detected and corrected by the receiver. Such an encoded data block, which may vary in size, is referred to as a *codeword*.

The subcarriers for a single symbol in an OFDM channel that are available for useful data, that is to transmit the codewords, are called *logical subcarriers*. Logical subcarriers are combined in a *frame*.

The codewords are assigned to the next available symbol in the order they are sent. If more subcarriers are required than are still empty, subcarriers in the next symbol are assigned to the block as well. Up to four consecutive symbols can be used by any one codeword. Therefore it is necessary to document the assignment of codewords to symbols.

For each new codeword that starts in a symbol, the first subcarrier of the codeword is provided as a *Next Codeword Pointer (NCP)*. The NCPs are also included in the frame. NCPs are modulated using QPSK, 16-QAM or 64-QAM. Which modulation is used for the NCP is indicated by the PLC.

Finally, for error protection, each frame contains a *Cyclic Redundancy Check (CRC)* block, based on all NCPs in the frame.

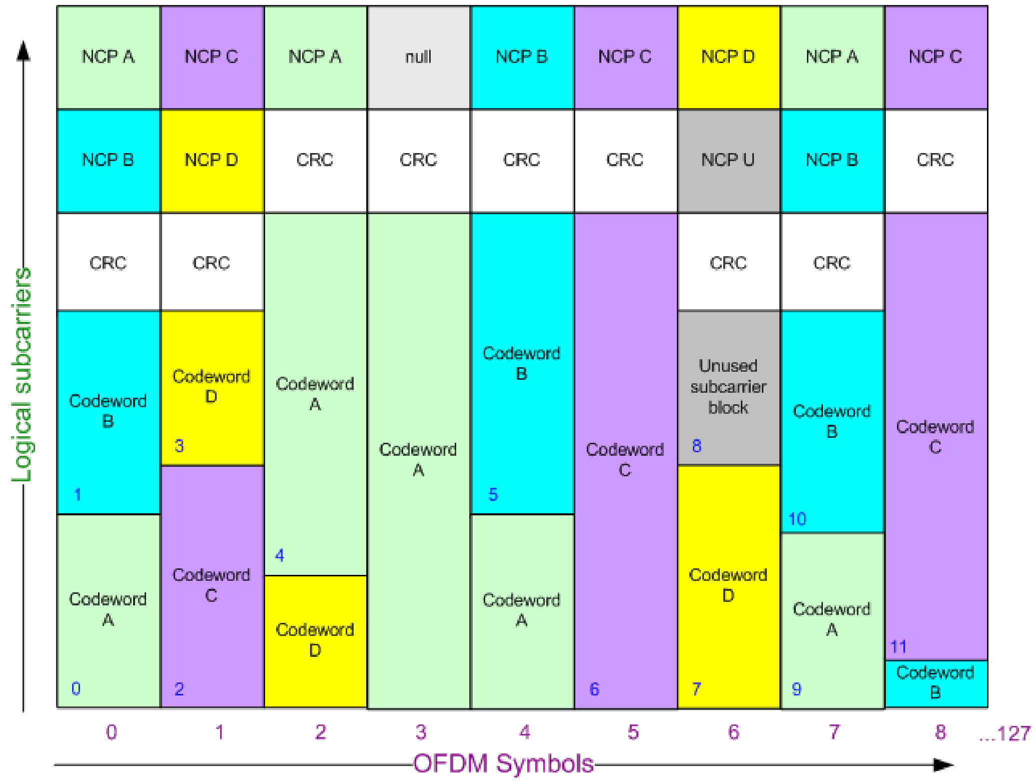


Figure 4-3: Frame/codeword configuration of the logical subcarriers

Frame configuration in the R&S FSW DOCSIS 3.1 application

In a realistic DOCSIS 3.1 transmission scenario, the transmitted data changes constantly. Thus, the frame configuration also changes accordingly. However, for analysis and test purposes, it is assumed that you use the same input signal to the R&S FSW DOCSIS 3.1 application for a specific test scenario, and thus the frame configuration need only be configured once for that signal.

The R&S FSW DOCSIS 3.1 application provides an auto-detection function to configure the frames automatically from the signal.

In the R&S FSW DOCSIS 3.1 application, you configure the assignment of codewords to symbols in a table. The codewords are numbered consecutively from the first to the last OFDM symbol, and from the first to last logical subcarrier (see Figure 4-3). For each codeword, an entry in the table is required, which assigns the (first and) total number of subcarriers per codeword, or alternatively the first and total number of OFDM symbols. Furthermore, the profile (that is: modulation) to be used for the codeword is defined. Note that since one OFDM symbol may contain more than one codeword, and each codeword may use a different modulation, the same OFDM symbol may have a "mixed modulation".

Physical vs. logical subcarriers

As described above, the physical subcarriers in a DOCSIS 3.1 channel may contain general signal information (PLC, pilots), useful data, or unspecified data (excluded carriers).

In order to improve modulation accuracy, the data is not transmitted in consecutive subcarriers, but scattered across all available subcarriers, by subjecting it to time and frequency interleaving. The time and frequency interleaved data, together with the NCPs and PLCs, are then distributed among all physical subcarriers, with exception of the excluded subcarriers, and modulated according to the assigned profiles.

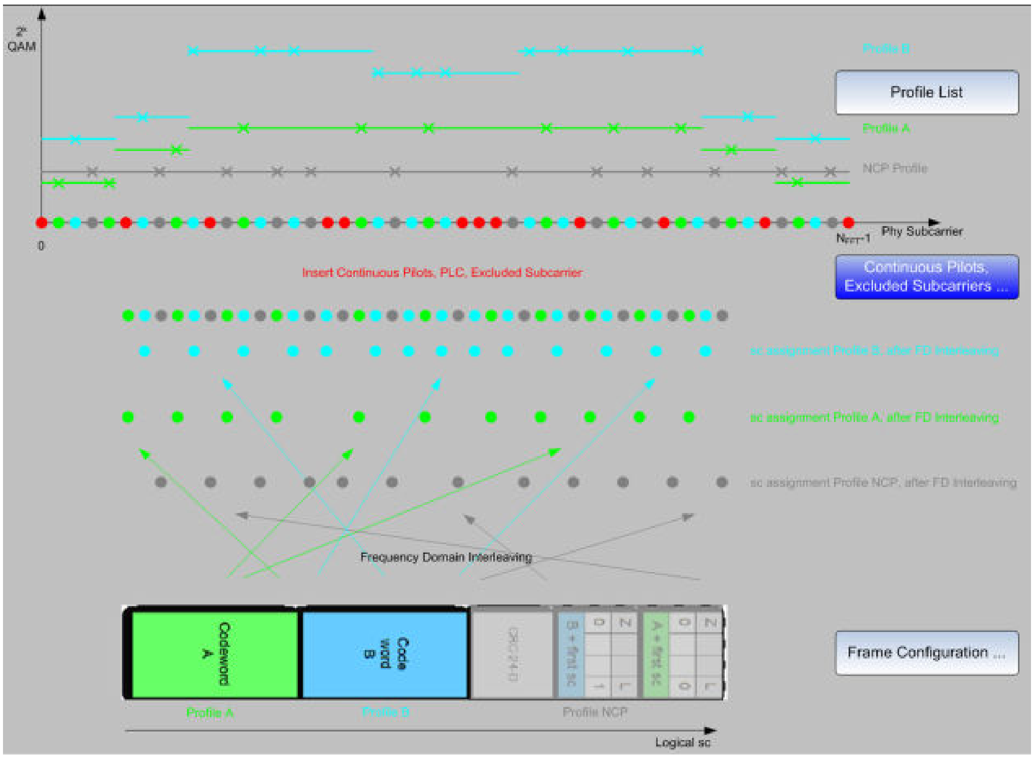


Figure 4-4: Relation between frames, logical subcarriers, profiles, and physical subcarriers

During demodulation, the R&S FSW DOCSIS 3.1 application must restore the original time and frequency order of the information, to form *logical subcarriers* with coherent data.

Demodulation and Analysis

When demodulating the DOCSIS 3.1 signal, the R&S FSW DOCSIS 3.1 application must restore the original correlation between the symbols in order to retrieve the blocks in the logical subcarriers, and thus the useful information. The continuous pilots and the PLC preamble help synchronize the time and phase information between symbols.

With the help of the frame/codeword configuration, the R&S FSW DOCSIS 3.1 application can demodulate the data in the logical subcarriers and restore the codewords. As a result, various signal characteristics, modulation accuracy parameters and constellation data are available.

The detailed signal content can also be output in a table. The order of entries in this table is similar to the frame configuration table: For each frame, the CRC and the codewords with the assigned NCP are listed in consecutive order of the codeword index. For each object in the table, modulation accuracy parameters, the measured power level and detected error bits are indicated.

Optionally, the codewords are not decoded to save calculation time; however, in this case codeword error bits are not evaluated.

Basis of (Statistical) Evaluation

Various modulation accuracy parameters as well as the symbol constellation can be displayed graphically. Graphical results are always based on a single frame. The Bitstream and detailed signal content is also always provided for a single frame. Which frame is to be evaluated is configurable (see Selected Frame). By default, it is always the first detected frame in the capture buffer (frame 0).

The numeric results in the "Result Summary" and Signal Content Summary, on the other hand, are summarized over all frames in the current capture buffer, by default. Optionally, they can be summarized over a specific number of frames (see "Frame Statistic Count / Number of Frames to Analyze" on page 114). In this case, multiple measurements are performed, if necessary, to obtain the required number of frames. Using a defined number of frames to base statistics on makes the results more consistent, as the number of frames detected in each measurement (and which are thus available in the capture buffer) may vary. If evaluation is restricted to a single frame, no statistics are calculated for the summarized results.

Note that frames from multiple measurements can be included in statistical evaluation; however, only frames in the current capture buffer can be analyzed and displayed individually.

4.3 DOCSIS 3.1 upstream signal processing

Upstream DOCSIS 3.1 signals are used to transmit data from numerous individual cable modems (CMs) to the cable modem termination system (CMTS). Signal processing in the R&S FSW DOCSIS 3.1 application is similar to processing downstream signals, as described in Chapter 4.2, "DOCSIS 3.1 downstream signal processing", on page 39. The main differences for upstream signals are described here.

Minislots and transmission profiles

According to the DOCSIS 3.1 specification [2], minislots are defined as follows:

"*The upstream spectrum is divided into groups of subcarriers called minislots. Minislots have dedicated subcarriers, of which all data subcarriers have the same modulation order ("bit loading"). A CM is allocated to transmit one or more minislots in a transmission burst. The modulation order of a minislot, as well as the pilot pattern to use, may change between different transmission bursts and are determined by a transmission profile.* [...]*This allows bit loading to vary across the spectrum.*"

Pilots, complementary pilots, data subcarriers

Each minislot consists of pilots, complementary pilots, and data subcarriers. Subcarriers that are not used for data or pilots are set to zero.

Pilots are subcarriers that do not carry data, but encode a pre-defined BPSK symbol known to the receiver. Pilot patterns differ by the number of pilots in a minislot, and by their arrangement within the minislot. The different pilot patterns enable the CMTS to optimize its performance according to different transmission conditions.

The DOCSIS 3.1 specification [2] also specifies complementary pilots:

"*Complementary pilots are subcarriers that carry data, but with a lower modulation order than other data subcarriers in the minislot. Complementary pilots allow phase tracking along the time axis for frequency offset and phase noise correction, and may be used by the CMTS upstream receiver to enhance signal processing, such as improving the accuracy of center frequency offset tracking.*"

Minislot structure

All data subcarriers in a minislot have the same QAM constellation. All complementary data subcarriers in a minislot also have the same QAM constellation, but lower in order than that of the data subcarriers in that minislot. QAM constellations of data and complementary pilots need not be the same for all minislots.

Minislots are defined by a fixed number (K) of symbols and a number (Q) of subcarriers. The number (K) of symbols per minislot is defined as a minimum of 6 and a maximum of 9 to 36, depending on the used bandwidth and FFT duration. The number (Q) of subcarriers per minislot is defined as 8 for 2K mode and 16 for 4K mode.

Between minislots, excluded subcarriers may exist.

In the R&S FSW DOCSIS 3.1 application, profiles for upstream signals contain the assignment of the pilot pattern and modulation per minislot or for a number of minislots (as opposed to the modulation-subcarrier assignment for downstream signals). Only a single profile is configurable for upstream signals in the R&S FSW DOCSIS 3.1 application.

Pilot patterns

As described above, pilot patterns differ by the number of pilots in a minislot, and by their arrangement within the minislot. Which patterns are available for a minislot depends on the number of subcarriers and thus the FFT mode.

For **2K mode** (=8 subcarriers per minislot), 8 different pilot patterns are available (defined in the DOCSIS 3.1 specification [2]):

In each figure, the horizontal axis represents OFDMA symbols, and the vertical axis represents the subcarriers. Each square in a figure represents a subcarrier at a specific symbol time. Pilots are designated by "P" and complementary pilots by "CP". All other subcarriers carry data with the modulation order of the minislot.

The figures show patterns for K between 6 and 16. For K>16 the complementary pilots are always located in the 14th and 16th symbols, all symbols from the 17th symbol to the end of the frame carry data only. Pilot locations are the same for any K.

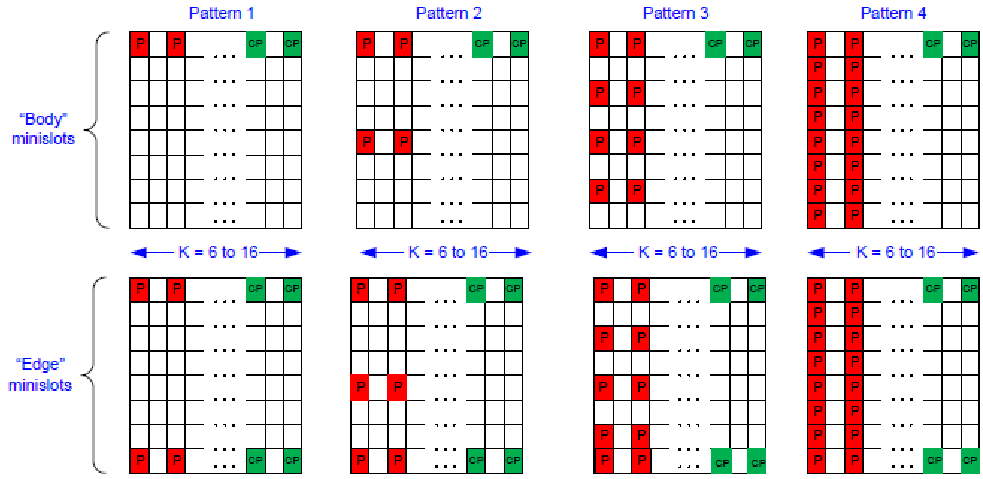


Figure 7-36 - Pilot Patterns 1-4 for Minislots with 8 Subcarriers

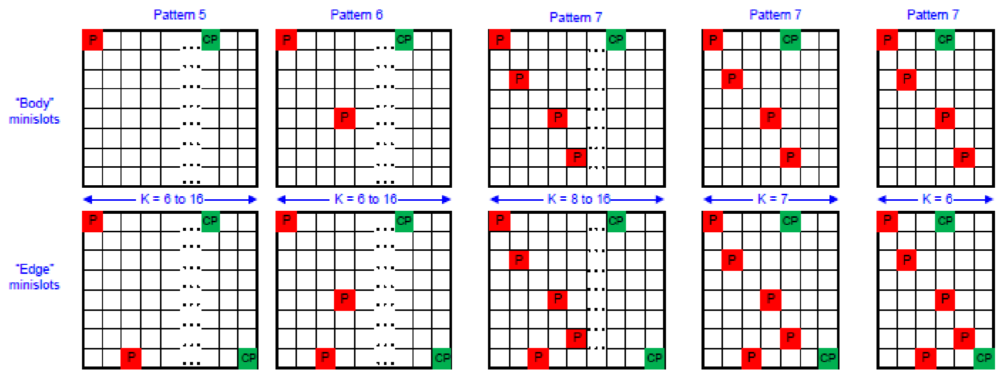


Figure 7-37 - Pilot Patterns 5 - 7 for Minislots with 8 Subcarriers

For **4K mode** (=16 subcarriers per minislot), 16 different pilot patterns are available (defined in the DOCSIS 3.1 specification [2]):

The figures show patterns for K between 6 and 9. For K>9, the complementary pilots are always located in the 7th and 9th symbols, all symbols from the 10th symbol to end of frame carry data only. Pilot locations are the same for any K.

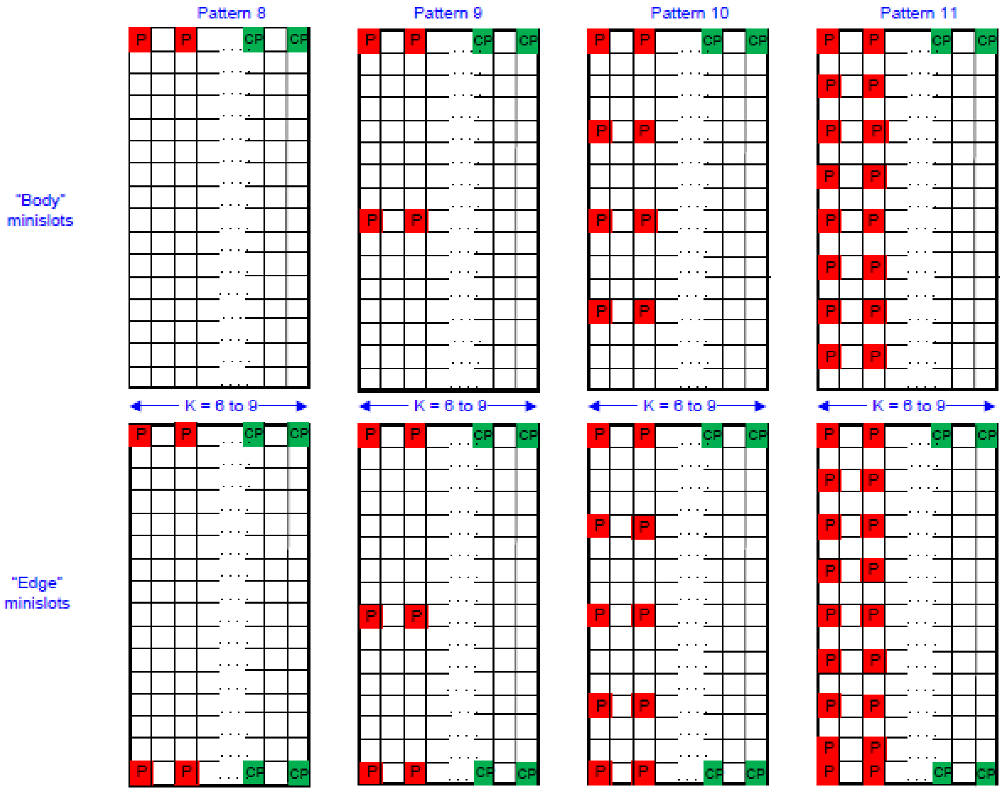


Figure 7-38 - Pilot Patterns 8-11 for Minislots with 16 Subcarriers

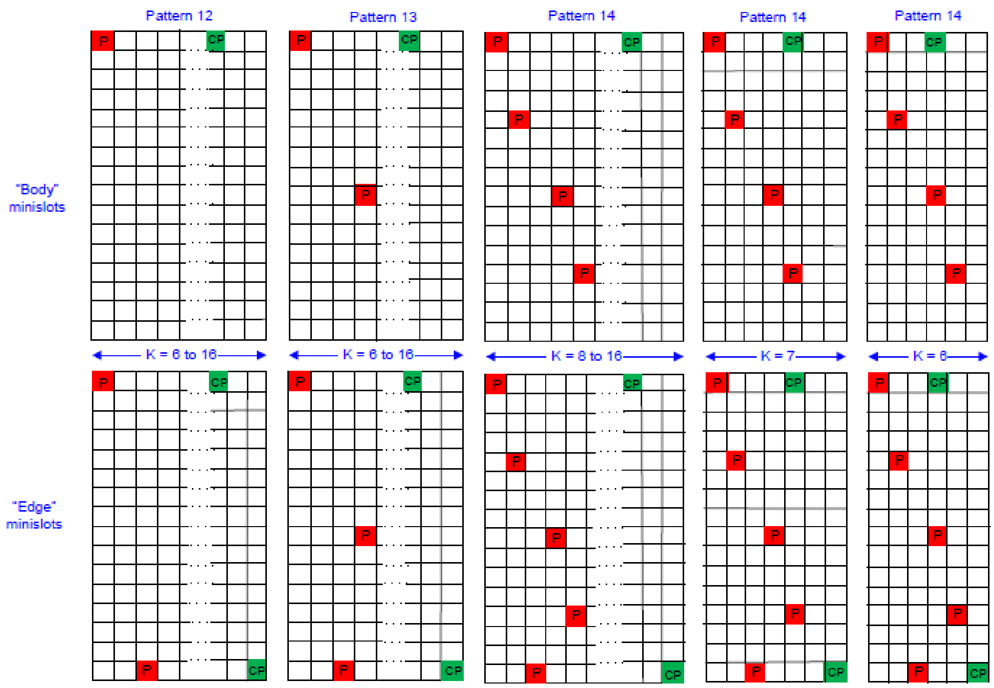


Figure 7-39 - Pilot Patterns 12 - 14 for Minislots with 16 Subcarriers

Frame structure

The DOCSIS 3.1 specification [2] defines frames as follows:

"*Upstream transmission uses OFDMA frames. Each OFDMA frame consists of a configurable number of OFDM symbols, K. Several transmitters may share the same OFDMA frame by transmitting data and pilots on allocated subcarriers of the OFDMA frame.*"

In upstream DOCSIS 3.1 signals, a frame comprises the minislots that use the same frequency range within the OFDMA channel spectrum.

The following figure illustrates the frame structure for upstream transmission.

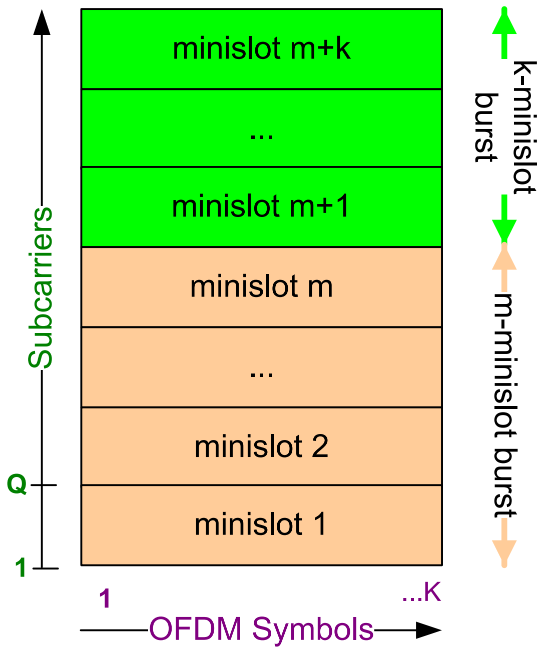


Figure 4-5: DOCSIS 3.1 OFDMA frame structure for upstream transmission

Mapping data and profiles to minislots

The order of data bits within a minislot is described in the DOCSIS 3.1 specification [2].

The useful data codewords are mapped into minislots, prior to time and frequency interleaving, using only contiguous subcarriers. There are no subcarrier exclusions or unused subcarriers within a minislot. "*The data is filled across all symbol periods, subcarrier by subcarrier, transmitted symbol period by symbol period, with complementary pilots filled inline.*" All data subcarriers within one minislot use the same modulation. Different minislots may use different modulation types.

4.4 Basics on input from I/Q data files

The I/Q data to be evaluated in a particular FSW application cannot only be captured by the application itself, it can also be loaded from a file, provided it has the correct format. The file is then used as the input source for the application.

For example, you can capture I/Q data using the I/Q Analyzer application, store it to a file, and then analyze the signal parameters for that data later using the AM/FM/PM Modulation Analysis application.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

When importing data from an I/Q data file using the import functions provided by some FSW applications, the data is only stored temporarily in the capture buffer. It overwrites the current measurement data and is in turn overwritten by a new measurement. If you use an I/Q data file as input, the stored I/Q data remains available for any number of subsequent measurements. Furthermore, the (temporary) data import requires the current measurement settings in the current application to match the settings that were applied when the measurement results were stored (possibly in a different application). When the data is used as an input source, however, the data acquisition settings in the current application (attenuation, center frequency, measurement bandwidth, sample rate) can be ignored. As a result, these settings cannot be changed in the current application. Only the measurement time can be decreased, to perform measurements on an extract of the available data (from the beginning of the file) only.

For input files that contain multiple data streams from different channels, you can define which data stream to be used for the currently selected channel in the input settings. You can define whether the data stream is used only once, or repeatedly, to create a larger amount of input data.

When using input from an I/Q data file, the [RUN SINGLE] function starts a single measurement (i.e. analysis) of the stored I/Q data, while the [RUN CONT] function repeatedly analyzes the same data from the file.

Sample iq.tar files

If you have the optional FSW VSA application (R&S FSW-K70), some sample `iq.tar` files are provided in the `C:\R_S\INSTR\USER\vsa\DemoSignals` directory on the FSW.

Pre-trigger and post-trigger samples

In applications that use pre-triggers or post-triggers, if no pre-trigger or post-trigger samples are specified in the I/Q data file, or too few trigger samples are provided to satisfy the requirements of the application, the missing pre- or post-trigger values are filled up with zeros. Superfluous samples in the file are dropped, if necessary. For pre-trigger samples, values are filled up or omitted at the beginning of the capture buffer. For post-trigger samples, values are filled up or omitted at the end of the capture buffer.

5 Configuration

Access: [MODE] > "Docsis 3.1"

The default DOCSIS 3.1 I/Q measurement captures the I/Q data from the DOCSIS 3.1 signal and determines various characteristic signal parameters such as the modulation accuracy, spectrum flatness, center frequency tolerance and symbol clock tolerance in just one measurement (see Chapter 3, "Measurements and result display", on page 14).

Other parameters specified in the DOCSIS 3.1 standard must be determined in separate measurements (see Chapter 5.4, "Frequency sweep measurements", on page 133).

The settings required to configure each of these measurements are described here.

5.1 Multiple measurement channels and sequencer function

When you activate an application, a new measurement channel is created which determines the measurement settings for that application. These settings include the input source, the type of data to be processed (I/Q or RF data), frequency and level settings, measurement functions etc. If you want to perform the same measurement but with different center frequencies, for instance, or process the same input data with different measurement functions, there are two ways to do so:

- Change the settings in the measurement channel for each measurement scenario. In this case the results of each measurement are updated each time you change the settings and you cannot compare them or analyze them together without storing them on an external medium.
- Activate a new measurement channel for the same application.
  In the latter case, the two measurement scenarios with their different settings are displayed simultaneously in separate tabs, and you can switch between the tabs to compare the results.
  For example, you can activate one DOCSIS 3.1 measurement channel to perform a DOCSIS 3.1 modulation accuracy measurement, and a second channel to perform an OBW measurement using the same DOCSIS 3.1 input source. Then you can monitor all results at the same time in the "MultiView" tab.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

Only one measurement can be performed on the FSW at any time. If one measurement is running and you start another, or switch to another channel, the first measurement is stopped. In order to perform the different measurements you configured in multiple channels, you must switch from one tab to another.

However, you can enable a Sequencer function that automatically calls up each activated measurement channel in turn. This means the measurements configured in the channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a symbol in the tab label. The result displays of the individual channels are updated in the corresponding tab (as well as the "MultiView") as the measurements are performed. Sequencer operation is independent of the currently *displayed* tab; for example, you can analyze the OBW measurement while the modulation accuracy measurement is being performed by the Sequencer.

For details on the Sequencer function see the FSW User Manual.

The Sequencer functions are only available in the "MultiView" tab.

Sequencer State
Activates or deactivates the Sequencer. If activated, sequential operation according to the selected Sequencer mode is started immediately.

Remote command:
`SYSTem:SEQuencer` on page 273
`INITiate:SEQuencer:IMMediate` on page 272
`INITiate:SEQuencer:ABORt` on page 272

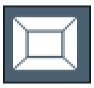
Sequencer Mode
Defines how often which measurements are performed. The currently selected mode softkey is highlighted blue. During an active Sequencer process, the selected mode softkey is highlighted orange.

"Single Sequence"
Each measurement is performed once, until all measurements in all active channels have been performed.

"Continuous Sequence"
The measurements in each active channel are performed one after the other, repeatedly, in the same order, until sequential operation is stopped.
This is the default Sequencer mode.

Remote command:
`INITiate:SEQuencer:MODE` on page 272

5.2 Display configuration



Access: "Overview" > "Display Config"

or: [MEAS] > "Display Config"

The measurement results can be displayed using various evaluation methods. All evaluation methods available for the R&S FSW DOCSIS 3.1 application are displayed in the evaluation bar in SmartGrid mode.

Drag one or more evaluations to the display area and configure the layout as required.

Up to 16 evaluation methods can be displayed simultaneously in separate windows. The DOCSIS 3.1 evaluation methods are described in Chapter 3, "Measurements and result display", on page 14.

To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the righthand corner of the toolbar, or press any key.

For details on working with the SmartGrid see the FSW Getting Started manual.

5.3 DOCSIS 3.1 I/Q measurement (modulation accuracy)

Access: [MODE] > "Docsis 3.1"

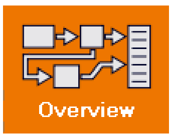
"Overview" > "Select Measurement" > "Modulation Accuracy"

When you activate the DOCSIS 3.1 application, an I/Q measurement of the input signal is started automatically with the default configuration. The "DOCSIS 3.1" menu is displayed and provides access to the most important configuration functions.

The "Span", "Bandwidth", "Lines", and "Marker Functions" menus are not available for DOCSIS 3.1 I/Q measurements.

Multiple access paths to functionality

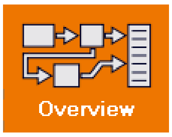
The easiest way to configure a measurement channel is via the "Overview" dialog box, which is displayed when you select the "Overview" softkey from any DOCSIS 3.1 softkey menu.



Alternatively, you can access the individual dialog boxes via softkeys from the corresponding menus, or via tools in the toolbars, if available.

In this documentation, only the most convenient method of accessing the dialog boxes is indicated - usually via the "Overview".

5.3.1 Configuration overview



Access: all menus

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview".

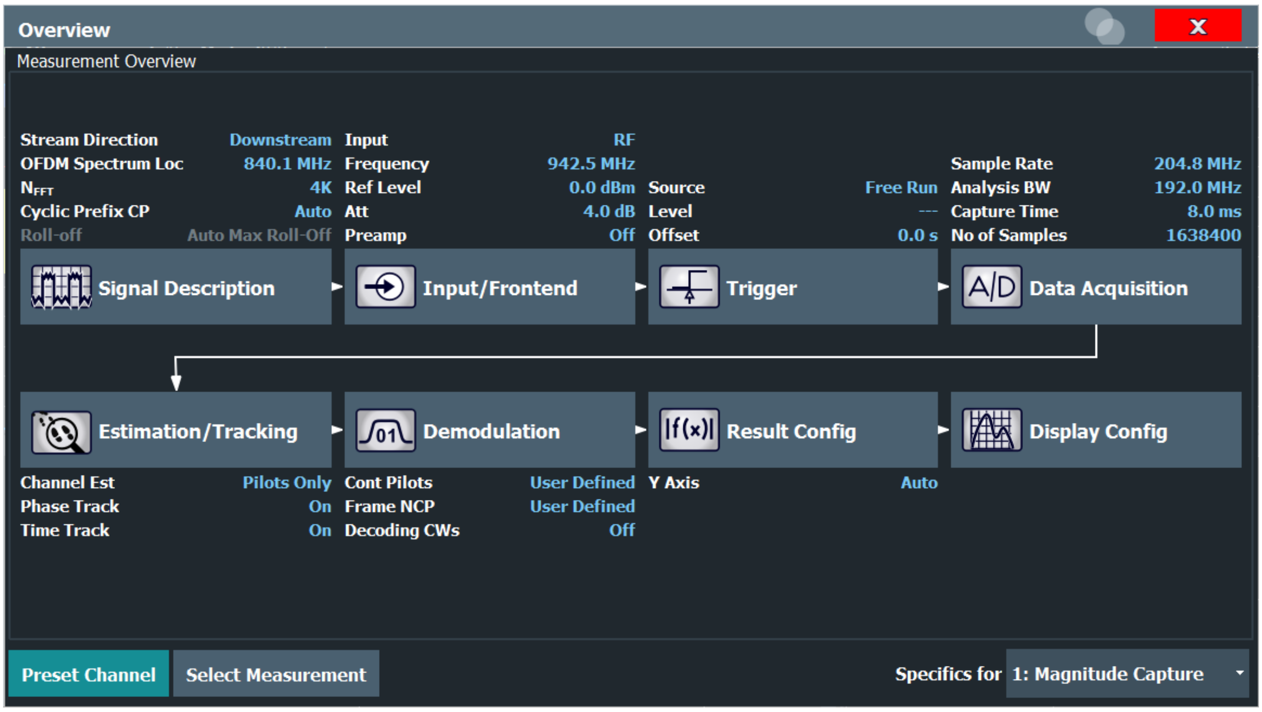


Figure 5-1: Documentation Overview for a DOCSIS 3.1 downstream measurement

The "Overview" not only shows the main measurement settings, it also provides quick access to the main settings dialog boxes. The indicated signal flow shows which parameters affect which processing stage in the measurement. 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".

The available settings and functions in the "Overview" vary depending on the currently selected measurement. For frequency sweep measurements see Chapter 5.4, "Frequency sweep measurements", on page 133.

For the DOCSIS 3.1 I/Q measurement, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. "Select Measurement"
   See "Select Measurement" on page 56
2. "Signal Description"
   See Chapter 5.3.2, "Signal description", on page 57
3. "Input/ Frontend"
   See and Chapter 5.3.3, "Input, output, and frontend settings", on page 82
4. "Trigger"
   See Chapter 5.3.4, "Trigger settings", on page 96
5. "Data Acquisition"
   See Chapter 5.3.5, "Data acquisition", on page 104
6. "Parameter Estimation and Tracking"
   See Chapter 5.3.8, "Parameter estimation and tracking", on page 108
7. "Demodulation" (downstream only)
   See Chapter 5.3.9, "Demodulation", on page 109
8. "Result Configuration"
   See Chapter 5.3.11, "Result configuration", on page 116
9. "Display Configuration"
   See Chapter 5.2, "Display configuration", on page 53

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 160

Select Measurement
Selects a measurement to be performed.

See Chapter 3, "Measurements and result display", on page 14.

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

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

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

5.3.2 Signal description

Access: "Overview" > "Signal Description"

or: [MEAS CONFIG] > "Signal Description"

The signal description provides information on the expected input signal.

5.3.2.1 Downstream signal description

Access: "Overview" > "Signal Description" > "Stream Direction": "Downstream"

or: [MEAS CONFIG] > "Signal Description" > "Stream Direction": "Downstream"

OFDM channel description (downstream)

Access: "Overview" > "Signal Description" > "OFDM Channel Description"

or: [MEAS CONFIG] > "Signal Description" > "OFDM Channel Description": "Downstream"

The general OFDM channel transmission settings are configured in the "Signal Description" dialog box.

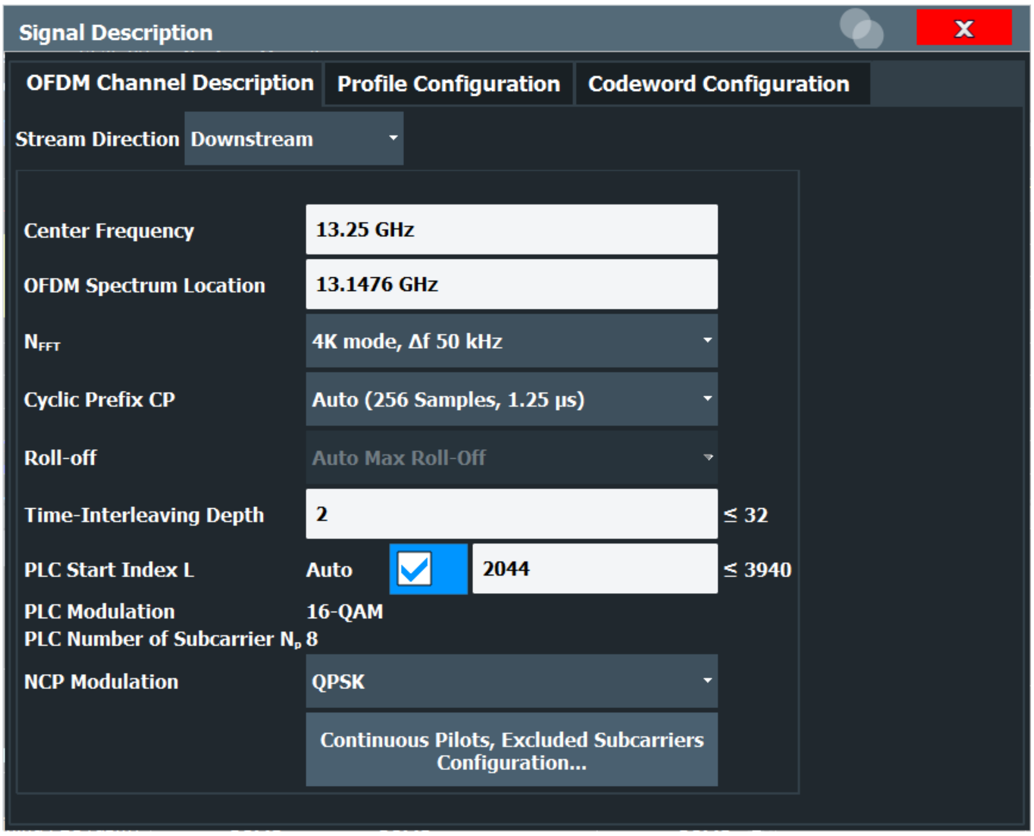


Figure 5-2: OFDM channel description for downstream DOCSIS 3.1 signals

The OFDM channel information detected in the PLC of the measured signal is displayed in the "PLC Messages (downstream only)" on page 27 result display.

Stream Direction

Defines the direction of the signal stream to be analyzed. Various configuration parameters for the DOCSIS 3.1 measurement depend on the stream direction.

"Downstream" (default) Downstream signal (from the CMTS to the cable modems). Requires FSW-K192 option.

"Upstream" Upstream signal (from the cable modems to the CMTS). Requires FSW-K193 option.

Remote command:
`CONFigure:SDIRection` on page 167

Center Frequency

Defines the center frequency of the signal in Hertz.

The center frequency of the complete signal depends on the center frequency of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum. If the OFDM Spectrum Location is changed, then the general center frequency is also changed, and vice versa.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 212

OFDM Spectrum Location

Specifies the center frequency in Hz of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum.

The default value for this setting is derived from the current Center Frequency. If the spectrum location is changed, the center frequency is adapted accordingly, and vice versa.

Remote command:
`CONFigure:DS:CHANnel:SPECtrum:FREQuency` on page 166
Query PLC information:
`FETCh:PLCMessages:OCD:SLOCation?` on page 288

N_{FFT} (FFT length)

Specifies the length of the FFT defining the OFDM transmission, which corresponds to the number of physical subcarriers.

"4K mode, Δf 50 kHz"
4096 subcarriers at = 50 kHz spacing; FFT length = 4096 samples

"8K mode, Δf 25 kHz"
8192 subcarriers at 25 kHz spacing; FFT length = 8192 samples

Remote command:
`CONFigure:CHANnel:NFFT` on page 163

Cyclic Prefix CP

Length of the configurable cyclic prefix.

The cyclic prefix determines where the useful data starts and prevents inter-symbol interference between multiple OFDM symbols during transmission.

Note: The cyclic prefix must be longer than the Roll-off period.

"AUTO" The length is determined automatically by the R&S FSW DOCSIS 3.1 application and indicated in the dialog box after the next measurement.
If the cyclic prefix is set to "AUTO", the Roll-off is also automatically set to "Auto Max Roll-Off" and cannot be edited.

"192 Samples, 0.9375µs"	Useful symbol period starts after 192 samples or 0.9375µs.
"256 Samples, 1.25µs"	Useful symbol period starts after 256 samples or 1.25µs.
"512 Samples, 2.5µs"	Useful symbol period starts after 512 samples or 2.5µs.
"768 Samples, 3.75µs"	Useful symbol period starts after 768 samples or 3.75 s.
"1024 Samples, 5.0µs"	Useful symbol period starts after 1024 samples or 5.0µs.

Remote command:
`CONFigure:CHANnel:CP` on page 163
Query PLC information:
`FETCh:PLCMessages:OCD:CP?` on page 285

Roll-off
Defines the roll-off period for the Tukey raised-cosine window which is applied at the beginning (and end) of an OFDM symbol. The roll-off period defines the steepness of the filter.

The required period depends on the current transmission conditions. The roll-off period can be between 0 µs and 1.25 µs for the downstream.

Note: The roll-off period is integrated in the Cyclic Prefix CP and must be shorter than the Cyclic Prefix CP.
If the Cyclic Prefix CP is set to "AUTO", the roll-off is also automatically set to "Auto Max Roll-Off" and cannot be edited.

"Auto Max Roll-Off"	The maximum possible roll-off period is used automatically.
"0 Samples, 0.0 µs"	No samples in the roll-off period (for no transmit windowing)
"64 Samples, 0.3125 µs"	The roll-off period contains 64 samples and lasts 0.3125 µs.
"128 Samples, 0.625 µs"	The roll-off period contains 128 samples and lasts 0.625 µs.
"192 Samples, 0.9375 µs"	The roll-off period contains 192 samples and lasts 0.9375 µs.
"256 Samples, 1.25 µs"	The roll-off period contains 256 samples and lasts 1.25 µs.

Remote command:
`CONFigure:CHANnel:ROFF` on page 164
Query PLC information:
`FETCh:PLCMessages:OCD:ROFF?` on page 287

Time-Interleaving Depth
Defines the maximum number of delay lines used for time interleaving. The possible depth depends on the N_{FFT} (FFT length).

The maximum depth for 4K mode is 32; for 8K mode it is 16.

Remote command:
CONFigure:DS:CHANnel:TIDepth on page 167
Query PLC information:
FETCh:PLCMessages:OCD:TIDepth? on page 288

PLC Start Index L
Defines the starting subcarrier index of the physical link channel (PLC).

The PLC is located at the same position in each OFDM symbol and consists of several consecutive subcarriers. The information in the PLC can be used by the R&S FSW DOCSIS 3.1 application to determine several of the signal description parameters automatically.

For more information see "Continuous pilots, excluded subcarriers, PLC" on page 41.

If "Auto" is enabled, the start index of the PLC is detected automatically. After successful detection, this field indicates the PLC start index L.

If "Auto" is disabled, the numeric value defined manually is used as the start index.

Note: If you enter a value manually, the "Auto" option is automatically disabled.

Remote command:
CONFigure:DS:CHANnel:PLC:INDex:AUTO on page 166
CONFigure:DS:CHANnel:PLC:INDex on page 165
Query PLC information:
FETCh:PLCMessages:OCD:PLC:INDex? on page 287

PLC Modulation
Indicates the used PLC modulation (for reference only).

16QAM modulation is required by the DOCSIS 3.1 standard.

Remote command:
CONFigure:DS:CHANnel:PLC:MODulation? on page 166

PLC Number of Subcarriers (N_p)
Indicates the number of subcarriers used by the PLC (for reference only). The number of subcarriers depends on the N_{FFT} (FFT length) setting.

Remote command:
CONFigure:DS:CHANnel:PLC:CARRiers? on page 165

NCP Modulation
Defines the modulation used by the Next Codeword Pointer (NCP).

The following modulation types are supported:
- QPSK
- 16-QAM
- 64-QAM

Remote command:
CONFigure:DS:CHANnel:NCP:MODulation on page 165
Query PLC information:
FETCh:PLCMessages:NCP:MODulation? on page 285

Continuous pilots and excluded subcarrier assignment

Access: "Overview" > "Signal Description" > "OFDM Channel Description" > "Continuous Pilots, Excluded Subcarriers Configuration..."

or: [MEAS CONFIG] > "Signal Description" > "OFDM Channel Description" > "Continuous Pilots, Excluded Subcarriers Configuration..."

Some subcarriers have a specific function and are used identically for all symbols. Such fixed objects in the channel must be configured so that the R&S FSW DOCSIS 3.1 application can distinguish their contents from the useful data. Subcarriers with a special function are configured in the signal description in the "Continuous Pilots and Excluded Subcarrier Assignment" table.

For downstream signals, the first row contains the PLC and is configured automatically according to the PLC Start Index L, and "PLC Number of Subcarriers (N_p)" on page 61 from the Signal description settings. Therefore the first row providing the PLC info is read only.

Below the table, a modulation vs. subcarrier diagram indicates which channels are defined for which function.

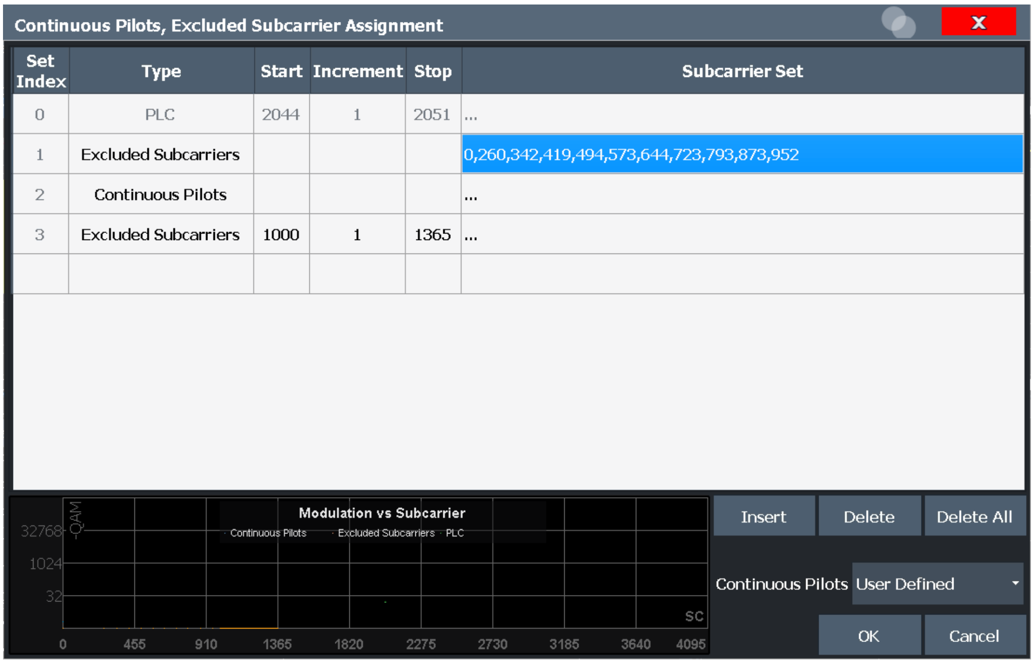


Figure 5-3: Continuous pilots and excluded subcarrier assignment for downstream DOCSIS 3.1 signals

Set Index

Continuous line number in configuration table.

Remote command:
CONFigure:DS:CHANnel:CPES<i>:COUNt? on page 170

Type

Type of special subcarrier; for upstream signals, only excluded subcarriers are available

"PLC"	Physical link channel (First line only, default, always available)
"Cont. Pilot"	Pilot that occurs at the same frequency location in every OFDM symbol, and which is used for frequency and phase synchronization. **Note:** As soon as an entry in the table is defined using the "Type": "Continuous Pilots", Auto Detection:Continuous Pilots (downstream only) is automatically set to "User Defined".
"Excluded Subcarrier"	Subcarrier that cannot be used because another type of service is using the subcarrier's frequency or a permanent interference is present on the frequency.

Remote command:
CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:TYPE on page 173

Subcarrier Range(Start / Increment / Stop)

Defines a series of subcarriers to be configured identically.

The following restrictions apply:
- "Start" < "Stop"
- "Increment" ≥ 1

For example: to configure all 10 carriers between subcarriers 2044 and 2053, define:
- "Start" = *2044*
- "Increment" = *1*
- "Stop" = *2053*

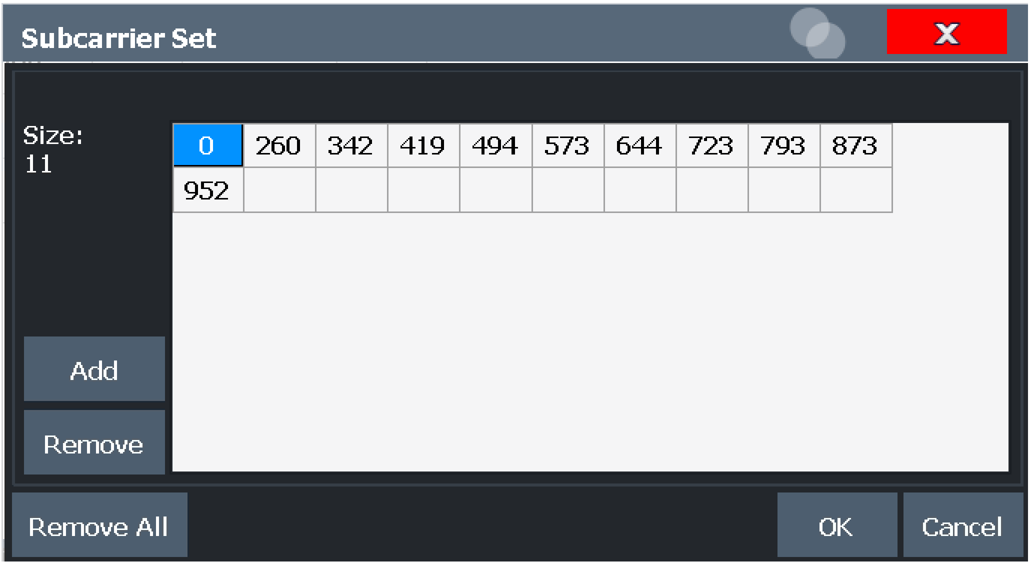
Remote command:
CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STARt on page 172
CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:INCRement on page 171
CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STOP on page 173

Subcarrier Set

Specifies the (discrete) subcarrier numbers to be configured in the same set.

When you select the input field, an edit dialog is displayed. Enter the individual subcarrier numbers in the dialog, selecting [Enter] after each number.

To add further entry fields, select Add.



Tip: to configure a series of subcarriers identically, use the Subcarrier Range(Start / Increment / Stop) settings.

Remote command:
`CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:SET` on page 172

Add ← Subcarrier Set
Adds a new entry to the left of the currently selected entry.

Remove ← Subcarrier Set
Removes the currently selected entry.

Remove All ← Subcarrier Set
Removes all entries in the list.

Insert
Inserts a new line in the table below the currently selected row.

Delete
Deletes the currently selected row.

Remote command:
`CONFigure:DS:CHANnel:CPES<i>:DELete` on page 171

Delete All
Deletes all lines in the table, except for the default PLC configuration.

Remote command:
`CONFigure:DS:CHANnel:CPES<i>:DALL` on page 171

Auto Detection:Continuous Pilots (downstream only)
Defines how continuous pilots are detected in the symbols.

If "Auto from Signal" is selected, continuous pilots are detected automatically during demodulation.

If "User Defined" is selected, the pilots must be configured manually in the Continuous pilots and excluded subcarrier assignment table, using the Type: "Continuous Pilots".

Note: As soon as an entry in the Continuous pilots and excluded subcarrier assignment table is defined or changed to the "Type": "Continuous Pilots", this setting is automatically set to "User Defined".

Remote command:
`[SENSe:]DEMod:CPILots:AUTO` on page 232

OK
Saves the changes to the table and closes the dialog box.

Cancel
Closes the dialog box without saving the changes.

Codeword / frame configuration

Access: "Overview" > "Signal Description" > "Codeword Configuration" > "Frame Configuration"

or: [MEAS CONFIG] > "Signal Description" > "Codeword Configuration" > "Frame Configuration"

The useful data that is to be transmitted to the same group of cable modems is summarized into codewords. Codewords are sequentially assigned to frames (subcarriers) and associated with a profile.

A codeword can either be defined by the first and total number of *subcarriers* it is assigned to, or by the first and total number of *symbols* it is assigned to.

For more information see also "Codewords, logical subcarriers, frames, and NCPs" on page 42.

Select the .

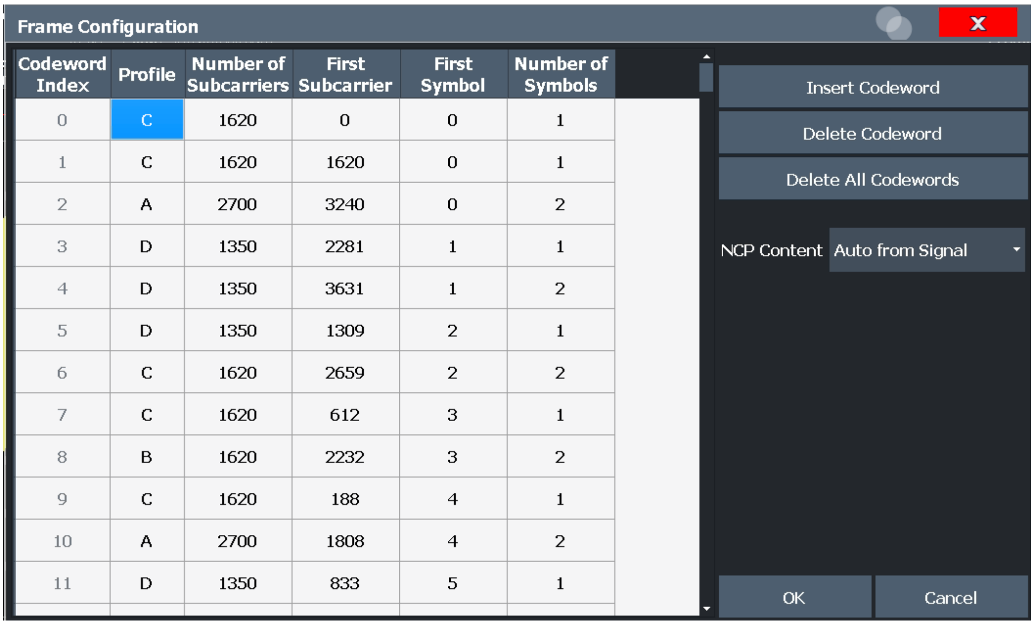


Figure 5-4: Frame/codeword configuration for downstream DOCSIS 3.1 signals

Codeword Index

Continuous line number in configuration table.

Remote command:

`CONFigure:DS:CHANnel:FCONfig<i>:COUNt?` on page 186

Profile

One of the active profiles defined in the "Profile List" on page 69, which is assigned to the selected codeword.

For zero-bit loaded codewords, assign the profile "Unused".

Remote command:

`CONFigure:DS:CHANnel:FCONfig<i>:PROFile` on page 187

First Subcarrier

Defines the first logical subcarrier to which the selected codeword is assigned.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:SUBCarrier:STARt` on page 188

Number of Subcarriers
Defines the number of subcarriers to which the selected codeword is assigned.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:SUBCarrier:COUNt` on page 187

First Symbol
Defines the first symbol to which the selected codeword is assigned.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:SYMBol:STARt` on page 188

Number of Symbols
Defines the number of symbols to which the selected codeword is assigned.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:SYMBol:COUNt` on page 188

Insert Codeword
Inserts a new row in the table below the currently selected row.

Delete Codeword
Deletes the currently selected row.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:DELete` on page 187

Delete All Codewords
Deletes all rows in the table.

Remote command:
`CONFigure:DS:CHANnel:FCONfig<i>:DALL` on page 186

Auto Detection: NCP Content (downstream only)
For each new codeword that starts in a frame, the first subcarrier and the number of subcarriers in total for the codeword is provided as a *Next Codeword Pointer (NCP)*. The contents of the NCP can be configured manually or detected automatically by the R&S FSW DOCSIS 3.1 application.

If "Auto from Signal" is selected, the position of the codewords (NCP content) is detected in the signal automatically during demodulation. The entire table is filled automatically.

If "User Defined" is selected, the frames must be configured manually in the Codeword / frame configuration table.

Remote command:
`[SENSe:]DEMod:NCP:AUTO` on page 233

OK
Saves the changes to the table and closes the dialog box.

Cancel
Closes the dialog box without saving the changes.

Profile configuration (downstream)

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

or: [MEAS CONFIG] > "Signal Description" > "Profile Configuration"

Profiles define the modulation used by each subcarrier. For each set of modems with similar transmission conditions, a profile can then be assigned (see "Codeword / frame configuration" on page 65).

For more information see also "Subcarriers and profiles" on page 41.

Profile management

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

or: [MEAS CONFIG] > "Signal Description" > "Profile Configuration"

A profile is a set of parameters that defines how information is transmitted from a CMTS to a cable modem, or from a cable modem to a CMTS.

Up to 16 different profiles can be defined and assigned to a specific block of data. Profiles that contain a configuration for at least one subcarrier are considered to be active, indicated by black text. Empty profiles are inactive, indicated by gray text.

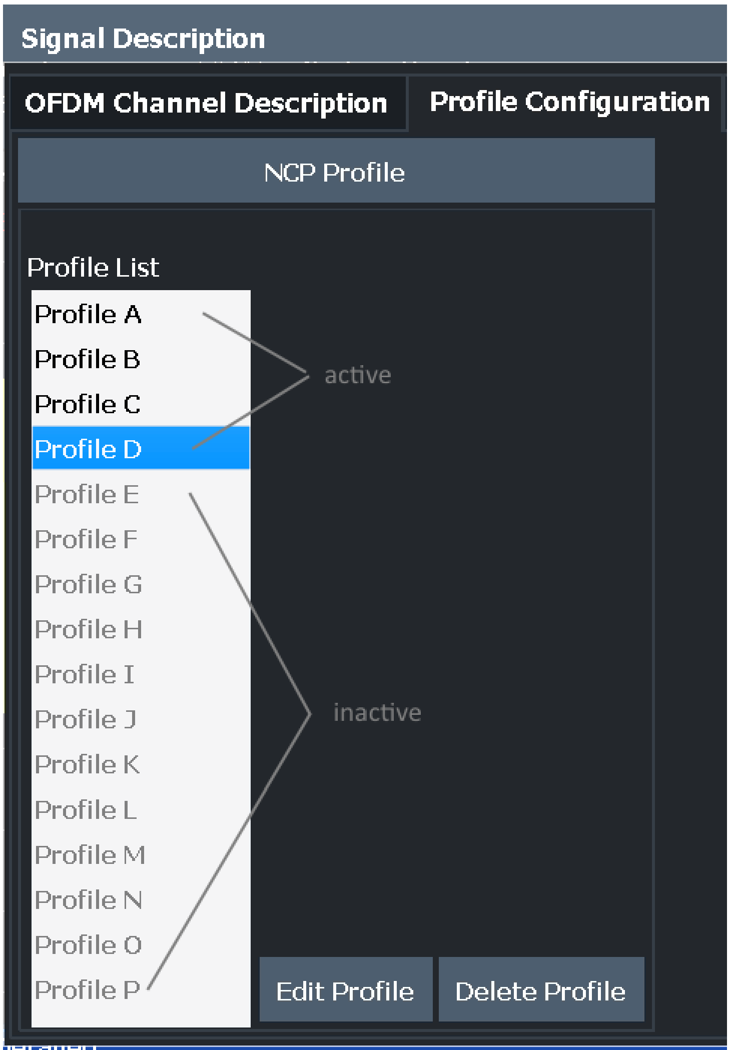


Figure 5-5: Profile configuration for downstream DOCSIS 3.1 signals

Profile List

Up to 16 different profiles can be defined and assigned to a specific set of subcarriers. Profiles that contain a configuration for at least one subcarrier are considered to be active, indicated by black text. Empty profiles are inactive, indicated by gray text.

Remote command:

`CONFigure:DS:CHANnel:PCONfig<pri>:SELect` on page 180

Edit Profile

Displays the "Modulation Subcarrier Assignment" dialog box for the selected profile. For details see "Profile settings: modulation subcarrier assignment" on page 70.

Delete Profile

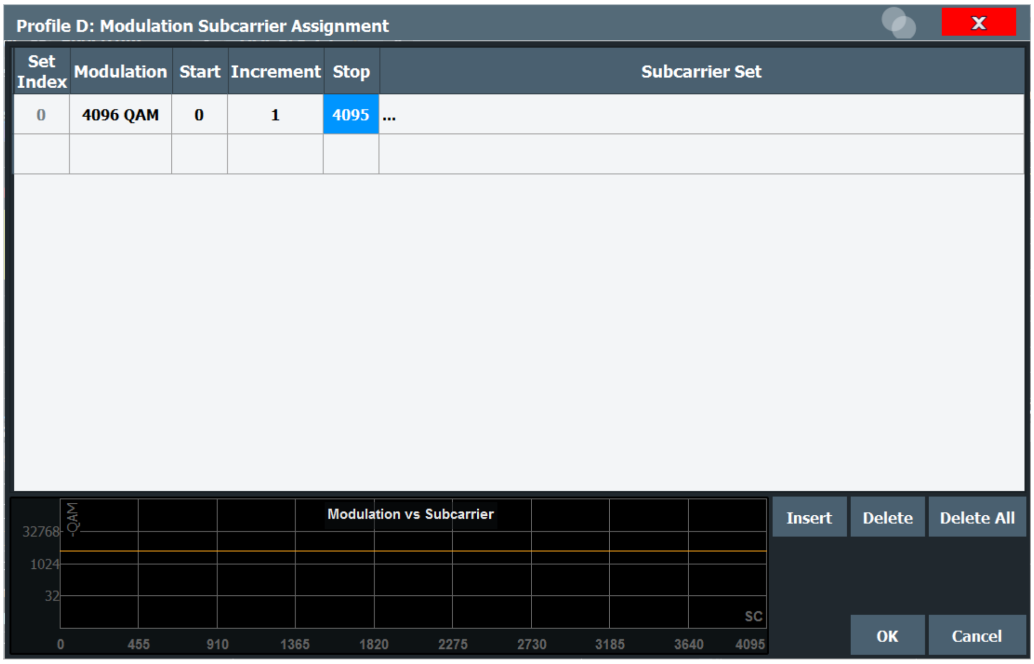
Deletes the currently selected profile in the "Modulation Subcarrier Assignment" list.

Remote command:
`CONFigure:DS:CHANnel:PCONfig<pri>:DELete` on page 180

Profile settings: modulation subcarrier assignment

Access: "Overview" > "Signal Description" > "Profile Configuration" > "Edit Profile"

or: [MEAS CONFIG] > "Signal Description" > "Profile Configuration" > "Edit Profile"



Set Index

Continuous line number in configuration table.

Remote command:
`CONFigure:DS:CHANnel:PCONfig<pri>:COUNt?` on page 179
`CONFigure:DS:CHANnel:NCP:PCONfig<pri>:COUNt?` on page 177

Modulation
Defines the modulation used by the specified subcarriers.

For the NCP profile, zero bit modulation is used for all entries except the index 0, whose modulation depends on the NCP Modulation setting and cannot be edited here.

Remote command:
`CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:MODulation` on page 182
`CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:MODulation` on page 178

Start / Increment / Stop
Defines a series of subcarriers to be configured identically.

The following restrictions apply:
- "Start" < "Stop"
- "Increment" ≥ 1

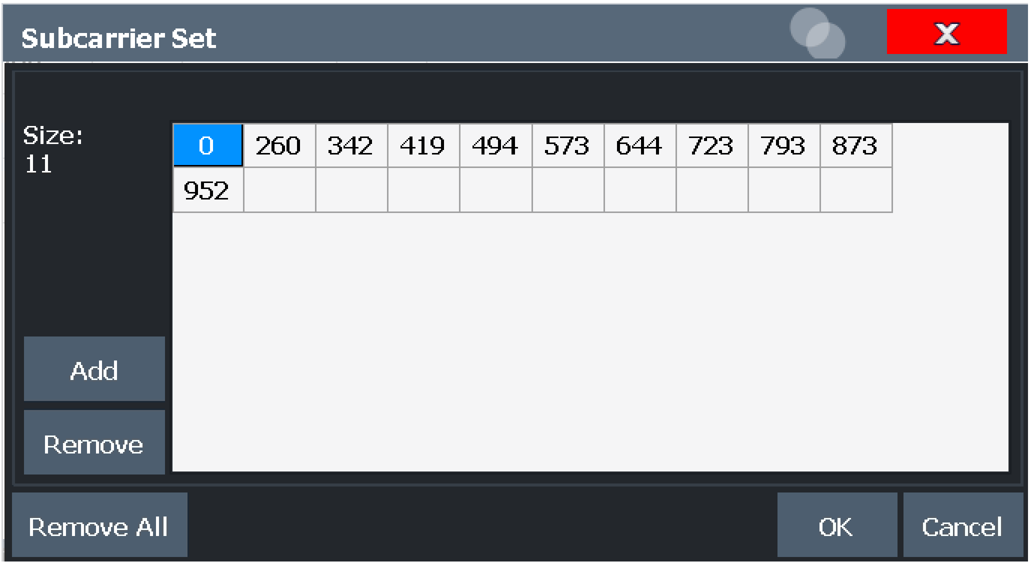
For example: to configure all 10 carriers between subcarriers 2044 and 2053, define:
- "Start" = *2044*
- "Increment" = *1*
- "Stop" = *2053*

Remote command:
`CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STARt` on page 183
`CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:INCRement` on page 181
`CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STOP` on page 183
`CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STARt` on page 179
`CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:INCRement` on page 177
`CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STOP` on page 179

Subcarrier Set
Specifies the (discrete) subcarrier numbers to be configured identically.

When you select the input field, an edit dialog is displayed. Enter the individual subcarrier numbers in the dialog, selecting [Enter] after each number.

To add further entry fields, select Add .



Tip: to configure a series of subcarriers identically, use the Subcarrier Range(Start / Increment / Stop) settings.

Remote command:
CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:SET on page 182
CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:SET on page 178

Add ← Subcarrier Set
Adds a new entry to the left of the currently selected entry.

Remove ← Subcarrier Set
Removes the currently selected entry.

Insert
Inserts a new line in the table below the currently selected row.

Delete
Deletes the currently selected row.

Remote command:
CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:DELete on page 181
CONFigure:DS:CHANnel:NCP:PCONfig<pri>:DELete on page 177

Delete All
Deletes all lines in the table.

Remote command:
CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:DALL on page 181
CONFigure:DS:CHANnel:NCP:PCONfig<pri>:DALL on page 177

OK
Saves the changes to the table and closes the dialog box.

Cancel
Closes the dialog box without saving the changes.

NCP profile

Access: "Overview" > "Signal Description" > "Profile Configuration" > "NCP Profile"

or: [MEAS CONFIG] > "Signal Description" > "Profile Configuration" > "NCP Profile"

The modulation used by the subcarriers for the NCP is defined in a separate profile, but in the same way as all other profiles (see "Profile settings: modulation subcarrier assignment" on page 70). However, the following restrictions apply:

- The entry with the index 0 is not editable. It is defined for the subcarriers from 0 to N_{FFT}-1, in steps of 1.
  The modulation depends on the NCP Modulation setting and cannot be edited in the "Profile" dialog box.
- For all other entries, zero bit modulation is used.

5.3.2.2 Upstream signal description

Access: "Overview" > "Signal Description" > "Stream Direction": "Upstream"

or: [MEAS CONFIG] > "Signal Description" > "Stream Direction"

OFDM channel description (upstream)

Access: "Overview" > "Signal Description" > "OFDM Channel Description"

or: [MEAS CONFIG] > "Signal Description" > "OFDM Channel Description"

The general OFDM channel transmission settings are configured in the "Signal Description" dialog box.

Figure 5-6: OFDM channel description for upstream DOCSIS 3.1 signals

Stream Direction

Defines the direction of the signal stream to be analyzed. Various configuration parameters for the DOCSIS 3.1 measurement depend on the stream direction.

"Downstream" (default) Downstream signal (from the CMTS to the cable modems). Requires FSW-K192 option.

"Upstream" Upstream signal (from the cable modems to the CMTS). Requires FSW-K193 option.

Remote command:
`CONFigure:SDIRection` on page 167

Center Frequency

Defines the center frequency of the signal in Hertz.

The center frequency of the complete signal depends on the center frequency of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum. If the OFDM Spectrum Location is changed, then the general center frequency is also changed, and vice versa.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 212

OFDM Spectrum Location
Specifies the center frequency in Hz of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum.

The default value for this setting is derived from the current Center Frequency. If the spectrum location is changed, the center frequency is adapted accordingly, and vice versa.

Remote command:
`CONFigure:US:CHANnel:SPECtrum:FREQuency` on page 169

N_{FFT} (FFT length)
Specifies the length of the FFT defining the OFDM transmission, which corresponds to the number of physical subcarriers.

"2K mode, Δf 50 kHz"
2048 subcarriers at = 50 kHz spacing; FFT length = 2048 samples

"4K mode, Δf 25 kHz"
4096 subcarriers at = 25 kHz spacing; FFT length = 4096 samples

Remote command:
`CONFigure:CHANnel:NFFT` on page 163

Cyclic Prefix CP
Length of the configurable cyclic prefix.

The cyclic prefix determines where the useful data starts and allows the application to detect delay spreads during transmission. The longer the delay spread, the longer the CP must be.

Note: The cyclic prefix must be longer than the Roll-off period.

"AUTO"	The length is determined automatically by the R&S FSW DOCSIS 3.1 application and indicated in the dialog box after the next measurement.
"96 Samples, 0.9375µs"	Useful symbol period starts after 96 samples or 0.9375 µs.
"128 Samples, 1.25µs"	Useful symbol period starts after 128 samples or 1.25 µs.
"160 Samples, 1.5625µs"	Useful symbol period starts after 160 samples or 1.5625 µs.
"192 Samples, 1.875µs"	Useful symbol period starts after 192 samples or 1.875µs.
"224 Samples, 2.1875µs"	Useful symbol period starts after 224 samples or 2.1875 µs.

"256 Samples, 2.5µs"	Useful symbol period starts after 256 samples or 2.5µs.
"288 Samples, 2.8125µs"	Useful symbol period starts after 288 samples or 2.8125 µs.
"320 Samples, 3.125µs"	Useful symbol period starts after 320 samples or 3.125 µs.
"384 Samples, 3.75µs"	Useful symbol period starts after 384 samples or 3.75 µs.
"512 Samples, 5.0µs"	Useful symbol period starts after 512 samples or 5.0µs.
"640 Samples, 6.25µs"	Useful symbol period starts after 640 samples or 6.25 µs.

Remote command:
`CONFigure:CHANnel:CP` on page 168
`FETCh:CP?` on page 278

Roll-off
Defines the roll-off period for the Tukey raised-cosine window which is applied at the beginning (and end) of an OFDM symbol. The roll-off period defines the steepness of the filter.

The required period depends on the current transmission conditions. The roll-off period can be between 0 µs and 2.1875 µs for the upstream.

Note: The roll-off period is integrated in the Cyclic Prefix CP and must be shorter than the Cyclic Prefix CP.

"Auto Max Roll-Off"	The maximum possible roll-off period is used automatically.
"0 Samples, 0.0 µs"	No samples in the roll-off period (for no transmit windowing)
"32 Samples, 0.3125µs"	The roll-off period contains 64 samples and lasts 0.3125 µs.
"64 Samples, 0.625 µs"	The roll-off period contains 128 samples and lasts 0.625 µs.
"96 Samples, 0.9375 µs"	The roll-off period contains 192 samples and lasts 0.9375 µs.
"128 Samples, 1.25 µs"	The roll-off period contains 256 samples and lasts 1.25 µs.
"160 Samples, 1.5625 µs"	The roll-off period contains 256 samples and lasts 1.25 µs.
"192 Samples, 1.875 µs"	The roll-off period contains 256 samples and lasts 1.25 µs.
"224 Samples, 2.1875 µs"	The roll-off period contains 256 samples and lasts 1.25 µs.

Remote command:
`CONFigure:CHANnel:ROFF` on page 164

Symbols Per Frame (K)
Defines the number of symbols per frame to be expected. The available number of symbols per frame varies depending on the used bandwidth and N_{FFT} (FFT length).
Values between 6 and 18 are allowed for 4K mode, values between 6 and 36 for 2K mode.

Remote command:
`CONFigure:US:CHANnel:SYMBols` on page 170

Excluded subcarrier assignment

Access: "Overview" > "Signal Description" > "OFDM Channel Description" > "Excluded Subcarriers Configuration"

or: [MEAS CONFIG] > "Signal Description" > "OFDM Channel Description" > "Excluded Subcarriers Configuration"

Some subcarriers are excluded for transmission. Such subcarriers must be configured so that the R&S FSW DOCSIS 3.1 application can distinguish their contents from the useful data. Excluded subcarriers are configured in the signal description in the "Excluded Subcarrier Assignment" table.

Below the table, a modulation vs. subcarrier diagram indicates which channels are defined as excluded subcarriers.

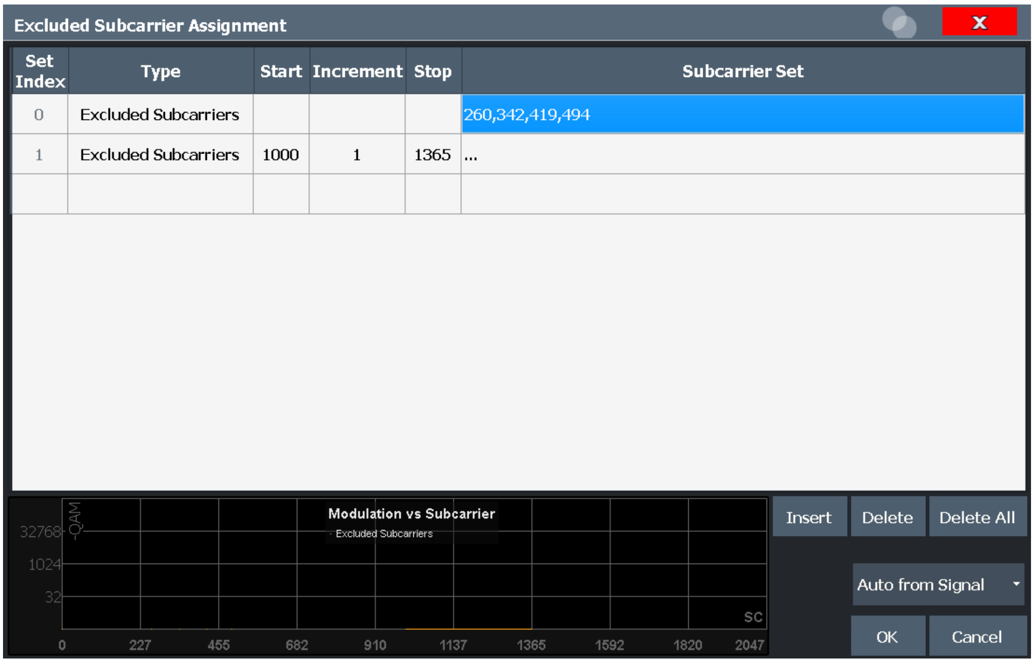


Figure 5-7: Excluded subcarrier assignment for upstream DOCSIS 3.1 signals

Set Index

Indicates the continuous line number in the configuration table.

Remote command:
`CONFigure:US:CHANnel:ESUB<i>:COUNt?` on page 173

Type

Defines the type of special subcarrier.

"Excluded Subcarrier"	Subcarrier that cannot be used because another type of service is using the subcarrier's frequency or a permanent ingressor is present on the frequency.

Remote command:
`CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:TYPE?` on page 176

Subcarrier Range(Start / Increment / Stop)

Defines a series of subcarriers to be configured identically.

The following restrictions apply:
- "Start" < "Stop"
- "Increment" ≥ 1

For example: to configure all 10 carriers between subcarriers 2044 and 2053, define:
- "Start" = *2044*
- "Increment" = *1*
- "Stop" = *2053*

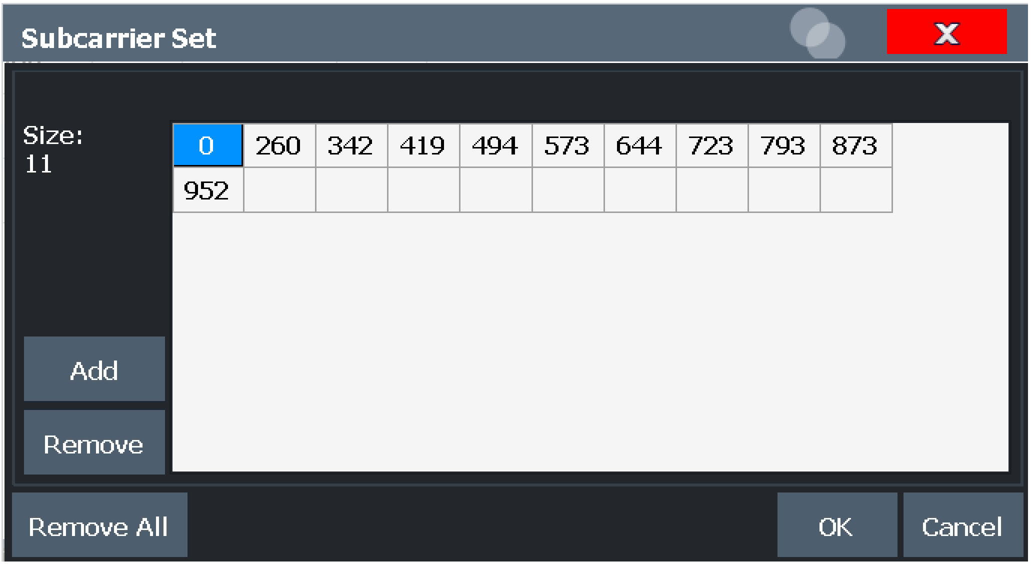
Remote command:
`CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:STARt` on page 175
`CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:INCRement` on page 174
`CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:STOP` on page 175

Subcarrier Set

Specifies the (discrete) subcarrier numbers to be configured identically.

When you select the input field, an edit dialog is displayed. Enter the individual subcarrier numbers in the dialog, selecting [Enter] after each number.

To add further entry fields, select Add.



Tip: to configure a series of subcarriers identically, use the Subcarrier Range(Start / Increment / Stop) settings.

Remote command:
CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:SET on page 175

Add ← Subcarrier Set
Adds a new entry to the left of the currently selected entry.

Remove ← Subcarrier Set
Removes the currently selected entry.

Inserting a line
Inserts a new line in the table below the currently selected row.

Deleting a line
Deletes the currently selected row.

Remote command:
CONFigure:US:CHANnel:ESUB<i>:DELete on page 174

Deleting the entire table
Deletes all lines in the table, except for the default PLC configuration.

Remote command:
CONFigure:US:CHANnel:ESUB<i>:DALL on page 174

OK
Saves the changes to the table and closes the dialog box.

Cancel
Closes the dialog box without saving the changes.

Profile configuration (upstream)

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

or: [MEAS CONFIG] > "Signal Description" > "Profile Configuration" > "Profile Configuration"

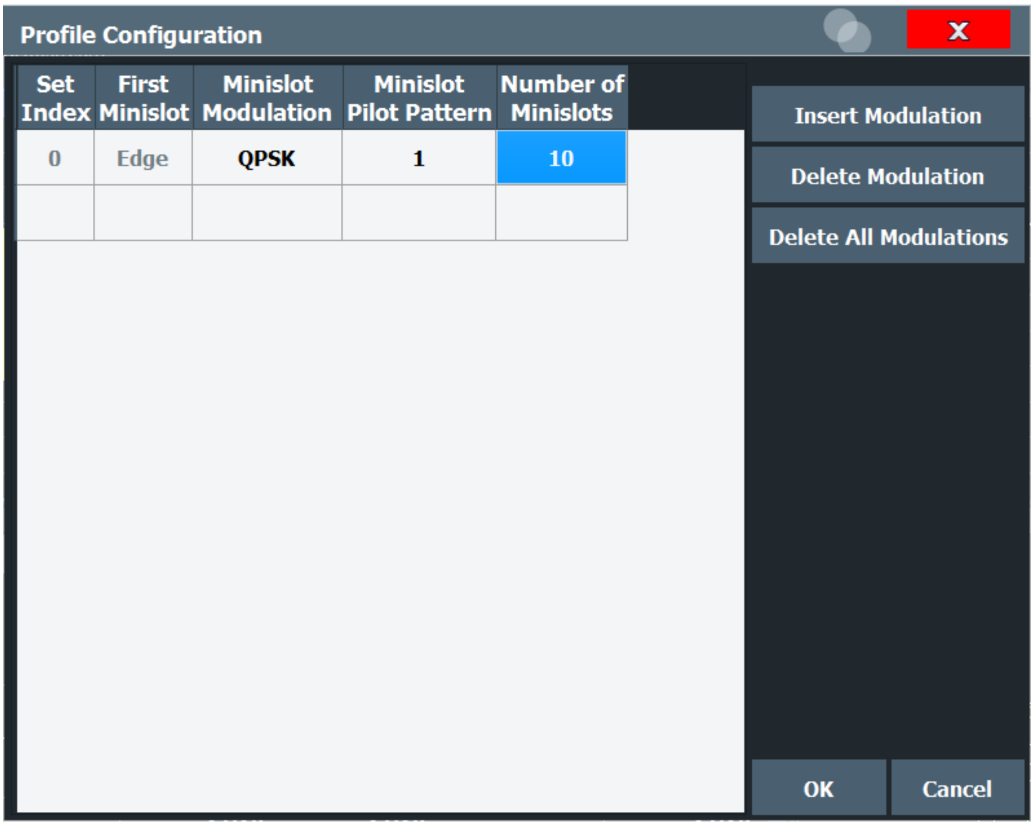


Figure 5-8: Profile configuration for upstream DOCSIS 3.1 signals

Set Index

Continuous line number in configuration table.

First Minislot
Defines the type of the minislot to determine if it is the first minislot in a transmission PPDU. The first minislot in a transmission burst must be an "Edge" minislot. All other minislots in the burst are "Body" minislots.

Thus, the minislot with the index 0 is always of type "Edge". Minislots with a zero-valued modulation are also always of type "Edge".

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:FIRSt` on page 185

Minislot Modulation
Defines the modulation used by the specified minislots.

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:MODulation` on page 185

Minislot Pilot Pattern
Defines the pilot pattern used by the specified minislots. Which patterns are available depends on the N_{FFT} (FFT length).

- **2K mode: 1 to 7**
- **4K mode: 8 to 14**

For more information, see "Pilot patterns" on page 46.

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:PPATtern` on page 185

Number of Minislots
Defines the number of minislots for which the modulation is used.

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:COUNt` on page 184

Insert Modulation
Inserts a new line in the table below the currently selected row.

Delete Modulation
Deletes the currently selected row.

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:DELete` on page 184

Delete All Modulations
Deletes all lines in the table.

Remote command:
`CONFigure:US:CHANnel:PCONfig<pri>:MINislot:DALL` on page 184

OK
Saves the changes to the table and closes the dialog box.

Cancel
Closes the dialog box without saving the changes.

5.3.3 Input, output, and frontend settings

Access: "Overview" ≥ "Input/Frontend"

or: [INPUT/OUTPUT]

The FSW can analyze signals from different input sources and provide various types of output (such as noise or trigger signals).

Importing and Exporting I/Q Data

The I/Q data to be analyzed for DOCSIS 3.1 cannot only be captured by the DOCSIS 3.1 application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the analyzed I/Q data from the DOCSIS 3.1 application can be exported for further analysis in external applications.

See the FSW I/Q Analyzer and I/Q Input user manual.

Frequency and amplitude settings are available to configure the frontend of the FSW.

5.3.3.1 Input source settings

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

The input source determines which data the FSW analyzes.

The default input source for the FSW is "Radio Frequency", i.e. the signal at the "RF Input" connector of the FSW. If no additional options are installed, this is the only available input source.

Input from other sources

The R&S FSW DOCSIS 3.1 application application can also process input from the following optional sources:

- I/Q Input files
- "Digital Baseband" interface
- "Analog Baseband" interface
- Probes
- Power sensors

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

Further input sources

The R&S FSW DOCSIS 3.1 application application can also process input from the following optional sources:

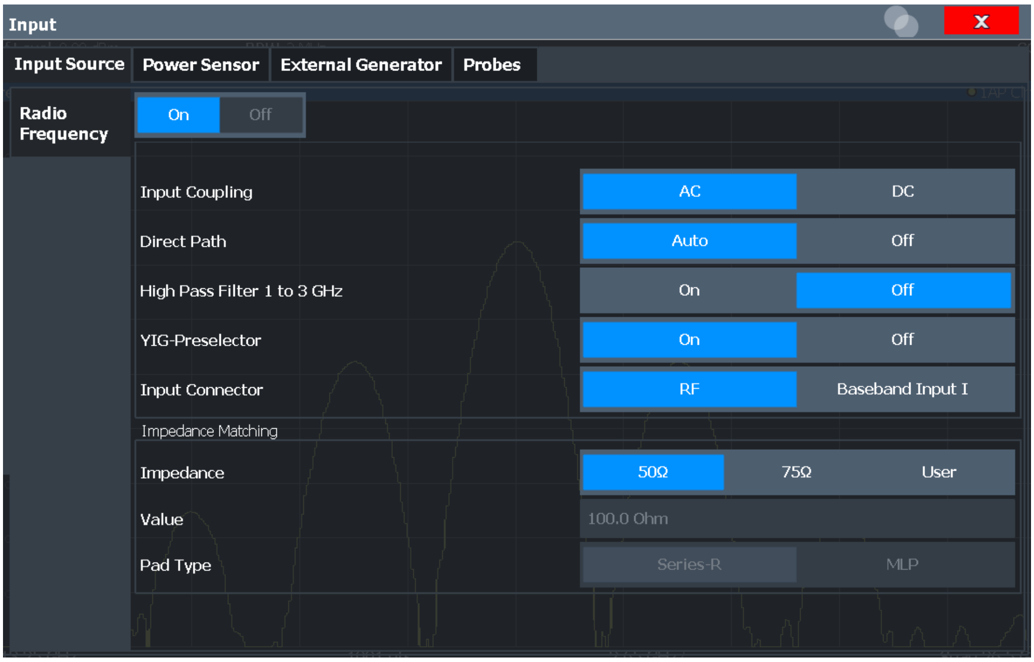
- I/Q Input files
- "Digital Baseband" interface (R&S FSW-B17)
- "Analog Baseband" interface
- Probes
- Power sensors

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

Since the Digital I/Q input and the Analog Baseband input use the same digital signal path, both cannot be used simultaneously. When one is activated, established connections for the other are disconnected. When the second input is deactivated, connections to the first are re-established. Reconnecting can cause a short delay in data transfer after switching the input source.

Radio frequency input

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



RF Input Protection

The RF input connector of the FSW must be protected against signal levels that exceed the ranges specified in the specifications document. Therefore, the FSW is equipped with an overload protection mechanism for DC and signal frequencies up to 30 MHz. This mechanism becomes active as soon as the power at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case, you must decrease the level at the RF input connector and then close the message box. Then measurement is possible again. Reactivating the RF input is also possible via the remote command `INPut:ATTenuation:PROTection:RESet`.

Radio Frequency State

Activates input from the "RF Input" connector.

For FSW85 models with two input connectors, you must define which input source is used for each measurement channel.

"Input 1"	1.00 mm RF input connector for frequencies up to 85 GHz (90 GHz with option R&S FSW-B90G)
"Input 2"	1.85 mm RF input connector for frequencies up to 67 GHz

Remote command:
`INPut:SELect` on page 192
`INPut:TYPE` on page 193

Input Coupling

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

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

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

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

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

Remote command:
`INPut:COUPling` on page 190

Impedance

The FSW has an internal impedance of 50 Ω. However, some applications use other impedance values. To match the impedance of an external application to the impedance of the FSW, an *impedance matching pad* can be inserted at the input. If the type and impedance value of the used matching pad is known to the FSW, it can convert the measured units accordingly so that the results are calculated correctly.

This function is not available for input from the optional "Digital Baseband" interface. Not all settings are supported by all FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output).

"50Ω"	(Default:) no conversion takes place
"75Ω"	The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)
"User"	The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

Remote command:
`INPut:IMPedance` on page 191
`INPut:IMPedance:PTYPe` on page 191
For Analog Baseband input:
`INPut:IQ:IMPedance` on page 196
`INPut:IQ:IMPedance:PTYPe` on page 197

Direct Path

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

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

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

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

Remote command:
`INPut:DPATh` on page 190

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

This function requires an additional hardware option.

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

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 190

YIG-Preselector
Enables or disables the YIG-preselector.

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

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

The "YIG-Preselector" is off by default.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 191

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

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

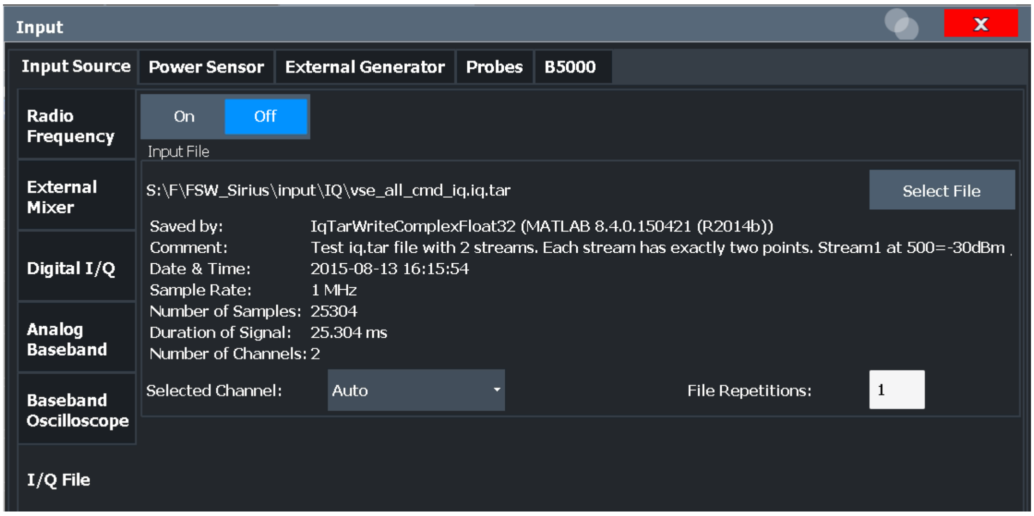
"RF"	(Default:) The "RF Input" connector
"RF Probe"	The "RF Input" connector with an adapter for a modular probe This setting is only available if a probe is connected to the "RF Input" connector.
"Baseband Input I"	The optional "Baseband Input I" connector This setting is only available if the optional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

Remote command:
`INPut:CONNector` on page 189

Settings for input from I/Q data files

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

Or: [INPUT/OUTPUT] > "Input Source Config" > "Input Source" > "I/Q File"



I/Q Input File State

Enables input from the selected I/Q input file.

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

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

Remote command:
`INPut:SELect` on page 192

Select I/Q data file

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

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

For details on formats, see the FSW I/Q Analyzer and I/Q Input user manual.

The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

Note: Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

Note: For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

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

Remote command:
`INPut:FILE:PATH` on page 208

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

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

Remote command:
`MMEMory:LOAD:IQ:STReam` on page 209
`MMEMory:LOAD:IQ:STReam:AUTO` on page 210
`MMEMory:LOAD:IQ:STReam:LIST?` on page 210

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

Remote command:
`TRACe:IQ:FILE:REPetition:COUNt` on page 210

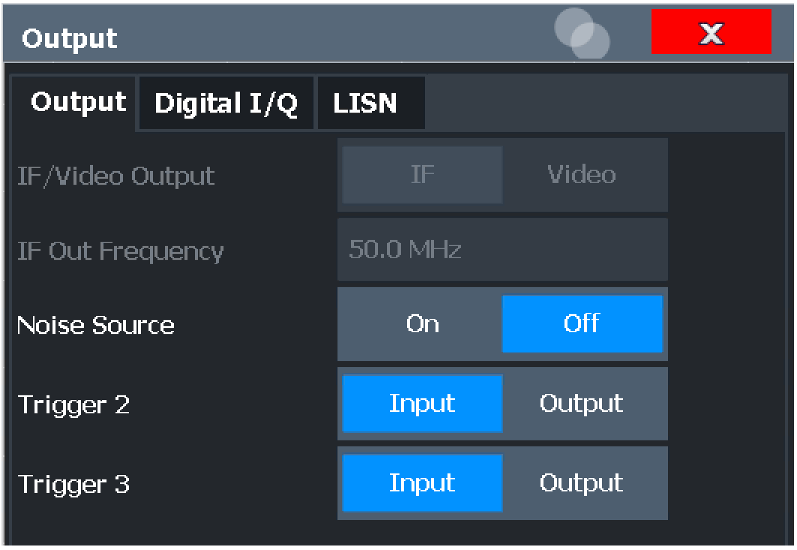
5.3.3.2 Output settings

Access: [Input/Output] > "Output"

The FSW can provide output to special connectors for other devices.

For details on connectors, refer to the FSW Getting Started manual, "Front / Rear Panel View" chapters.

How to provide trigger signals as output is described in detail in the FSW base unit user manual.



Data Output

Defines the type of signal available at one of the output connectors of the FSW.

"IF" The measured IF value is provided at the IF/VIDEO/DEMOD output connector.
For bandwidths up to 80 MHZ, the IF output is provided at the specified "IF Out Frequency".
If an optional bandwidth extension FSW-B160/-B320/-B512 is used, the measured IF value is available at the "IF WIDE OUTPUT" connector. The frequency at which this value is output is determined automatically. It is displayed as the "IF Wide Out Frequency". For details on the used frequencies, see the specifications document.
This setting is not available for bandwidths larger than 512 MHz.

"2ND IF" The measured IF value is provided at the "IF OUT 2 GHz/ IF OUT 5 GHz" output connector, if available, at a frequency of 2 GHz and with a bandwidth of 2 GHz. The availability of this connector depends on the instrument model.
This setting is not available if the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) is active.

Remote command:
`OUTPut:IF[:SOURce]` on page 211
`OUTPut:IF:IFFRequency` on page 211

Noise Source Control

Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise source control / Power sensor") connector. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

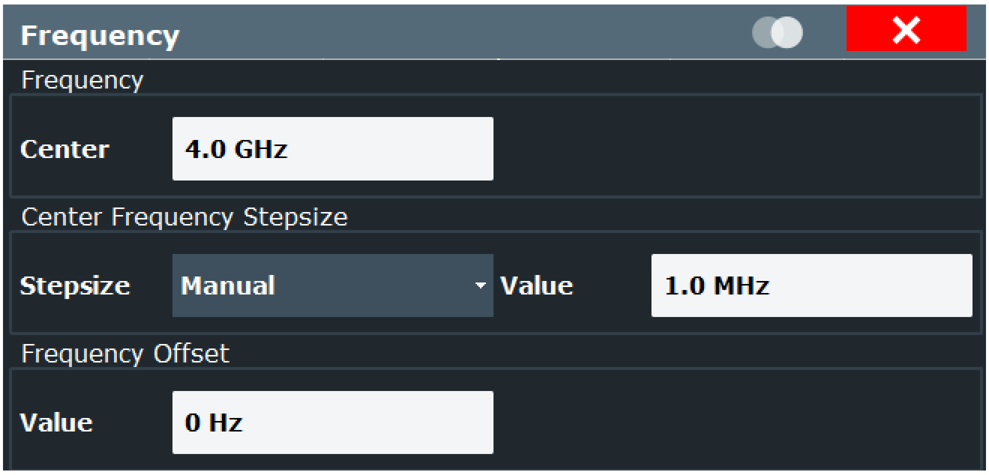
External noise sources are useful when you are measuring power levels that fall below the noise floor of the FSW itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the FSW and measure the total noise power. From this value, you can determine the noise power of the FSW. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 211

5.3.3.3 Frequency settings

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



Center Frequency

Defines the center frequency of the signal in Hertz.

The center frequency of the complete signal depends on the center frequency of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum. If the OFDM Spectrum Location is changed, then the general center frequency is also changed, and vice versa.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 212

Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased using the arrow keys.

When you use the rotary knob the center frequency changes in steps of only 1/10 of the span.

The step size can be coupled to another value or it can be manually set to a fixed value.

"= Center"	Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.
"Manual"	Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP` on page 213

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, on the captured data, or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies. However, if it shows frequencies relative to the signal's center frequency, it is not shifted.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

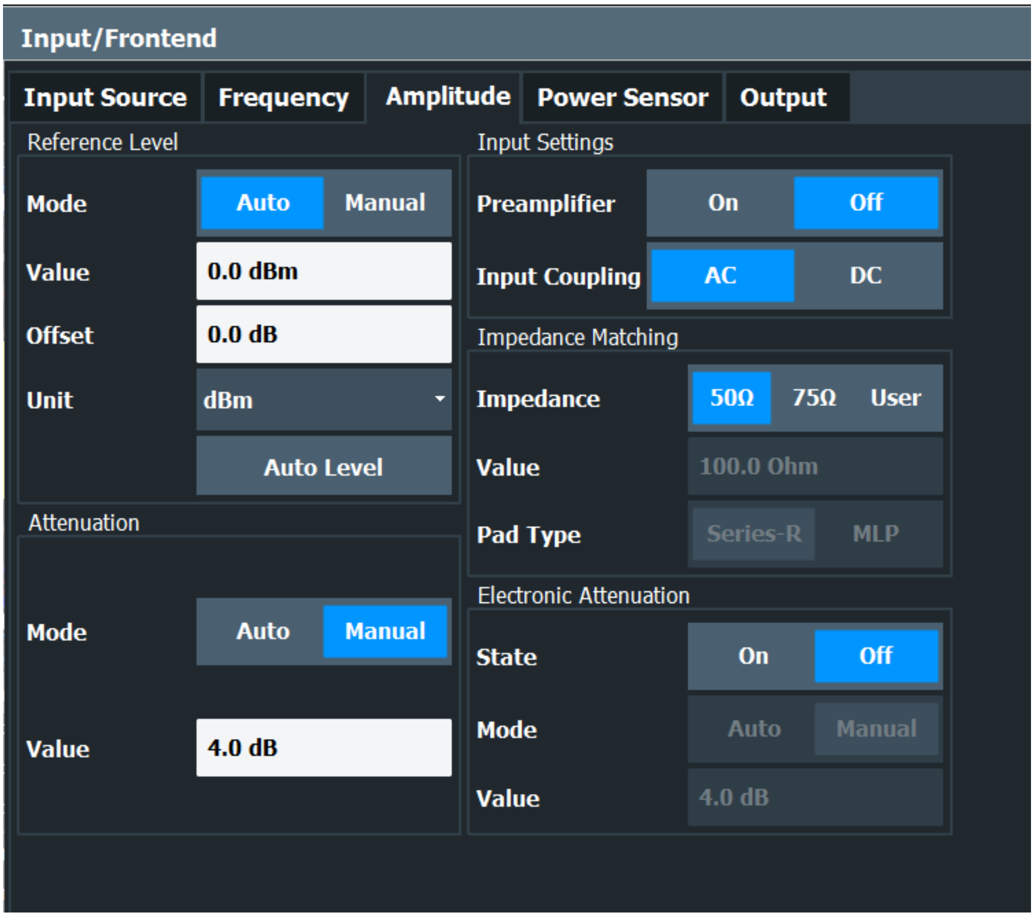
The allowed values range from -1 THz to 1 THz. The default setting is 0 Hz.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 213

5.3.3.4 Amplitude settings

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

Amplitude settings determine how the FSW must process or display the expected input power levels.



Reference Level Settings

The reference level defines the expected maximum signal level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

Reference Level Mode ← Reference Level Settings
By default, the reference level is automatically adapted to its optimal value for the current input data (continuously). At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to define the reference level manually, switch to "Manual" mode. In this case you must define the following reference level parameters.

Remote command:
`CONF:POW:AUTO ON`, see `CONFigure:POWer:AUTO` on page 214

Reference Level ← Reference Level Settings
Defines the expected maximum signal level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

This value is overwritten if "Auto Level" mode is turned on.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 215

Shifting the Display (Offset) ← Reference Level Settings
Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the FSW so the application shows correct power results. All displayed power level results will be shifted by this value.

Note, however, that the Reference Level value ignores the "Reference Level Offset". It is important to know the actual power level the FSW must handle.

To determine the required offset, consider the external attenuation or gain applied to the input signal. A positive value indicates that an attenuation took place (FSW increases the displayed power values) , a negative value indicates an external gain (FSW decreases the displayed power values).

The setting range is ±200 dB in 0.01 dB steps.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 215

Unit ← Reference Level Settings
The FSW measures the signal voltage at the RF input.

In the default state, the level is displayed at a power level of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 85), conversion to other units is possible.

Remote command:
`INPut:IMPedance` on page 191
`CALCulate<n>:UNIT:POWer` on page 214

Setting the Reference Level Automatically (Auto Level) ← Reference Level Settings
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

Note that for sample rates larger than 160 MHz and active B1200 or B2001 bandwidth extension options, auto leveling is not available.

Remote command:
`[SENSe:]ADJust:LEVel` on page 238

RF Attenuation
Defines the attenuation applied to the RF input.

This function is not available for input from the "Digital Baseband" interface (FSW-B17).

This function is not available for input from the "Digital Baseband" interface (FSW-B17).

Attenuation Mode / Value ← RF Attenuation
Defines the attenuation applied to the RF input of the FSW.

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

The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

By default and when no (optional) electronic attenuation is available, mechanical attenuation is applied.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the specifications document. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload can lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 216
`INPut:ATTenuation:AUTO` on page 216

Using Electronic Attenuation
If the (optional) Electronic Attenuation hardware is installed on the FSW, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) above 15 GHz.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation can provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation can be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

The electronic attenuation can be varied in 1 dB steps. If the electronic attenuation is on, the mechanical attenuation can be varied in 5 dB steps. Other entries are rounded to the next lower integer value.

For the FSW85, the mechanical attenuation can be varied only in 10 dB steps.

If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed in the status bar.

Remote command:
`INPut:EATT:STATe` on page 217
`INPut:EATT:AUTO` on page 217
`INPut:EATT` on page 216

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

The parameters "Input Coupling" and "Impedance" are identical to those in the "Input" settings, see Chapter 5.3.3.1, "Input source settings", on page 82.

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

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

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

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

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

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

For older FSW43/FSW50/FSW67 models, the input signal is always ampilfied by about 30 dB when the preamplifier is active.

For FSW85 models, no preamplifier is available.

Remote command:
`INPut:GAIN:STATe` on page 218
`INPut:GAIN[:VALue]` on page 219

Ext. PA Correction ← Input Settings
This function is only available if an external preamplifier is connected to the FSW, and only for frequencies above 1 GHz. For details on connection, see the preamplifier's documentation.

Using an external preamplifier, you can measure signals from devices under test with low output power, using measurement devices which feature a low sensitivity and do not have a built-in RF preamplifier.

When you connect the external preamplifier, the FSW reads out the touchdown (`.S2P`) file from the EEPROM of the preamplifier. This file contains the s-parameters of the preamplifier. As soon as you connect the preamplifier to the FSW, the preamplifier is permanently on and ready to use. However, you must enable data correction based on the stored data explicitly on the FSW using this setting.

When enabled, the FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results. Any internal preamplifier, if available, is disabled.

For FSW85 models with two RF inputs, you can enable correction from the external preamplifier for each input individually, but not for both at the same time.

When disabled, no compensation is performed even if an external preamplifier remains connected.

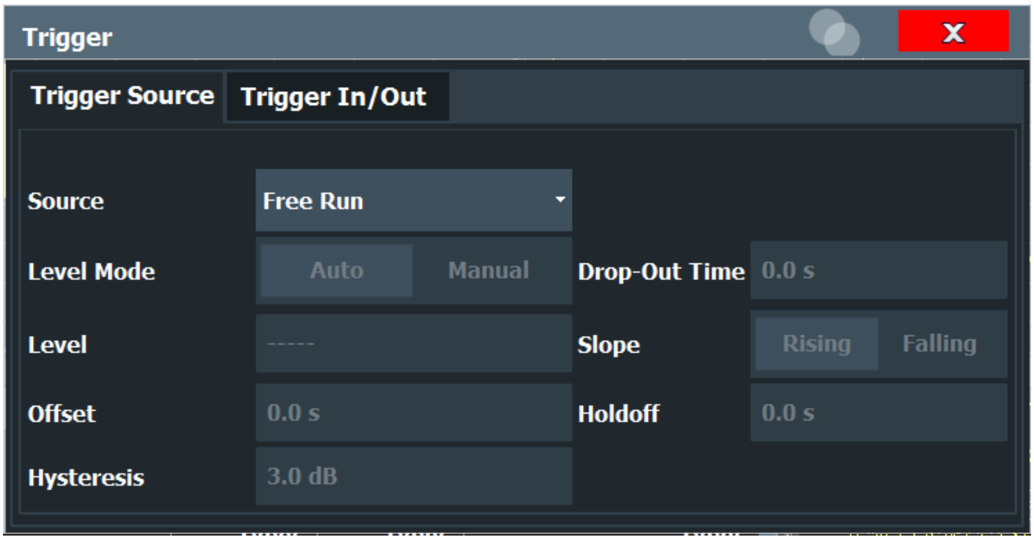
Remote command:
`INPut:EGAin[:STATe]` on page 217

5.3.4 Trigger settings

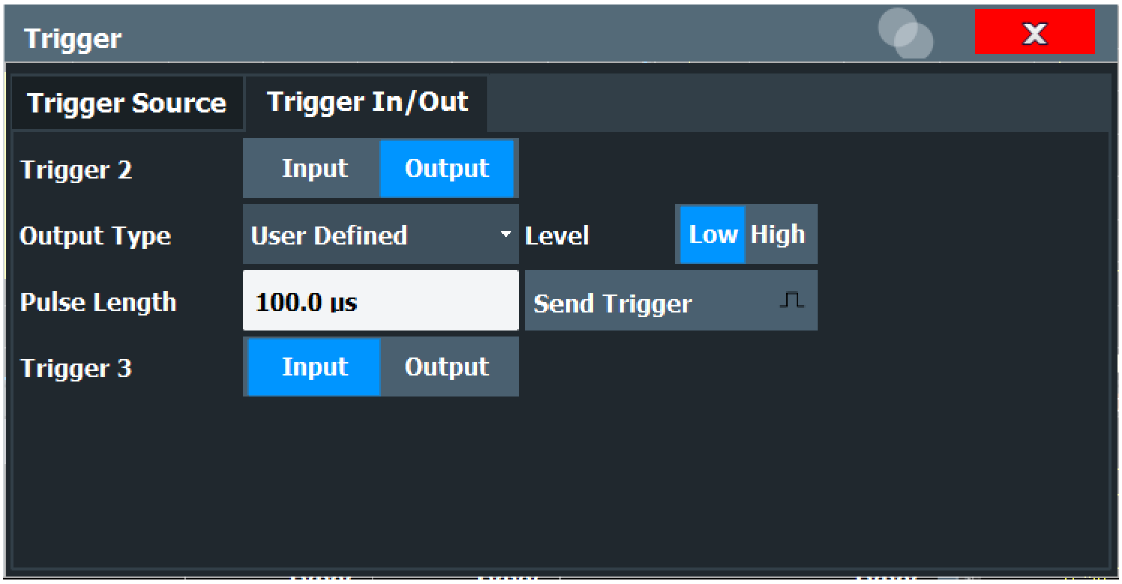
Access: "Overview" > "Trigger"

or: [TRIG] > "Trigger Config"

Trigger settings determine when the FSW starts to capture the input signal.



External triggers from one of the [TRIGGER INPUT/OUTPUT] connectors on the FSW are configured in a separate tab of the dialog box.



For more information on trigger settings and step-by-step instructions on configuring triggered measurements, see the FSW User Manual.

Trigger Source Settings

The Trigger Source settings define when data is captured.

Trigger Source ← Trigger Source Settings
Defines the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 225

Free Run ← Trigger Source ← Trigger Source Settings
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 225

External Trigger 1/2/3 ← Trigger Source ← Trigger Source Settings
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

(See "Trigger Level" on page 101).

Note: "External Trigger 1" automatically selects the trigger signal from the "TRIGGER 1 INPUT" connector on the front panel.

For details, see the "Instrument Tour" chapter in the FSW Getting Started manual.

"External Trigger 1"
Trigger signal from the "TRIGGER 1 INPUT" connector.

"External Trigger 2"
Trigger signal from the "TRIGGER 2 INPUT / OUTPUT" connector.
Note: Connector must be configured for "Input" in the "Output" configuration
For FSW85 models, "Trigger 2" is not available due to the second RF input connector on the front panel.
(See the FSW base unit user manual).

"External Trigger 3"
Trigger signal from the "TRIGGER 3 INPUT / OUTPUT" connector on the rear panel.
Note: Connector must be configured for "Input" in the "Output" configuration.
(See FSW base unit user manual).

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
`TRIG:SOUR EXT3`
See `TRIGger[:SEQuence]:SOURce` on page 225

Baseband Power ← Trigger Source ← Trigger Source Settings
Defines triggering on the baseband power for baseband input.

Available for input from the optional "Analog Baseband" interface.

Available for input from the optional "Digital Baseband" interface.

Remote command:
`TRIG:SOUR BBP`, see `TRIGger[:SEQuence]:SOURce` on page 225

Digital I/Q ← Trigger Source ← Trigger Source Settings
For applications that process I/Q data, such as the I/Q Analyzer or optional applications, and only if the optional "Digital Baseband" interface is available:

Defines triggering of the measurement directly via the "LVDS" connector. In the selection list, specify which general-purpose bit ("GP0" to "GP5") provides the trigger data.

Note: If the Digital I/Q enhanced mode is used, i.e. the connected device supports transfer rates up to 200 Msps, only the general-purpose bits "GP0" and "GP1" are available as a Digital I/Q trigger source.

The following table describes the assignment of the general-purpose bits to the LVDS connector pins.

(For details on the LVDS connector, see the FSW I/Q Analyzer User Manual.)

Table 5-1: Assignment of general-purpose bits to LVDS connector pins

Bit	LVDS pin
GP0	SDATA4_P - Trigger1
GP1	SDATA4_P - Trigger2
GP2 *)	SDATA0_P - Reserve1
GP3 *)	SDATA4_P - Reserve2
GP4 *)	SDATA0_P - Marker1
GP5 *)	SDATA4_P - Marker2
*): not available for Digital I/Q enhanced mode	

Remote command:
`TRIG:SOUR GP0`, see `TRIGger[:SEQuence]:SOURce` on page 225

IF Power ← Trigger Source ← Trigger Source Settings
The FSW starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

Available for input from the optional "Analog Baseband" interface.

Available for input from the optional "Digital Baseband" interface.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

For details on available trigger levels and trigger bandwidths, see the specifications document.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 225

RF Power ← Trigger Source ← Trigger Source Settings
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose, the instrument uses a level detector at the first intermediate frequency.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels, see the instrument's specifications document.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement can be aborted. A message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

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

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

If the trigger source "RF Power" is selected and you enable baseband input, the trigger source is automatically switched to "Free Run".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 225

I/Q Power ← Trigger Source ← Trigger Source Settings
Not available for the optional "Digital Baseband" interface.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the bandwidth setting for I/Q data acquisition.

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 225

Power Sensor ← Trigger Source ← Trigger Source Settings
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

Note: For Rohde & Schwarz power sensors, the "Gate Mode" *Lvl* is not supported. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed.

Remote command:
`TRIG:SOUR PSE`, see `TRIGger[:SEQuence]:SOURce` on page 225

Time ← Trigger Source ← Trigger Source Settings
Triggers in a specified repetition interval.

See "Repetition Interval" on page 101.

Remote command:
`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 225

Trigger Level Mode ← Trigger Source Settings
By default, the optimum trigger level for power triggers is automatically measured and determined at the start of each sweep (for Modulation Accuracy measurements).

In order to define the trigger level manually, switch to "Manual" mode.

Remote command:
`TRIG:SEQ:LEV:POW:AUTO ON`, see `TRIGger[:SEQuence]:LEVel:POWer:AUTO` on page 224

Trigger Level ← Trigger Source Settings
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the instrument specifications document.

Remote command:
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 223
For baseband input only:
`TRIGger[:SEQuence]:LEVel:BBPower` on page 223

Repetition Interval ← Trigger Source Settings
Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If the required interval cannot be set with the available granularity, configure a multiple of the interval that can be set. Thus, the trigger remains synchronized to the signal.

Remote command:
`TRIGger[:SEQuence]:TIME:RINTerval` on page 227

Drop-Out Time ← Trigger Source Settings
Defines the time that the input signal must stay below the trigger level before triggering again.

Note: For input from the optional "Analog Baseband" interface using the baseband power trigger (BBP), the default drop out time is set to 100 ns. This avoids unintentional trigger events (as no hysteresis can be configured in this case).

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 222

Trigger Offset ← Trigger Source Settings
Defines the time offset between the trigger event and the start of the measurement.

Offset > 0:	Start of the measurement is delayed
Offset < 0:	Measurement starts earlier (pretrigger)

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 222

Hysteresis ← Trigger Source Settings
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 223

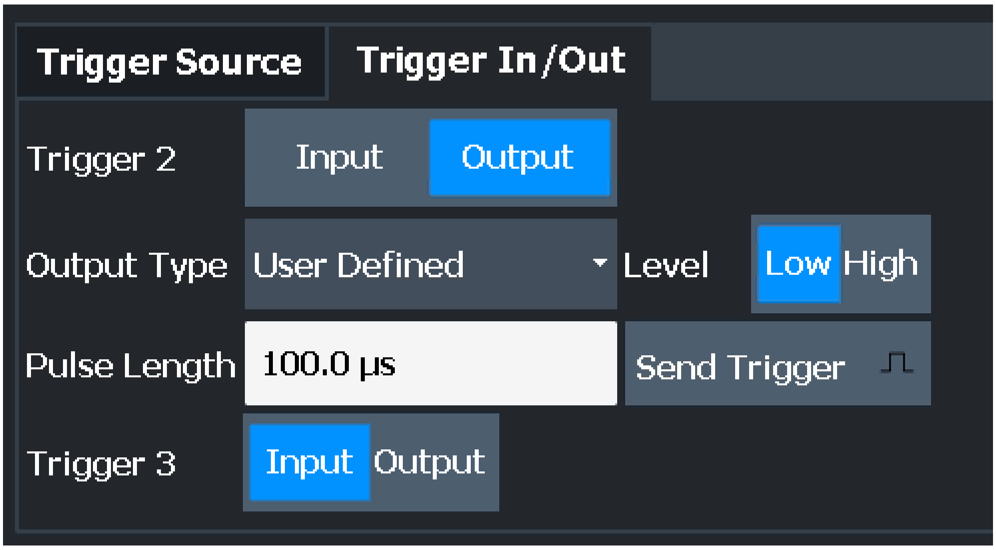
Trigger Holdoff ← Trigger Source Settings
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 222

Slope ← Trigger Source Settings
For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 225

Trigger 2/3



The trigger input and output functionality depends on how the variable "Trigger Input/ Output" connectors are used.

Note: Providing trigger signals as output is described in detail in the FSW base unit user manual.

"Trigger 1" "Trigger 1" is input only.

"Trigger 2" Defines the usage of the variable "Trigger Input/Output" connector on the front panel
(not available for FSW85 models with 2 RF input connectors)

"Trigger 3"	Defines the usage of the variable "Trigger 3 Input/Output" connector on the rear panel
"Input"	The signal at the connector is used as an external trigger source by the FSW. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The FSW sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<tp>:DIRection` on page 227

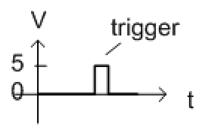
Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered"	(Default) Sends a trigger when the FSW triggers.
"Trigger Armed"	Sends a (high level) trigger when the FSW is in "Ready for trigger" state. This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the "AUX" port (pin 9).
"User Defined"	Sends a trigger when you select "Send Trigger". In this case, further parameters are available for the output signal.

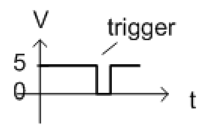
Remote command:
`OUTPut:TRIGger<tp>:OTYPe` on page 228

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User Defined".

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level" = "High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



low-level constant, high-level trigger



high-level constant, low-level trigger

Remote command:
`OUTPut:TRIGger<tp>:LEVel` on page 227

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<tp>:PULSe:LENGth` on page 229

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level" = "High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

Which pulse level is sent is indicated by a graphic on the button.

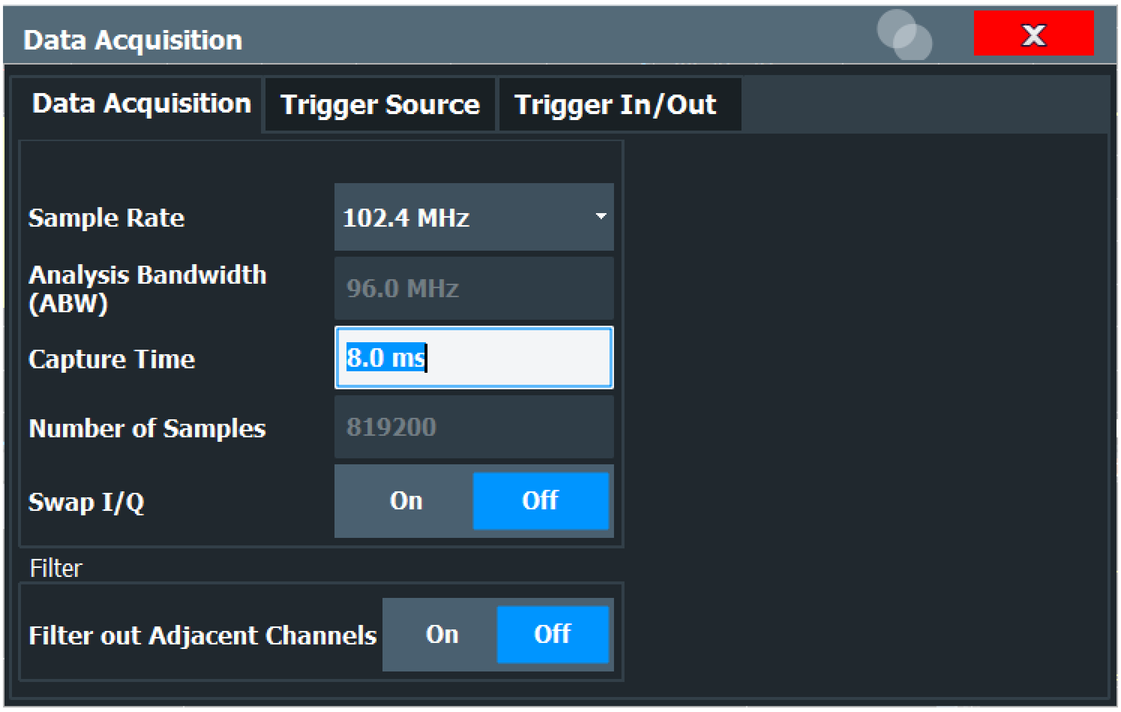
Remote command:
`OUTPut:TRIGger<tp>:PULSe:IMMediate` on page 228

5.3.5 Data acquisition

Access: "Overview" > "Data Acquisition"

or: [MEAS CONFIG] > "Data Acquisition"

You can define how much and how data is captured from the input signal. For DOCSIS 3.1 measurements, data is always captured with a fixed bandwidth of 192.00 MHz and a fixed sample rate of 204.80 MHz (downstream) or 102.4 MHz (upstream).



Sample Rate
Defines or indicates the amount of data that is analyzed within the specified Capture Time.

For DOCSIS 3.1 downstream measurements, a fixed sample rate of 204.8 MHz is used.

For DOCSIS 3.1 upstream measurements, a fixed sample rate of 102.4 MHz or 204.8 MHz (oversampling *2) can be used.

Note: Synchronous Band Power measurements require a sample rate of 204.8 MHz (see Synchronous band power settings).

Remote command:
`TRACe:IQ:SRATe` on page 221

Analysis Bandwidth (ABW)
The bandwidth of the signal which is analyzed for the modulation accuracy measurement.

For DOCSIS 3.1 downstream measurements, a fixed bandwidth of 192.0 MHz is used.

For DOCSIS 3.1 upstream measurements, a fixed bandwidth of 96.0 MHz is used.

Remote command:
`TRACe:IQ:BWIDth?` on page 221

Capture Time
Specifies the duration (and therefore the amount of data) to be captured in the capture buffer. If the capture time is too short, demodulation will fail. The capture time may not exceed 470 ms.

If the capture time is changed, the Number of Samples is adapted according to the following equation:

*Number of samples = capture time * sample rate*

Remote command:
`[SENSe:]SWEep:TIME` on page 220

Number of Samples
The number of samples is indicated for reference only. It is calculated from the Capture Time and the Sample Rate according to the following equation:

*Number of samples = capture time * sample rate*

The maximum number of samples for downstream is thus 96,256,000.

The maximum number of samples for upstream is thus 48,128,000.

Remote command:
`[SENSe:]SWEep:LENGth?` on page 220

Swap I/Q
Activates or deactivates the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the FSW can do the same to compensate for it.

On	I and Q signals are interchanged Inverted sideband, Q+j*I
Off	I and Q signals are not interchanged Normal sideband, I+j*Q

Remote command:
`[SENSe:]SWAPiq` on page 220

Filter Out Adjacent Channels
If activated, only the useful signal is analyzed, signal data in adjacent channels is filtered out as much as possible.

This setting improves the signal to noise ratio and thus the MER results for signals with strong or a large number of adjacent channels. In particular, the filter is required for MER tests according to the DOCSIS 3.1 Physical Layer Acceptance Test Plan (see [3]).

However, for some measurements, information on the effects of adjacent channels on the measured signal may be of interest.

Note: Synchronous Band Power measurements require data from adjacent channels to be filtered out.

Remote command:
`INPut:FILTer:ACHannels[:STATe]` on page 219

5.3.6 Sweep settings

Access: [Sweep]

The sweep settings define how the data is measured.

Continuous Sweep / Run Cont
While the measurement is running, "Continuous Sweep" and [RUN CONT] are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. If the Sequencer is active, "Continuous Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the FSW base unit user manual.

Remote command:
INITiate<n>:CONTinuous on page 271

Single Sweep / Run Single
While the measurement is running, "Single Sweep" and [RUN SINGLE] are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, "Single Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, [RUN SINGLE] controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed channel is updated.

For details on the Sequencer, see the FSW base unit user manual.

Remote command:
INITiate<n>[:IMMediate] on page 271

Refresh
This function is only available if the Sequencer is deactivated and only in single sweep mode.

The data in the capture buffer is re-evaluated by the R&S FSW DOCSIS 3.1 application. This is useful, for example, after evaluation changes have been made.

Remote command:
INITiate:REFResh on page 271

Continue Single Sweep
After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

While the measurement is running, "Continue Single Sweep" and [RUN SINGLE] are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
INITiate<n>:CONMeas on page 270

5.3.7 Synch/ OFDM-demodulation

Access: [MEAS CONFIG] > "Synch/OFDM-Demod." (upstream only)

Synchronization settings are only available for upstream DOCSIS 3.1 signals.

Power Interval Search
Determines the area within the capture buffer in which the frame start is searched.

If enabled (default), the frame start is only searched in "Magnitude Capture" (time-domain) areas with sufficient power. This improves the measurement speed performance.

If disabled, the complete "Magnitude Capture" buffer is searched for frame starts. This makes the frame detection more robust in case of existing neighbor signals.

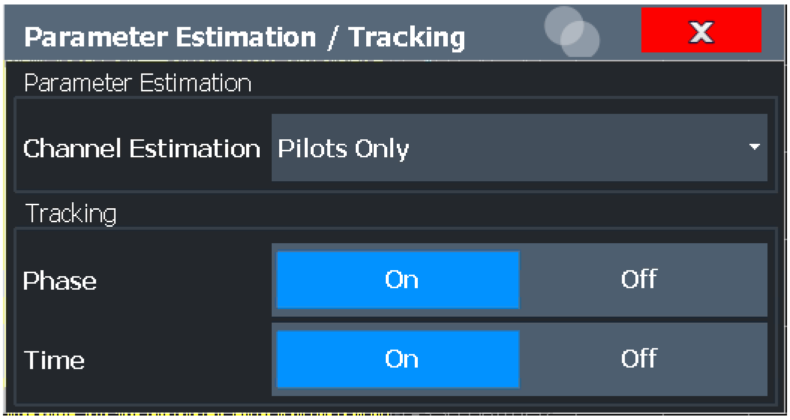
Remote command:
`[SENSe:]DEMod:TXARea` on page 229

5.3.8 Parameter estimation and tracking

Access: "Overview" > "Estimation/Tracking"

or: [MEAS CONFIG] > "Parameter Estimation Tracking"

The channel estimation settings determine which channels are assumed in the input signal. Tracking settings allow for compensation of some transmission effects in the signal.



Channel Estimation
The channel estimation settings determine how channels are detected and compensated for in the input signal.

"Pilots only" (Downstream only, default:) An optimal channel estimation using all available pilots is performed, as defined in the DOCSIS 3.1 downstream standard.

"Pilots and Data" (Downstream only:) An optimal channel estimation using all available pilots and data is performed.

"Off" (Downstream only:) The channel transfer function is not compensated for in the measurement results.

"Minimal Test Receiver Equalization"
(Downstream only:) Minimal test receiver equalization according to the definition in the physical layer standardization document in section 7.5.9.1. The estimated channel impulse response used by the test receiver is limited to half the length of the smallest transmit cyclic prefix.

"Equalized MER"
(Upstream only, default:) Measurements with linear distortions are equalized by the R&S FSW DOCSIS 3.1 application equalizer.

"Unequalized MER"
(Upstream only:) Measurements with linear distortions are not equalized by the R&S FSW DOCSIS 3.1 application equalizer.
Only one carrier amplitude adjustment common for all subcarriers and OFDM symbols in the burst is performed.
Only one timing adjustment is performed, resulting in phase ramp across subcarriers.

"Partial Equalization"
(Upstream only:) Partial equalization according to the definition in the standardization document *ATP TC1409.4 Procedure 3.1*. The partial equalizer is configured such that it does not correct components of the cable modem’s impulse response that are longer than +/-200 ns.

Remote command:
`[SENSe:]CHANnel:ESTimation` on page 230

Phase Tracking (downstream only)
Activates or deactivates the compensation for phase drifts. If activated, the measurement results are compensated for phase drifts on a per-symbol basis.

Remote command:
`SENSe:TRACking:PHASe` on page 231

Timing Error Tracking
Activates or deactivates the compensation for timing drift. If activated, the measurement results are compensated for timing error on a per-symbol basis.

Remote command:
`SENSe:TRACking:TIME` on page 231

5.3.9 Demodulation

Access: "Overview" > "Demodulation"

or: [MEAS CONFIG] > "Demod"

The demodulation settings define which functions are performed during demodulation. Different functions are available for downstream and upstream signals.

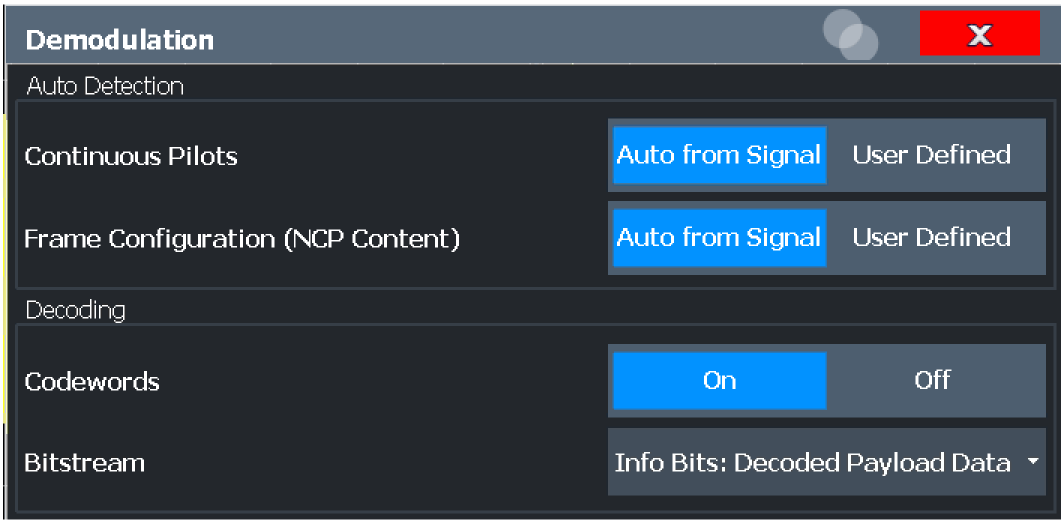


Figure 5-9: Demodulation settings for downstream signals

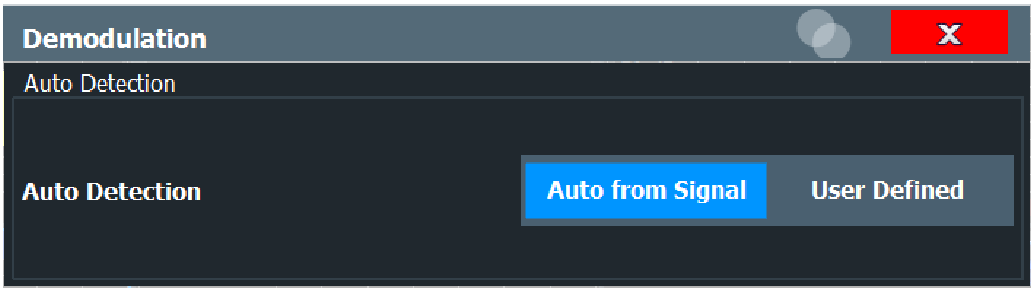


Figure 5-10: Demodulation settings for upstream signals

Auto Detection:Continuous Pilots (downstream only)

Defines how continuous pilots are detected in the symbols.

If "Auto from Signal" is selected, continuous pilots are detected automatically during demodulation.

If "User Defined" is selected, the pilots must be configured manually in the Continuous pilots and excluded subcarrier assignment table, using the Type: "Continuous Pilots".

Note: As soon as an entry in the Continuous pilots and excluded subcarrier assignment table is defined or changed to the "Type": "Continuous Pilots", this setting is automatically set to "User Defined".

Remote command:
`[SENSe:]DEMod:CPILots:AUTO` on page 232

Auto Detection: NCP Content (downstream only)
For each new codeword that starts in a frame, the first subcarrier and the number of subcarriers in total for the codeword is provided as a *Next Codeword Pointer (NCP)*. The contents of the NCP can be configured manually or detected automatically by the R&S FSW DOCSIS 3.1 application.

If "Auto from Signal" is selected, the position of the codewords (NCP content) is detected in the signal automatically during demodulation. The entire table is filled automatically.

If "User Defined" is selected, the frames must be configured manually in the Codeword / frame configuration table.

Remote command:
`[SENSe:]DEMod:NCP:AUTO` on page 233

Codewords (downstream only)
Determines whether codewords are decoded or not.

If the codewords are not decoded, calculation time decreases; however, in this case codeword error bits are not evaluated (in the "Signal Content Detailed" on page 31 display).

Remote command:
`[SENSe:]DEMod:DECode:CODewords` on page 233

Bitstream (downstream only)
Determines which bits of the data stream are decoded and then displayed in a Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

"Info Bits: Decoded Payload Data"
(Default) Only the bits containing the actual information (the payload bits) are decoded and displayed

"Raw Bits"
Bits mapped to QAM constellation points, undecoded

"Raw Bits Descrambled"
Bits mapped to QAM constellation points, randomization undone, undecoded

"Input Bits LDPC"
Undecoded hard-decisions of the log-likelihood ratio values seen by the LDPC decoder, whole FEC codeword (16200 bits)

"Output Bits LDPC"
Decoded LDPC decoder output, whole FEC codeword (16200 bits)

Remote command:
`[SENSe:]DEMod:DECode:BITStream` on page 232

Auto Detection: Signal description (upstream only)
The signal description for upstream signals can also be detected automatically by the R&S FSW DOCSIS 3.1 application.

If "User Defined" is selected, the frame profiles must be configured manually in the Upstream signal description table.

If "Auto from Signal" is selected, the signal description is detected in the signal automatically after an initial measurement. The entire table is filled automatically. If you change a setting in any of the Upstream signal description tables manually, the auto detection setting is automatically set to "User Defined".

Note: As opposed to the Auto Detection & Run (upstream only) function in the [AUTO SET] menu, the initial measurement to determine the required parameters is performed for each new measurement. However, this function does *not* determine the N_{FFT} (FFT length) or Center Frequency.

The following restrictions apply to this function:

- Only one profile is detected
- Only pilot patters 1 to 4 and 8 to 11 are detected
- A minimum of 32 pilot subcarriers are required per continuous minislot set

Remote command:
`[SENSe:]DEMod:US:AUTO` on page 234

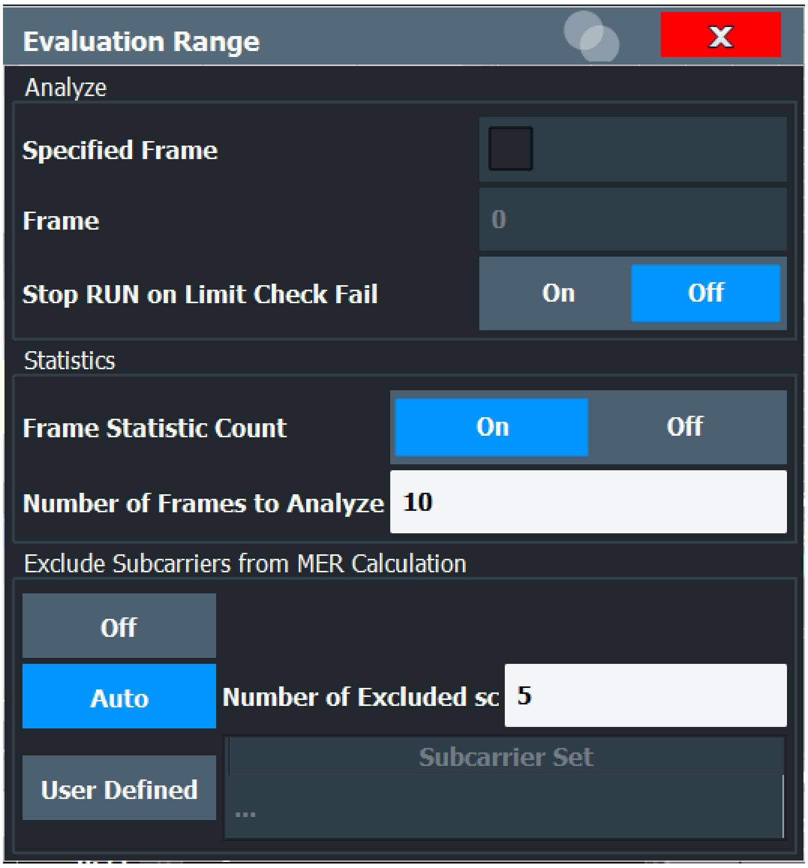
5.3.10 Evaluation range

Access: [MEAS CONFIG] > "Evaluation Range"

The evaluation range defines which objects the result evaluation is based on.

As a rule, graphical result displays are always based on a single frame, while the numeric results may include statistical evaluation over several frames.

For more information see "Basis of (Statistical) Evaluation" on page 45.



Evaluation range settings are only available when no measurement is being performed, that is, after a single sweep has finished or when a continuous sweep has been interrupted.

Analyzing a single frame (Specified Frame)

If "Specified Frame" is enabled, the DOCSIS 3.1 I/Q results are based on one individual frame only, namely the one defined in Selected Frame. Statistic evaluation for numeric results is not performed, as only one result is available for each frame parameter.

If disabled, all detected frames in the capture buffer (or the Frame Statistic Count / Number of Frames to Analyze, if enabled) are evaluated for numeric results. For graphical results, the first frame to be detected in the capture buffer (frame 0) is automatically selected for evaluation.

Remote command:
[SENSe:]FRAMe:SELect:STATe on page 237

Selected Frame

If single frame evaluation is enabled (see Analyzing a single frame (Specified Frame)), the specified frame number is evaluated in all graphical and numeric result displays.

If single frame evaluation is disabled, the first frame to be detected in the capture buffer (frame 0) is automatically selected for evaluation.

Note that only frames in the current capture buffer can be analyzed and displayed individually, even if frames from multiple measurements were captured for statistical evaluation (see "Frame Statistic Count / Number of Frames to Analyze" on page 114).

When you select a new frame, the result displays are updated to show the results for the new evaluation range. The selected frame is marked by a blue bar in the capture buffer display (see "Magnitude Capture" on page 23).

Remote command:
[SENSe:]FRAMe:SELect on page 236

Stop RUN on Limit Check Fail

This function is only available for Signal Content Detailed and Signal Content Summary (downstream only) result displays.

If enabled, the measurement is stopped if the limit check fails at any time during the measurement.

The limit check fails if the bit or block error rate after decoding (BER Pre, BER Post, BLER Post, see Table 3-3) is not zero. An error message in the status bar and a status bit in the SYNC register (bit 3) indicate the failure.

Remote command:
[SENSe:]SWEep:LIMit:ABORt:STATe on page 238

Frame Statistic Count / Number of Frames to Analyze

Measurements are performed continuously until the required number of frames are available. The number of captured and required frames in the current measurement are indicated as "Analyzed Frames" in the channel bar. The number in parenthesis indicates the number of frames detected in the current capture buffer. (See "Channel bar information" on page 12).

If the frame statistic count is enabled (and single frame evaluation is disabled, see Analyzing a single frame (Specified Frame)), the specified number of frames is taken into consideration for the statistical evaluation in numeric results. (For graphical results, even if frames from multiple measurements were captured for statistical evaluation, only frames in the current capture buffer can be analyzed and displayed individually).

If disabled, all detected frames in the current capture buffer are evaluated for statistics. Note that in this case, the number of frames contributing to the current results may vary extremely.

Remote command:
`[SENSe:]FRAMe:COUNt:STATe` on page 236
`[SENSe:]FRAMe:COUNt` on page 236

Excluding Subcarriers from MER Calculation

Up to five specific subcarriers can be excluded from modulation error ratio (MER) calculation.

"Off" (Default:) All subcarriers are included in MER calculation.

"Auto" The specified "Number of Excluded sc" with the worst MER are automatically excluded from MER calculation. Up to five subcarriers can be eliminated automatically.
Note: if you enter a value in "Number of Excluded sc", the setting is automatically set to "Auto".

"User Defined" Up to five subcarriers defined in the set are excluded.
Note: if you enter a value in the set of excluded subcarriers, the setting is automatically changed to "User Defined".

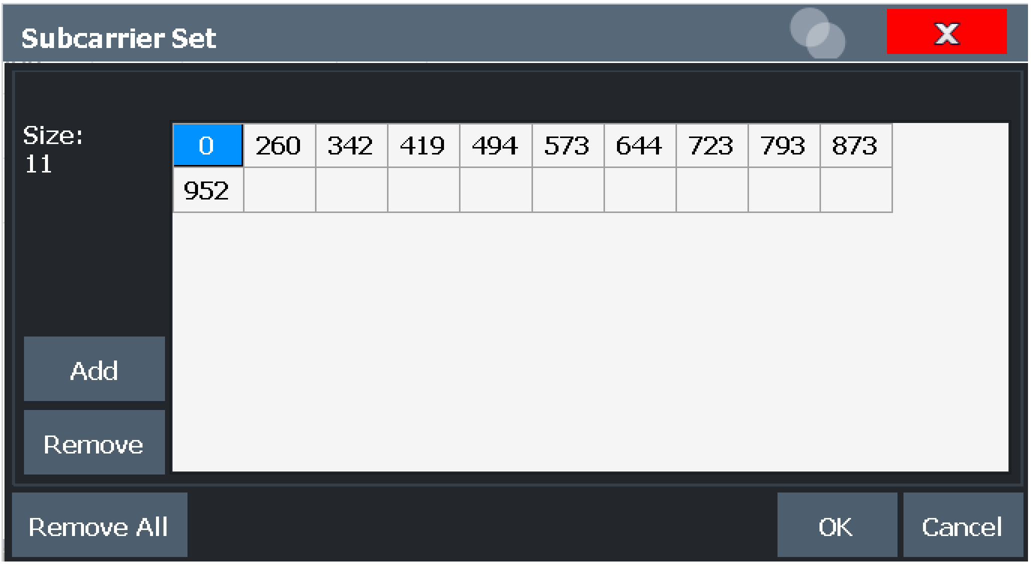
Remote command:
`CONFigure:MEXC:STATe` on page 235
`CONFigure:MEXC:SUBCarrier:COUNt` on page 235

Subcarrier Set ← Excluding Subcarriers from MER Calculation

Specifies up to five subcarrier numbers to be excluded.

When you select the input field, an edit dialog is displayed. Enter the individual subcarrier numbers in the dialog, selecting [Enter] after each number.

To add further entry fields, select "Add" on page 64.



Remote command:
`CONFigure:MEXC:SUBCarrier:SET` on page 235

Add ← Subcarrier Set ← Excluding Subcarriers from MER Calculation

Adds a new entry to the left of the currently selected entry.

Remove ← Subcarrier Set ← Excluding Subcarriers from MER Calculation
Removes the currently selected entry.

OK ← Subcarrier Set ← Excluding Subcarriers from MER Calculation
Saves the changes to the table and closes the dialog box.

Cancel ← Subcarrier Set ← Excluding Subcarriers from MER Calculation
Closes the dialog box without saving the changes.

5.3.11 Result configuration

Access: "Overview" ≥ "Result Config"

or: [MEAS CONFIG] > "Result Config"

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window (see "Specific Settings for" on page 56).

Marker settings are described in Chapter 6.2, "Markers", on page 138.

5.3.11.1 Table configuration

Access: "Overview" ≥ "Result Config" > "Table Config"

or: [MEAS CONFIG] > "Result Config" > "Table Config"

You can configure which results are displayed in the following table results:

- "Result Summary" on page 30
- "Signal Content Detailed" on page 31
- "Signal Content Summary (downstream only)" on page 32
- "Bitstream (downstream only)" on page 20
- "Synchronous Band Power (upstream only)" on page 33

However, the results are always *calculated*, regardless of their visibility on the screen.

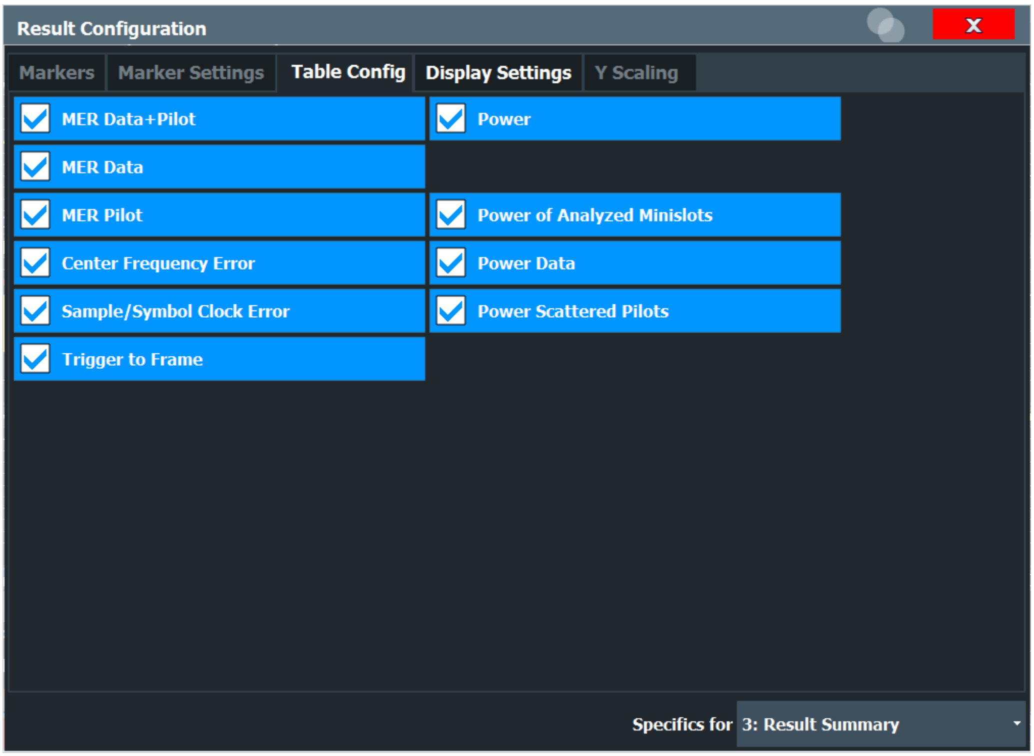


Figure 5-11: Result summary configuration

For details on individual parameters see Chapter 3.1.1, "Modulation accuracy parameters", on page 14 and "Synchronous Band Power (upstream only)" on page 33.

Remote command:

"Result Summary" only:

`DISPlay[:WINDow<n>]:TABLe:ITEM` on page 251

Not available for Signal Content, Bitstream, and Synchronous Band Power results

5.3.11.2 Display settings

Access: "Overview" ≥ "Result Config" > "Display Settings"

or: [MEAS CONFIG] > "Result Config" > "Display Settings"

Display settings are available for specific graphical result displays.

Display settings for constellation results

Access: "Overview" ≥ "Result Config" > "Display Settings"

or: [MEAS CONFIG] > "Result Config" > "Display Settings"

The following settings are available for "Constellation" result displays.

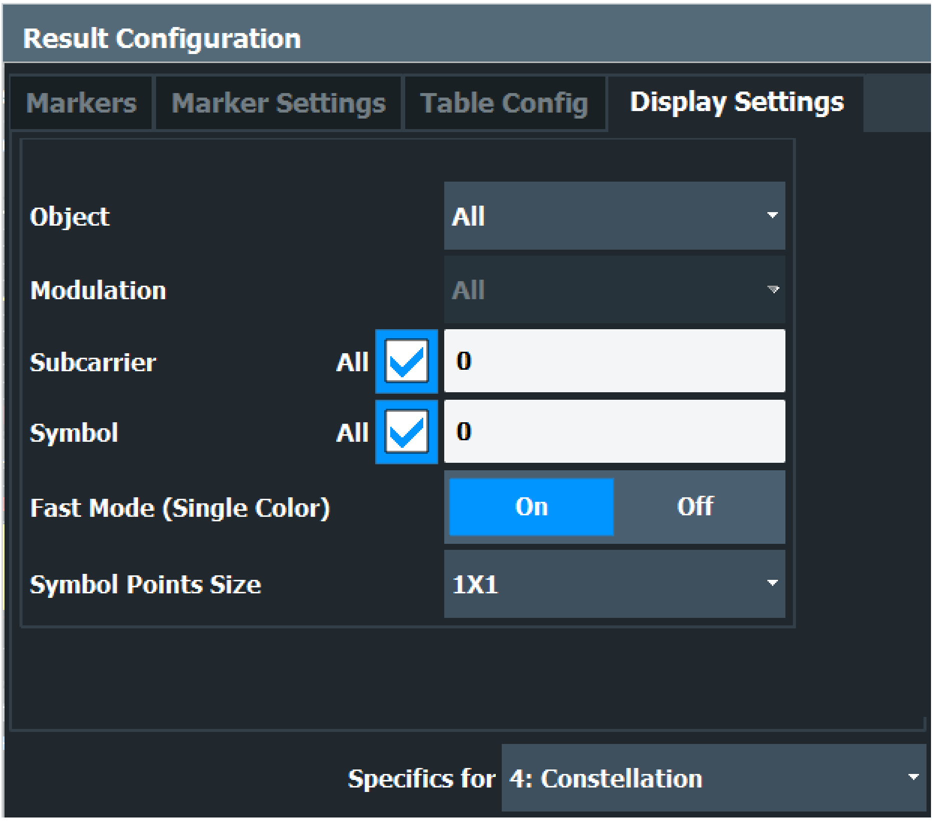


Figure 5-12: Result configuration settings for Constellation results

Object

The constellation diagram is restricted to the specified object.

If "All" is selected (default), the "Constellation" diagram is displayed for the following objects:

- Pilots
- Complementary Pilots (upstream only)
- PLC preamble (downstream only)
- PLC data (downstream only)
- NCP all (downstream only)
- Individual profile (A to P) (downstream) / current profile (upstream)
- Scattered pilots (downstream only)
- Continuous pilots (downstream only)

Remote command:
[SENSe:]OBJect:SELect on page 252

Modulation
The constellation diagram is restricted to the specified modulation type(s) of the selected Object.

A specific modulation cannot be selected if Object is set to "All" and Fast Mode (Single Color) is "ON" (default).

Optionally, the points for each modulation can be displayed by a different color, see "Fast Mode (Single Color)" on page 119 and "Constellation" on page 21.

Remote command:
[SENSe:]MODulation:SELect on page 252

Subcarrier
The constellation diagram is restricted to the specified subcarrier.

If "All" is selected, the "Constellation" diagram is displayed for all detected subcarriers.

Remote command:
[SENSe:]SUBCarrier:SELect on page 253

Symbol
The constellation diagram is restricted to the specified symbol.

If "All" is selected, the "Constellation" diagram is displayed for all symbols.

Remote command:
[SENSe:]SYMBol:SELect on page 253

Fast Mode (Single Color)
If enabled, the constellation uses a single color for all modulations, which improves performance. However, individual Modulation types cannot be selected.

If disabled, different colors are used for different modulation types (see "Constellation" on page 21). Which Modulation types are displayed (depending on the selected Object) is configurable.

Remote command:
[SENSe:]SWEep:FMODE:STATe on page 252

Symbol Points Size
Defines the size of the individual symbol points in the Constellation diagram.

"1X1"	One symbol point is displayed by 1 pixel on the x-axis and 1 pixel on the y-axis
"2X2"	One symbol point is displayed by 2 pixels on the x-axis and 2 pixels on the y-axis
"3X3"	One symbol point is displayed by 3 pixels on the x-axis and 3 pixels on the y-axis

Remote command:
[SENSe:]SYMBol:SIZE on page 254

Display settings for carrier-based results

Access: "Overview" ≥ "Result Config" > "Display Settings"

or: [MEAS CONFIG] > "Result Config" > "Display Settings"

The following settings are available for carrier-based result displays, such as MER vs. Carrier.

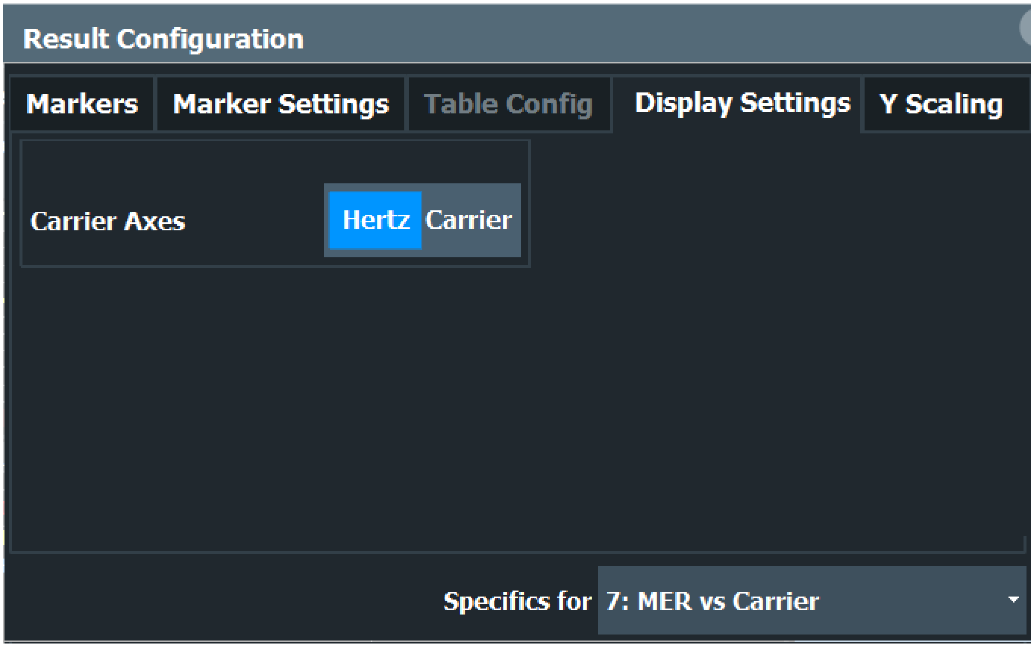


Figure 5-13: Result configuration settings for carrier-based results

Carrier Axes Unit

For result displays that evaluate a parameter per carrier (e.g. MER vs Carrier, Group Delay, or Spectrum Flatness), you can define whether the carrier number or the carrier frequency (in Hz) is displayed on the x-axis. Note, however, that this setting applies to *ALL* result displays based on carriers.

Remote command:
`UNIT:CAXes` on page 269

Display settings for bitstream results

Access: "Overview" ≥ "Result Config" > "Display Settings"

or: [MEAS CONFIG] > "Result Config" > "Display Settings"

The following settings are available for Bitstream result displays.

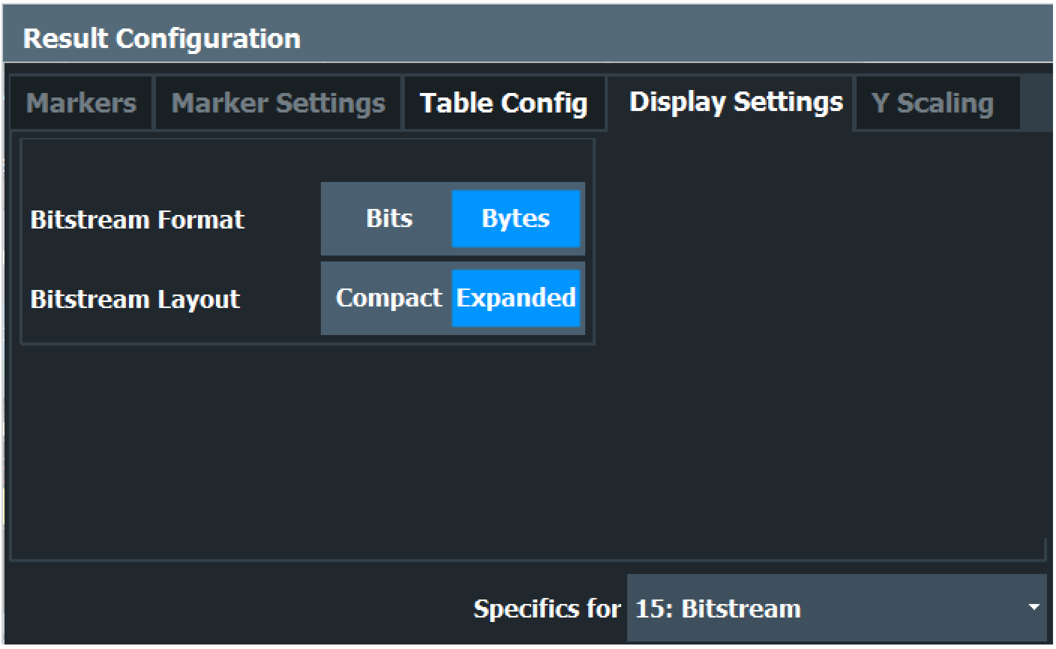


Figure 5-14: Result configuration settings for Bitstream results

Bitstream Format

Determines whether the data is displayed as bits or bytes (default) in a Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

Remote command:
`UNIT:BITStream` on page 268

Bitstream Layout

Determines whether a compact or expanded view of the bits is displayed in the Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

Remote command:
`DISPlay[:WINDow<n>]:BITStream:LAYout` on page 251

Display settings for result summary and signal content detailed tables

Access: "Overview" ≥ "Result Config" > "Display Settings"

or: [MEAS CONFIG] > "Result Config" > "Display Settings"

The following settings are available for "Result Summary" and Signal Content Detailed result displays.

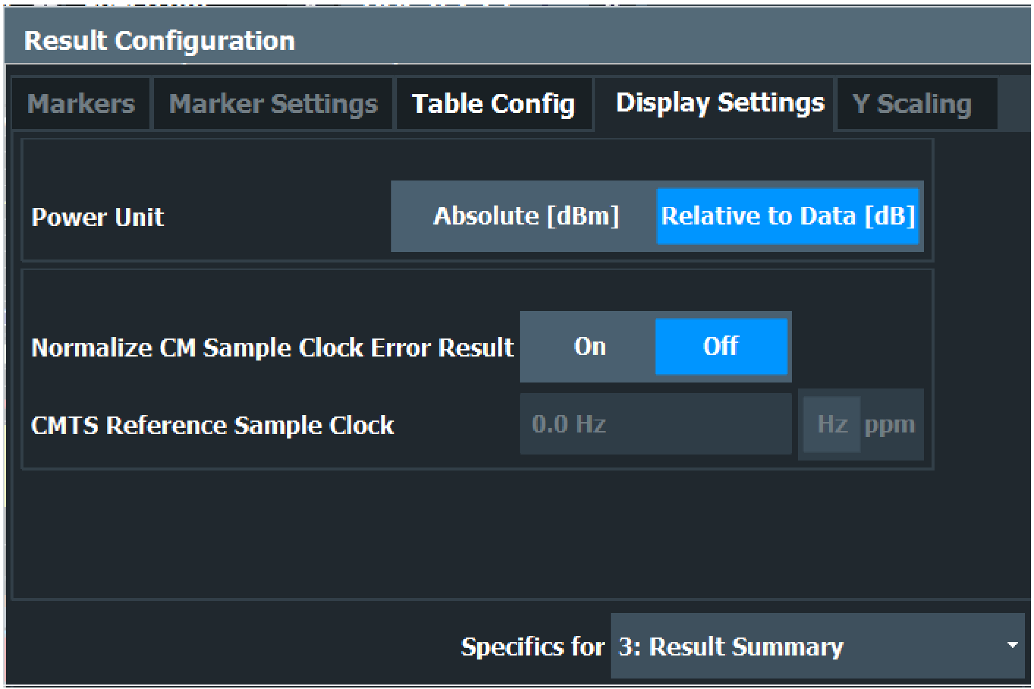


Figure 5-15: Result configuration settings for Upstream Result Summary results

Power Unit

Determines whether the power results in the "Result Summary" and Signal Content Detailed are calculated as absolute values or relative to the power measured in the data subcarriers.

For absolute values, the unit depends on the Unit setting in the amplitude settings.

Note that in the "Signal Content Detailed" table, all power values use the same unit (as defined here), whereas in the "Result Summary", the total power of the OFDM channel and the power measured in the 6-MHz channel containing the PLC are always provided as absolute values, regardless of the "Power Unit" setting.

Remote command:
`UNIT:POWer` on page 254

Normalize CM Sample Clock Error Result (upstream only)

If enabled, the sample clock error (`CERR`) of the cable modem is normalized with reference to the sample clock value of the CMTS.

You must provide the reference value of the CMTS (see CMTS Reference Sample Clock (Error) (upstream only)) using one of the following methods:

- Provide the actual sample clock value (in MHz) used by the CMTS.
  The sample clock error of the CM is then determined using this reference value, rather than the 102.4 MHz specified by the DOCSIS 3.1 standard.
- Provide the known error of the CMTS sample clock in ppm.
  CERR (CMTS) = <Actual_sample_clock_value> - 102.4 MHz
  In this case, the error of the CMTS sample clock is deducted from the determined error of the CM.
  $CERR\ (CM)_{norm} = CERR\ (CM) - CERR\ (CMTS)$

The "Result Summary" indicates "Sample Clock Error Normalized".

Note: Currently, if normalization is enabled, the center frequency error result is not available.

If disabled, the calculated sample clock error is determined with reference to the 102.4 MHz specified by the DOCSIS 3.1 standard.

Remote command:
`CONFigure:US:NORMalize:CM:CERRor:STATe` on page 249

CMTS Reference Sample Clock (Error) (upstream only)
Defines the reference value used to Normalize CM Sample Clock Error Result (upstream only), if enabled.

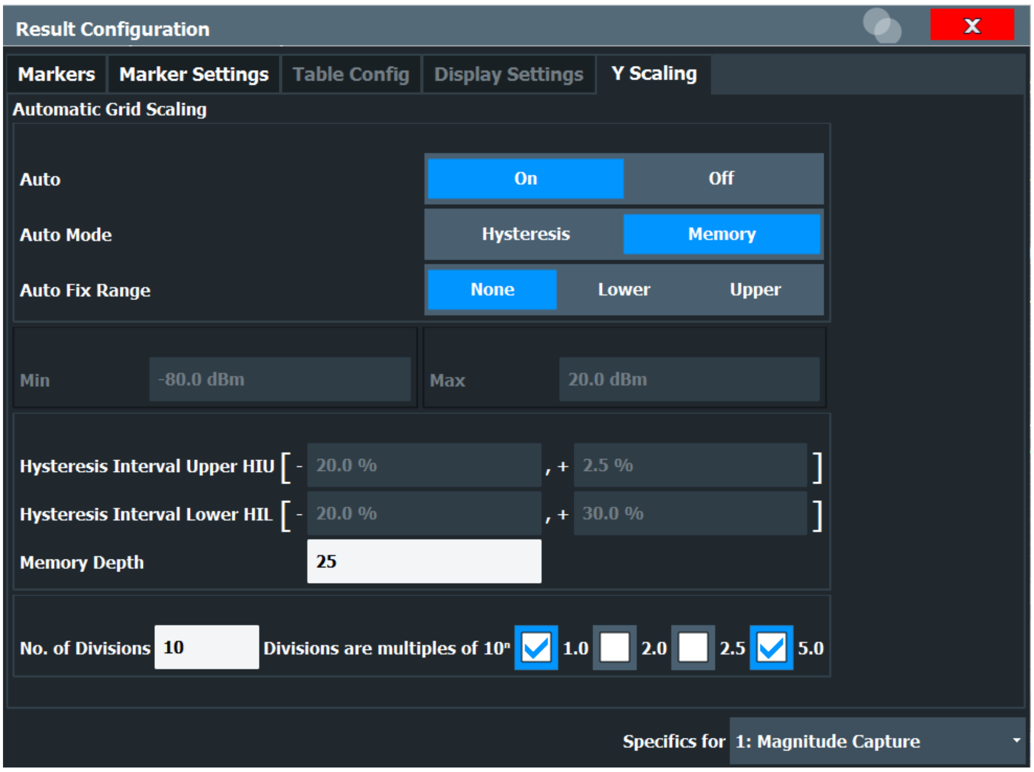
Remote command:
`CONFigure:US:NORMalize:CMTSref:SCLock` on page 250
`CONFigure:US:NORMalize:CMTSref:SCLock:UNIT` on page 250

5.3.11.3 Y-Scaling settings

Access: "Overview" ≥ "Result Config" > "Y Scaling"

or: [MEAS CONFIG] > "Result Config" > "Y Scaling"

The scaling for the vertical axis in (most) graphical displays is highly configurable, using either absolute or relative values. These settings are described here.



Automatic Grid Scaling

Activates or deactivates automatic scaling of the y-axis for the specified trace display. If enabled, the R&S FSW DOCSIS 3.1 application automatically scales the y-axis to best fit the measurement results.

If disabled, the y-axis is scaled according to the specified Minimum / Maximum and Number of Divisions.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO` on page 262

Auto Mode

Determines which algorithm is used to determine whether the y-axis requires automatic rescaling.

"Hysteresis" If the minimum and/or maximum values of the current measurement exceed a specific value range (hysteresis interval), the axis is rescaled. The hysteresis interval is defined as a percentage of the currently displayed value range on the y-axis. An upper hysteresis interval is defined for the maximum value, a lower hysteresis interval is defined for the minimum value.
(See Hysteresis Interval Upper/Lower)

"Memory" If the minimum or maximum values of the current measurement exceed the minimum or maximum of the <x> previous results, respectively, the axis is rescaled.
The minimum and maximum value of each measurement is added to the memory. After <x> measurements, the oldest results in the memory are overwritten by each new measurement.
The number <x> of results in the memory to be considered is configurable (see Memory Depth).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:MODE` on page 266

Auto Fix Range

This command defines the use of fixed value limits.

"None" Both the upper and lower limits are determined by automatic scaling of the y-axis.

"Lower" The lower limit is fixed (defined by the Minimum / Maximum settings), while the upper limit is determined by automatic scaling of the y-axis.

"Upper" The upper limit is fixed (defined by the Minimum / Maximum settings), while the lower limit is determined by automatic scaling of the y-axis.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:FIXed:RANGe`
on page 263

Hysteresis Interval Upper/Lower

For automatic scaling based on hysteresis, the hysteresis intervals are defined here. Depending on whether either of the limits are fixed or not (see Auto Fix Range), one or both limits are defined by a hysteresis value range.

The hysteresis range is defined as a percentage of the currently displayed value range on the y-axis.

Example:

The currently displayed value range on the y-axis is 0 to 100. The upper limit is fixed by a maximum of 100. The lower hysteresis range is defined as -10% to +10%. If the minimum value in the current measurement drops below -10 or exceeds +10, the y-axis will be rescaled automatically, for example to [-10..+100] or [+10..+100], respectively.

"Upper"[(HIU)] If the maximum value in the current measurement exceeds the specified range, the y-axis is rescaled automatically.

"Lower"[(HIL)] If the minimum value in the current measurement exceeds the specified range, the y-axis is rescaled automatically.

Remote command:
`DISPlay[:WINDow<N>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:LOWer:UPPer` on page 264
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:LOWer:LOWer` on page 264
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:UPPer:LOWer` on page 265
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:UPPer:UPPer` on page 265

Minimum / Maximum

Defines the minimum and maximum value to be displayed on the y-axis of the specified evaluation diagram.

For automatic scaling with a fixed range (see Auto Fix Range), the minimum defines the fixed lower limit, the maximum defines the fixed upper limit.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 267
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 268

Memory Depth

For automatic scaling based on memory (see "Auto Mode" on page 124), this value defines the number <x> of previous results to be considered when determining if rescaling is required.

The minimum and maximum value of each measurement are added to the memory. After <x> measurements, the oldest results in the memory are overwritten by each new measurement.

If the maximum value in the current measurement exceeds the maximum of the <x>previous results, and the upper limit is not fixed, the y-axis is rescaled.

If the minimum value in the current measurement drops below the minimum of the <x>previous results, and the lower limit is not fixed, the y-axis is rescaled.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:MEMory:DEPTh
on page 265

Number of Divisions

Defines the number of divisions to be used for the y-axis. By default, the y-axis is divided into 10 divisions.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:DIVisions on page 267

Scaling per division

Determines the values shown for each division on the y-axis.

One or more multiples of 10^n can be selected. The R&S FSW DOCSIS 3.1 application then selects the optimal scaling from the selected values.

Example:

- Multiples of "2.0" and **"2.5"** selected; division range = [-80..-130]; number of divisions: 10;
  Possible scaling (n=1):
  [-80;-85;-90;-95;-100;-105;-110;-115;-130;]
- Multiples of **"2.0"** selected; division range = [-80..-130]; number of divisions: 10;
  Possible scaling (n=1):
  [0;-20;-40;-60;-80;-100;-120;-140;-160;-180;]

"1.0" Each division on the y-axis displays multiples of $1*10^n$:
For example for n= -1; division range = [0..1]; number of divisions: 10;
[0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]

"2.0" Each division on the y-axis displays multiples of $2*10^n$:
For example for n= -1;division range = [0..1]; number of divisions: 5;
[0, 0.2, 0.4, 0.6, 0.8, 1.0]

"2.5" Each division on the y-axis displays multiples of $2.5*10^n$:
For example for n= -1; division range = [0..1]; number of divisions: 5;
[0, 0.25, 0.5, 0.75, 1.0]

"5.0" Each division on the y-axis displays multiples of $5*10^n$:
For example for n= -1; division range = [0..1]; number of divisions: 5,
[-0.5, 0, 0.5, 1.0, 1.5]

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision on page 268

5.3.11.4 Synchronous band power settings

For upstream transmission, the DOCSIS 3.1 standard requires a power measurement in specified bands adjacent to the signal channels. The R&S FSW DOCSIS 3.1 application provides such power results in the Synchronous Band Power table, together with the Power vs. Carrier result display. The power for configured bands is calculated synchronously with the modulation accuracy results in the default I/Q measurement, rather than in a separate sweep measurement.

The R&S FSW DOCSIS 3.1 application can determine the bands for the power measurement automatically as required by the standard, or it can apply a user-defined configuration. The bands for which the power is calculated are indicated by blue lines in the Power vs. Carrier result display, and are labeled according to the configuration.

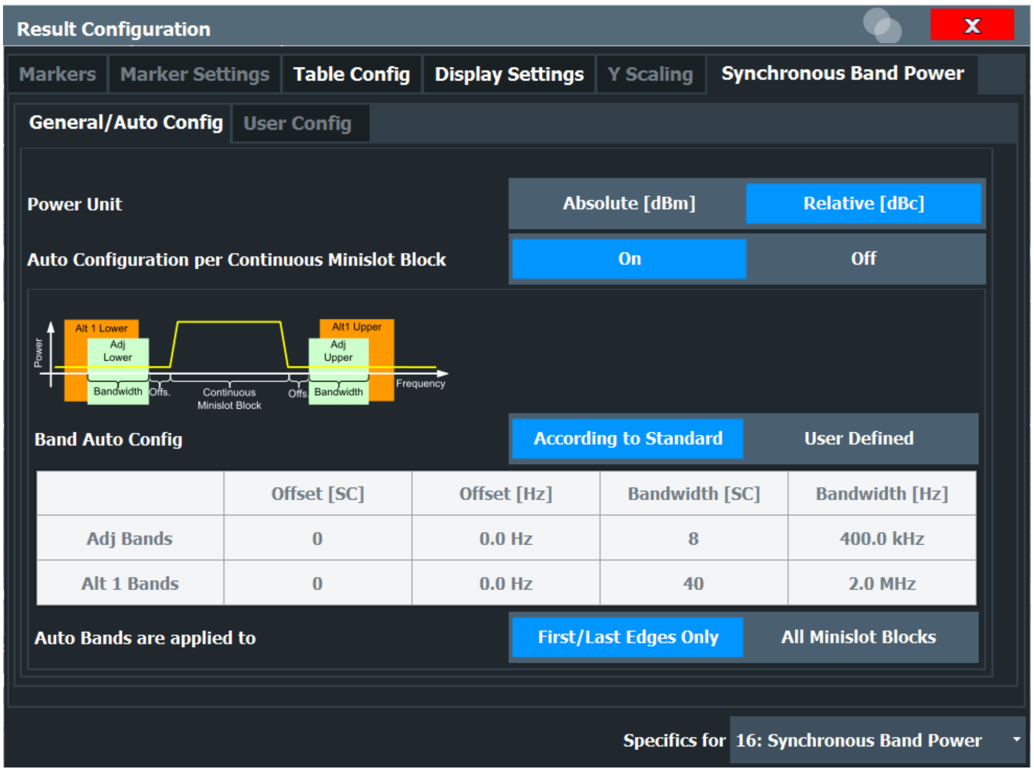
Capture oversampling required

To measure the power in bands adjacent to the transmission channel, additional data must be acquired to either side of the channel. Therefore, you must set the Sample Rate to 204.8 MHz (2-times oversampling) for this measurement.

Data from adjacent channels must be filtered out (see "Filter Out Adjacent Channels" on page 106).

General settings/ auto configuration

The R&S FSW DOCSIS 3.1 application can determine the bands for the power measurement automatically as required by the standard, or it can apply a user-defined configuration.



Power Unit

Defines whether power results are provided as absolute values (dBm) or relative to the carrier (dBc).

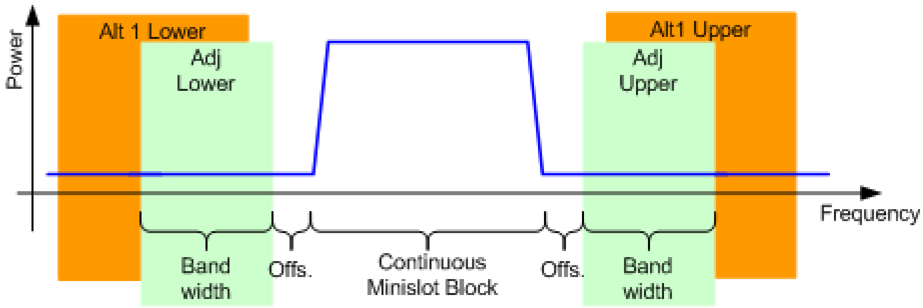
Remote command:

`CONFigure:US:CHANnel:SBPower:UNIT:POWer` on page 262

Auto Configuration per Continuous Minislot Block

Determines how the bands to be measured are configured - automatically by the R&S FSW DOCSIS 3.1 application, or manually by the user.

If enabled, the R&S FSW DOCSIS 3.1 application calculates the lower and upper band power for each continuous block of minislots (which is assumed to be the actual upstream transmission signal). Each block is detected by its rising and falling edges. It then applies an offset to each side of the block, and measures the power in a specific bandwidth from there. Up to 40 auto bands are calculated.



If disabled, you can define up to 20 independent frequency bands manually (see "User configuration" on page 130). For each band, the R&S FSW DOCSIS 3.1 application calculates the band power from the Power vs. Carrier trace.

Remote command:
`CONFigure:US:CHANnel:SBPower:CONFigure:AUTO[:STATe]` on page 255

Automatic band configuration
If Auto Configuration per Continuous Minislot Block is "ON", you can configure further settings for the band detection.

Band Auto Config ← Automatic band configuration
The bands for which the power is calculated can be detected strictly according to the DOCSIS 3.1 standard, or you can configure how bands are detected manually (see "Band Configuration Table" on page 129).

Remote command:
`CONFigure:US:CHANnel:SBPower:CONFigure` on page 255

Band Configuration Table ← Automatic band configuration
If you set Band Auto Config to "User-defined", you can configure how bands are detected manually.

You can define the offsets and bandwidths for the bands (in relation to the detected miniblock sets) as a number of subcarriers or a frequency range.

Remote command:
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:CHANnel<ch>:SCARrier` on page 258
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:CHANnel<ch>[:FREQuency]` on page 259
`CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:CHANnel<ch>:SCARrier` on page 256
`CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:CHANnel<ch>[:FREQuency]` on page 257

Auto Bands are applied to ← Automatic band configuration
Defines which bands the power is calculated for: all edges or only for the first and last edges.

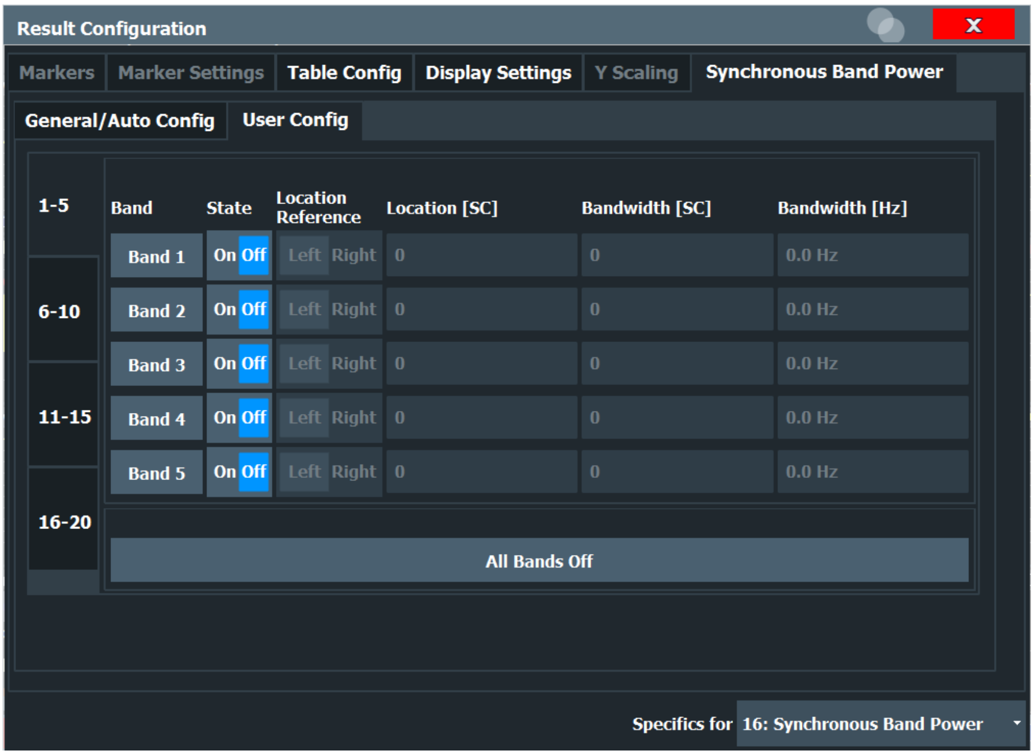
According to the DOCSIS 3.1 standard, only the power in the bands adjacent to the first and last edges of the transmission signal must be measured.

However, in some cases you may want additional results for bands adjacent to individual minislot blocks in the transmission channel.

Remote command:
`CONFigure:US:CHANnel:SBPower:CONFigure:AUTO:BANDs` on page 256

User configuration

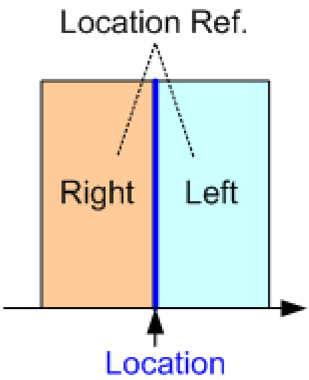
If Auto Configuration per Continuous Minislot Block is disabled, you can define up to 20 independent (fixed) frequency bands manually (see "User configuration" on page 130). For each band, the R&S FSW DOCSIS 3.1 application calculates the band power from the Power vs. Carrier trace.



State
Enables/disables the configured band for the Synchronous Band Power measurement.

Remote command:
`CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>[:STATe]`
on page 261

Location Reference
Defines whether the indicated "Location" is located on the left or on the right edge of the band to be measured.



Remote command:
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:LREFerence on page 260

Location [SC]
Defines the subcarrier at the specified edge of the power band to be measured

Remote command:
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:LOCation on page 260

Bandwidth [SC]
Defines the number of subcarriers in the power band to be measured

Remote command:
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:BWIDth:SCARrier on page 259

Bandwidth [Hz]
Defines the frequency range of the power band to be measured

Remote command:
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:BWIDth[:FREQuency] on page 260

All Bands Off
Disables all configured bands for the Synchronous Band Power measurement.

Remote command:
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>[:STATe] on page 261

5.3.12 Automatic settings

Access: [AUTO SET]

Some settings can be adjusted by the FSW automatically according to the current measurement settings and signal characteristics.

Setting the Reference Level Automatically (Auto Level)
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

Note that for sample rates larger than 160 MHz and active B1200 or B2001 bandwidth extension options, auto leveling is not available.

Remote command:
`[SENSe:]ADJust:LEVel` on page 238

Auto Set from PLC & Run (downstream only)
Performs an initial measurement in order to determine the required signal description settings automatically from the detected PLC before starting (or continuing) the actual Modulation Accuracy measurement.

This function is **only** available for **downstream** DOCSIS 3.1 signals.

The center frequency need not be defined beforehand; however, the PLC must be located inside the captured signal bandwidth.

Note that if auto detection is not possible, the initial measurement will continue endlessly while trying to synchronize to the input signal. In this case, abort the detection process by selecting Single Sweep / Run Single or Continuous Sweep / Run Cont, or Auto Set from PLC & Run (downstream only) again.

The following parameters are determined automatically:
- Center Frequency
- OFDM Spectrum Location
- N_{FFT} (FFT length)
- Cyclic Prefix CP
- Roll-off
- Time-Interleaving Depth
- PLC Start Index L
- Continuous Pilots
- Excluded Subcarriers
- Profile A (only)

Tip: The OFDM channel information detected in the PLC of the measured signal is displayed in the "PLC Messages (downstream only)" on page 27 result display.

Remote command:
`CONFigure:DS:PLC:AUTO` on page 238

Auto Detection & Run (upstream only)
Performs an initial measurement in order to determine the required signal description settings automatically from the detected signal characteristics before starting (or continuing) the actual Modulation Accuracy measurement.

This function is **only** available for **upstream** DOCSIS 3.1 signals.

Note: As opposed to the Auto Detection function in the "Demodulation" settings, the "Auto Detection & Run" function only performs an initial measurement to detect the required parameters *once*. For subsequent measurements, in particular if the input signal changes, you must activate this function again to adapt the parameters accordingly.

The following parameters are determined automatically:
- "N_{FFT} (FFT length)" on page 75
- "Cyclic Prefix CP" on page 75
- "Symbols Per Frame (K)" on page 77
- "Excluded subcarrier assignment" on page 77
- "Profile configuration (upstream)" on page 80

The Center Frequency and therefore OFDM Spectrum Location are corrected.

Remote command:
`CONFigure:US:AUTO` on page 239

5.4 Frequency sweep measurements

Access: [MODE] > "Docsis 3.1"

"Overview" > "Select Measurement"

When you activate a measurement channel in DOCSIS 3.1 mode, an I/Q measurement of the input signal is started automatically (see Chapter 3, "Measurements and result display", on page 14). However, some parameters specified in the DOCSIS 3.1 standard require a better signal-to-noise level or a smaller bandwidth filter than the default measurement on I/Q data provides and must be determined in separate measurements based on RF data (see Chapter 3.2, "Frequency sweep measurements", on page 34). In these measurements, demodulation is not performed.

The R&S FSW DOCSIS 3.1 application uses the functionality of the FSW base system (Spectrum application) to perform the DOCSIS 3.1 frequency sweep measurements. Some parameters are set automatically according to the DOCSIS 3.1 standard the first time a measurement is selected (since the last [PRESET] operation). These parameters can be changed, but are not reset automatically the next time you re-enter the measurement. Refer to the description of each measurement type for details.

The main measurement configuration menus for the DOCSIS 3.1 frequency sweep measurements are identical to the Spectrum application.

For details refer to "Measurements" in the FSW User Manual.

5.4.1 Occupied bandwidth

Access: "Overview" > "Select Measurement" > "OBW"

or: [MEAS] > "Select Measurement" > "OBW"

The "Occupied Bandwidth" measurement is performed as in the Spectrum application with default settings.

Table 5-2: Predefined settings for DOCSIS 3.1 OBW measurements

Setting	Default value
% Power Bandwidth	99 %
Channel bandwidth	3.84 MHz

The "Occupied Bandwidth" measurement determines the bandwidth that the signal occupies. The occupied bandwidth is defined as the bandwidth in which – in default settings - 99 % of the total signal power is to be found. The percentage of the signal power to be included in the bandwidth measurement can be changed.

For further details about the "Occupied Bandwidth" measurements refer to "Measuring the Occupied Bandwidth" in the FSW User Manual.

To restore adapted measurement parameters, the following parameters are saved on exiting and are restored on re-entering this measurement:

- Reference level and reference level offset
- RBW, VBW
- Sweep time
- Span

5.4.2 CCDF

Access: "Overview" > "Select Measurement" > "CCDF"

or: [MEAS] > "Select Measurement" > "CCDF"

The "CCDF" measurement determines the distribution of the signal amplitudes (complementary cumulative distribution function). The "CCDF" and the Crest factor are displayed. For the purposes of this measurement, a signal section of user-definable length is recorded continuously in zero span, and the distribution of the signal amplitudes is evaluated.

The measurement is useful to determine errors of linear amplifiers. The crest factor is defined as the ratio of the peak power and the mean power. The "Result Summary" displays the number of included samples, the mean and peak power and the crest factor.

The "CCDF" measurement is performed as in the Spectrum application with the following settings:

Table 5-3: Predefined settings for DOCSIS 3.1 CCDF measurements

Setting	Default value
"CCDF"	Active on trace 1
Analysis bandwidth	10 MHz
Number of samples	62500
Detector	Sample

For further details about the "CCDF" measurements refer to "Statistical Measurements" in the FSW User Manual.

To restore adapted measurement parameters, the following parameters are saved on exiting and are restored on re-entering this measurement:

- Reference level and reference level offset
- Analysis bandwidth
- Number of samples

6 Analysis

General result analysis settings concerning the trace and markers etc. are currently not available for the standard DOCSIS 3.1 measurements. Only one marker is available for these measurements.

Analysis of frequency sweep measurements

General result analysis settings concerning the trace, markers, lines etc. for RF measurements are identical to the analysis functions in the Spectrum application except for some special marker functions and spectrograms, which are not available in the DOCSIS 3.1 application.

For details see the "Common Analysis and Display Functions" chapter in the FSW User Manual.

The remote commands required to perform these tasks are described in Chapter 10.10, "Analysis", on page 303.

6.1 Traces

Access: [Trace] > "Trace Config"

For I/Q measurements in the R&S FSW DOCSIS 3.1 application, the displayed traces are not configurable. However, the traces can be exported to an ASCII file.

For RF measurements, see the FSW User Manual.

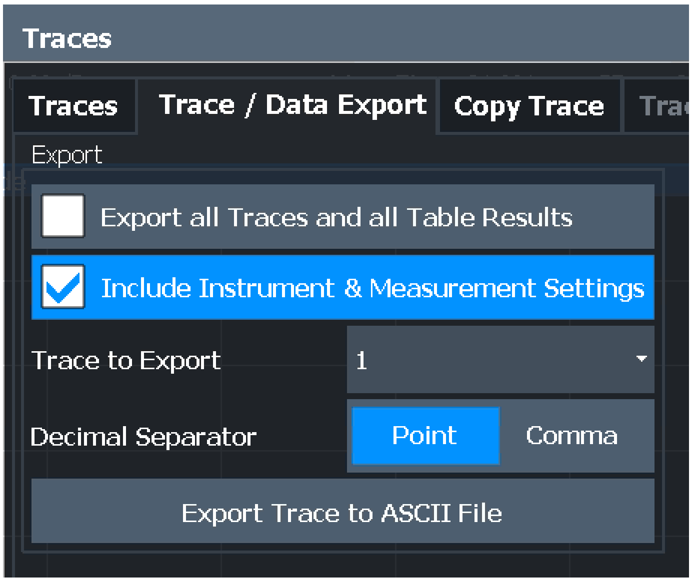
6.1.1 Trace / data export configuration

Access: "Save" > "Export" > "Export Configuration"

Or: [TRACE] > "Trace Config" > "Trace / Data Export"

The standard data management functions (e.g. saving or loading instrument settings) that are available for all FSW applications are not described here.

See the FSW base unit user manual for a description of the standard functions.



Export all Traces and all Table Results

Selects all displayed traces and result tables (e.g. "Result Summary", marker table etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:
`FORMat:DEXPort:TRACes` on page 309

Include Instrument & Measurement Settings

Includes additional instrument and measurement settings in the header of the export file for result data.

Remote command:
`FORMat:DEXPort:HEADer` on page 308

Trace to Export

Defines an individual trace to be exported to a file.

This setting is not available if Export all Traces and all Table Results is selected.

Decimal Separator

Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 308

Export Trace to ASCII File
Opens a file selection dialog box and saves the selected trace in ASCII format (`.dat`) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "memory limit reached" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 309

6.2 Markers

Access: "Overview" > "Result Configuration" > "Markers"

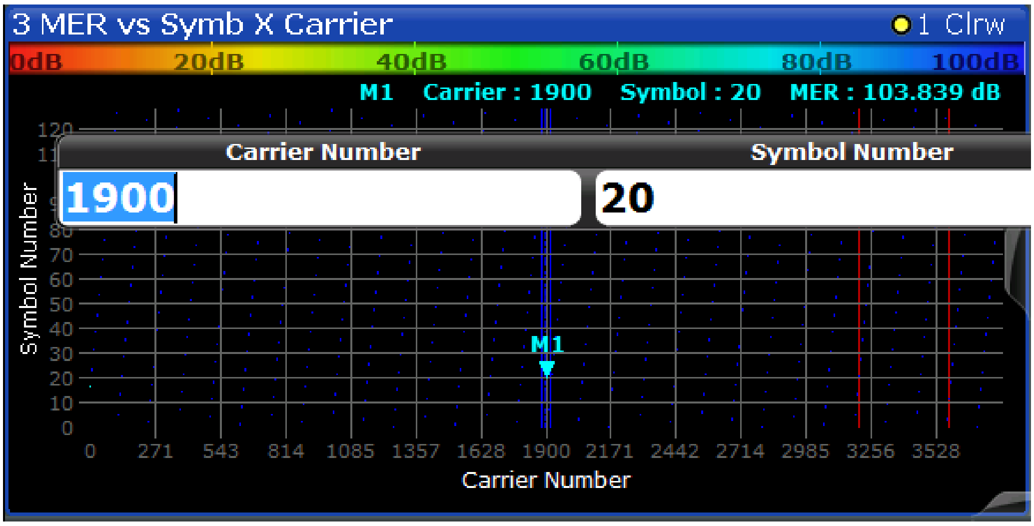
Or: [MKR]

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

Markers in 3-dimensional result displays

Common markers are defined by their value on the x-axis. In 3-dimensional result displays, where a parameter value is indicated by color for all carriers and symbols, the marker position must be defined by its value on the x-axis (carrier) and y-axis (symbol). The third dimension is the parameter value (MER or power).

In these result displays, only a single (normal) marker is available.



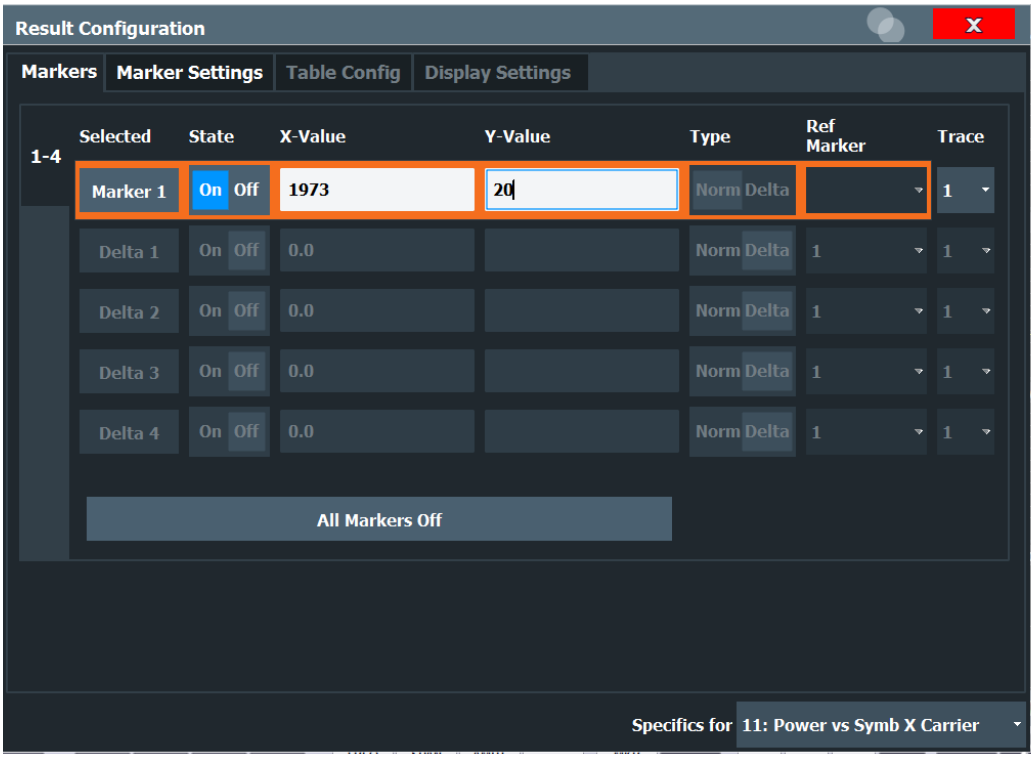
6.2.1 Individual marker settings

Access: "Overview" > "Result Configuration" > "Markers"

Or: [MKR] > "Marker Config"

In DOCSIS 3.1 evaluations, up to 4 markers can be activated in each diagram at any time.

In 3-dimensional result displays, only a single (normal) marker is available (see "Markers in 3-dimensional result displays" on page 139).



Selected Marker

Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State

Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 305
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 304

X-value

Defines the position of the marker on the x-axis (frequency, carrier, symbol, depending on evaluation).

Remote command:
`CALCulate<n>:DELTamarker<m>:X` on page 305
`CALCulate<n>:MARKer<m>:X` on page 294

Y-value

Defines the position of the marker on the y-axis (symbol) for 3-dimensional result displays (MER vs Symbol X Carrier, Power vs Symbol X Carrier).

Remote command:
`CALCulate<n>:MARKer<m>:Y` on page 306
`CALCulate<n>:MARKer<m>:Y?` on page 306

Marker Type

Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal"	A normal marker indicates the absolute value at the defined position in the diagram.
"Delta"	A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 305
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 304

Reference Marker

Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If the reference marker is deactivated, the delta marker referring to it is also deactivated.

Remote command:
`CALCulate<n>:DELTamarker<m>:MREFerence` on page 304

Assigning the Marker to a Trace

The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 306

All Markers Off

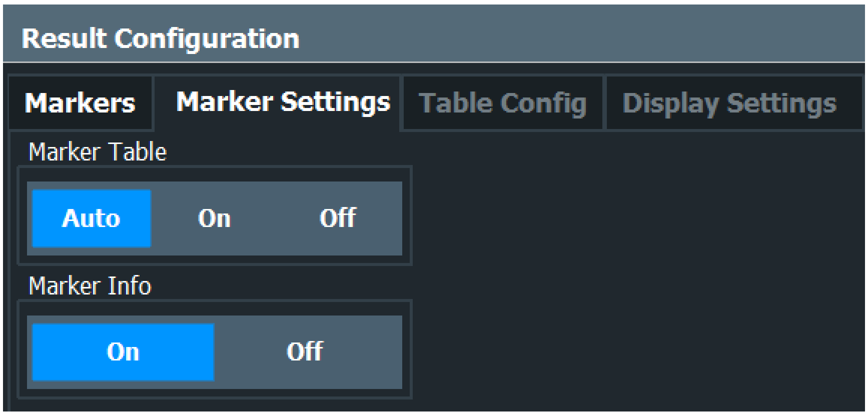
Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 305

6.2.2 General marker settings

Access: "Overview" > "Result Configuration" > "Marker Settings"

Or: [MKR] > "Marker Config" > "Marker Settings"



Marker Table Display
Defines how the marker information is displayed.

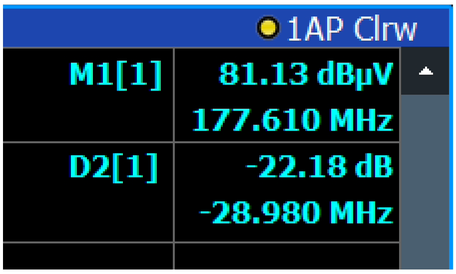
"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" No separate marker table is displayed.
If Marker Info is active, the marker information is displayed within the diagram area.

"Auto" (Default) If more than two markers are active, the marker table is displayed automatically.
If Marker Info is active, the marker information for up to two markers is displayed in the diagram area.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 308

Marker Info
Turns the marker information displayed in the diagram on and off.



Remote command:
`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 307

7 I/Q data import and export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the inphase (I) and the quadrature (Q) channel. Such signals are referred to as I/Q signals. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Importing and exporting I/Q signals is useful for various applications:

- Generating and saving I/Q signals in an RF or baseband signal generator or in external software tools to analyze them with the FSW later.
  The FSW supports various I/Q data formats for import.
  For details on formats, see the FSW I/Q Analyzer and I/Q Input user manual.
- Capturing and saving I/Q signals with the FSW to analyze them with the FSW or an external software tool later
  As opposed to storing trace data, which can be averaged or restricted to peak values, I/Q data is stored as it was captured, without further processing. Multi-channel data is not supported.
  The data is stored as complex values in 32-bit floating-point format.
  The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.
  For a detailed description, see the FSW I/Q Analyzer and I/Q Input User Manual.

For example, you can capture I/Q data using the I/Q Analyzer application, if available, and then analyze that data later using the R&S FSW DOCSIS 3.1 application.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

The import and export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar.

See the FSW I/Q Analyzer and I/Q Input User Manual.

8 How to perform measurements in the R&S FSW DOCSIS 3.1 application

The following step-by-step instructions demonstrate how to perform a measurement with the R&S FSW DOCSIS 3.1 application. The following tasks are described:

8.1 How to analyze modulation accuracy and signal contents for DOCSIS 3.1 downstream signals

1. Press [MODE].

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

2. Select the "DOCSIS 3.1" item.

   The FSW opens a new measurement channel for the DOCSIS 3.1 application.

3. Select "Overview" to display the "Overview" for a DOCSIS 3.1 measurement.

4. Select "Signal Description" to describe the expected input signal.

5. In the "OFDM Channel Description" tab, define the general OFDM channel transmission settings, including:

   - Stream direction (*Downstream*)
   - the OFDM spectrum location
   - the PLC location
   - the NCP modulation
   - the FFT length

6. Select "Continuous Pilots, Excluded Subcarriers Configuration...".
   (Note: continuous pilots can also be detected automatically, see step 16.)
   For each set of continuous pilots and excluded subcarriers:

   a) Insert a new line.
   b) Assign the subcarriers either by entering a discrete set of numbers or by defining a series with a fixed start, stop and increment value.

c) Select "OK" and close the "Continuous Pilots, Excluded Subcarriers Configuration..." dialog box.

7. In the "Signal Description" dialog box, select the "Profile Configuration" tab.
8. For each set of modems with similar transmission conditions, configure a profile that defines the modulation to be used by which subcarrier.
   a) Select a profile from the list and then "Edit profile".
   b) Insert a new line.
   c) Select the subcarriers either by entering a discrete set of numbers or by defining a series with a fixed start, stop and increment value.
   d) Select the modulation these subcarriers use for transmission.
   e) Select "OK" and close the "Profile: Modulation Subcarrier Assignment" dialog box.
9. In the "Signal Description" dialog box, select the "Codeword Configuration" tab.
10. Select "Frame Configuration".
11. To let the R&S FSW DOCSIS 3.1 application determine the frame configuration automatically from the input signal, set "NCP Content" to "Auto from Signal" and skip the next step.
    To configure the frames manually, set "NCP Content" to "User-Defined" and continue with the next step.
12. For each codeword in the signal, that is: the useful data transmitted to the same group of cable modems:
    a) Insert a new line.
    b) Assign a profile (which must have been configured, see step 8).
    c) Define either the first and total number of *subcarriers* the codeword is assigned to, or the first and total number of *symbols* it is assigned to.
    d) Select "OK" and close the "Frame Configuration" dialog box.
13. Select "Input/Frontend" and then the "Frequency" tab to define the input signal's center frequency.
14. Select "Signal Capture" to define how much and which data to capture from the input signal.
15. Select "Estimation/Tracking" to define how the data channels are to be estimated and which distortions will be compensated for.
16. Select "Demodulation" to activate automatic detection of continuous pilots and frames and to decode codewords during demodulation.
17. Select "Evaluation Range" to configure a specific number of frames as the basis for statistical evaluation in the "Result Summary".
    Enable the "Frame Statistic Count" option and enter the "Number of Frames to Analyze".
18. Select "Display Config" and select the displays that are of interest to you (up to 16).
    Arrange them on the display to suit your preferences.

19. Exit the SmartGrid mode.
20. Start a new sweep with the defined settings.
    - To perform a single sweep measurement, press [RUN SINGLE].
    - To perform a continuous sweep measurement, press [RUN CONT].

    Measurement results are updated once the measurement has completed.
21. To restrict the number of numeric results displayed in the "Result Summary" or "Signal Content Detailed" tables, select the result display, then select "Result Config". In the "Table Config" tab, deactivate the information you want to hide in the tables.
22. To restrict constellation results to specific subcarriers or symbols, select the "Constellation" result display, then "Result Config". In the "Display Settings" tab, define which data you want to analyze.
23. To scroll through the results for individual frames in graphical results, select "Evaluation Range" and change the Selected Frame number .
24. To configure the y-axis scaling for graphical results, select the result display, then select "Result Config".

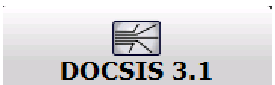
    In the "Y Scaling" tab, do one of the following:
    - Set "Auto" to "Off", then configure the "Min" and "Max" values for the y-axis range.
    - Set the "Auto Mode" to "Memory" and select the number of results to consider for rescaling ("Memory Depth").
    - Set the "Auto Mode" to "Hysteresis" and define the percentage of the currently displayed value range to be used as "Hysteresis Intervals" for rescaling.

    Optionally, for automatic scaling, define a fixed upper or lower limit for the y-axis scale ("Auto Fix Range").
25. Press [Sweep], then select "Refresh" to update the result displays for the new settings without performing a new measurement.

8.2 How to analyze modulation accuracy and signal contents for DOCSIS 3.1 upstream signals

1. Press [MODE].

   A dialog box opens that contains all operating modes and applications currently available on your FSW.
2. Select the "DOCSIS 3.1" item.

The FSW opens a new measurement channel for the DOCSIS 3.1 application.

3. Select "Overview" to display the "Overview" for a DOCSIS 3.1 measurement.
4. Select "Signal Description" to describe the expected input signal.
5. In the "OFDM Channel Description" tab, define the general OFDM channel transmission settings, including:
   - Stream direction (*Upstream*)
   - OFDM spectrum location
   - FFT length
   - Cyclic prefix
   - Roll-off
   - Number of symbols per frame
6. Select "Excluded Subcarriers Configuration...".
   For each set of excluded subcarriers:
   a) Insert a new line.
   b) Assign the subcarriers either by entering a discrete set of numbers or by defining a series with a fixed start, stop and increment value.
   c) Select "OK" and close the "Excluded Subcarriers Configuration..." dialog box.
7. In the "Signal Description" dialog box, select the "Profile Configuration" tab.
8. Configure the transmission profile that defines the modulation and pilot pattern to be used by which minislot(s).
   a) Insert a new line.
   b) Select the number of minislots that use the same transmission configuration.
   c) Define the modulation and pilot pattern these minislots use for transmission.
   d) Select "OK" and close the "Profile Configuration" dialog box.
9. Select "Input/Frontend" and then the "Frequency" tab to define the input signal's center frequency.
10. Select "Signal Capture" to define how much and which data to capture from the input signal.
11. Select "Estimation/Tracking" to define which distortions will be compensated for.
12. Select "Evaluation Range" to configure a specific number of frames as the basis for statistical evaluation in the "Result Summary".
    Enable the "Frame Statistic Count" option and enter the "Number of Frames to Analyze".
13. Select "Display Config" and select the displays that are of interest to you (up to 16).
    Arrange them on the display to suit your preferences.
14. Exit the SmartGrid mode.
15. Start a new sweep with the defined settings.
    - To perform a single sweep measurement, press [RUN SINGLE].
    - To perform a continuous sweep measurement, press [RUN CONT].

Measurement results are updated once the measurement has completed.

16. To restrict the number of numeric results displayed in the "Result Summary" table, select the result display, then select "Result Config". In the "Table Config" tab, deactivate the information you want to hide in the tables.
17. To restrict constellation results to specific subcarriers or symbols, select the "Constellation" result display, then "Result Config". In the "Display Settings"tab, define which data you want to analyze.
18. To scroll through the results for individual frames in graphical results, select "Evaluation Range" and change the Selected Frame number .
19. To configure the y-axis scaling for graphical results, select the result display, then select "Result Config".

    In the "Y Scaling" tab, do one of the following:
    - Set "Auto" to "Off", then configure the "Min" and "Max" values for the y-axis range.
    - Set the "Auto Mode" to "Memory" and select the number of results to consider for rescaling ("Memory Depth").
    - Set the "Auto Mode" to "Hysteresis" and define the percentage of the currently displayed value range to be used as "Hysteresis Intervals" for rescaling.

    Optionally, for automatic scaling, define a fixed upper or lower limit for the y-axis scale ("Auto Fix Range").
20. Press [Sweep], then select "Refresh" to update the result displays for the new settings without performing a new measurement.

8.3 How to evaluate the OBW or CCDF for DOCSIS 3.1 signals

1. Press [MODE] and select the "DOCSIS 3.1" application.

   The FSW opens a new measurement channel for the DOCSIS 3.1 application. I/Q data acquisition is performed by default.
2. Select "Signal Description" to describe the expected input signal.
3. Select the required measurement:
   a) Press [MEAS].
   b) In the "Select Measurement" dialog box, select the required measurement.

   The selected measurement is activated with the default settings for DOCSIS 3.1 immediately.
4. If necessary, adapt the settings as described for the individual measurements in the FSW User Manual.

9 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

Error Messages

Requires R&S®FSW-B320/B512/B1200/B2001
Both R&S FSW DOCSIS 3.1 applications require the bandwidth extension hardware FSW-B320+ (11325.4867.04), or a larger (internal) bandwidth option.

The options do not work with the optional 2 GHz bandwidth extension (FSW-B2000).

If the required options are not installed, an error message is displayed and no measurements can be performed with the R&S FSW DOCSIS 3.1 applications.

10 Remote commands for DOCSIS 3.1 measurements

The following commands are required to perform measurements in the R&S FSW DOCSIS 3.1 application in a remote environment.

It is assumed that the FSW has already been set up for remote control in a network as described in the FSW User Manual.

Note that basic tasks that are independent of the application are not described here. For a description of such tasks, see the FSW User Manual.

In particular, this includes:

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

After an introduction to SCPI commands, the following tasks specific to the R&S FSW DOCSIS 3.1 application are described here:

10.1 Common suffixes

In the R&S FSW DOCSIS 3.1 application, the following common suffixes are used in remote commands:

Table 10-1: Common suffixes used in remote commands in the R&S FSW DOCSIS 3.1 application

Suffix	Value range	Description
<m>	1 to 4 (RF: 1 to 16)	Marker
<n>	1 to 16	Window (**in the currently selected channel**)

Suffix	Value range	Description
<t>	1 (RF: 1 to 6)	Trace
	1 to 8	Limit line

10.2 Introduction

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

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

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

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

Remote command examples

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

10.2.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

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

Commands that are taken from the SCPI standard are indicated as "SCPI confirmed". All commands used by the FSW follow the SCPI syntax rules.

- *Asynchronous commands*
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an "Asynchronous command".
- *Reset values (*RST)*
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as "*RST" values, if available.
- *Default unit*
  The default unit is used for numeric values if no other unit is provided with the parameter.
- *Manual operation*
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

10.2.2 Long and short form

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

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

Example:

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

10.2.3 Numeric suffixes

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

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

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

Example:

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

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

10.2.4 Optional keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

10.2.5 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`.

10.2.6 SCPI parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters can have different forms of values.

10.2.6.1 Numeric values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

Sometimes, numeric values are returned as text.

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

10.2.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

10.2.6.3 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 10.2.2, "Long and short form", on page 152.

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`

10.2.6.4 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'`

10.2.6.5 Block data

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

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

10.3 Activating DOCSIS 3.1 measurements

DOCSIS 3.1 measurements require a special application on the FSW (R&S FSW-K192). The measurement is started immediately with the default settings.

Bandwidth extension option required

Both R&S FSW DOCSIS 3.1 applications require bandwidth extension hardware. See "Specific bandwidth extension option required" on page 10.

If the required options are not installed, or non-supported bandwidth extension options are active, an error message is displayed and no measurements can be performed with the R&S FSW DOCSIS 3.1 applications.

These are basic FSW commands, listed here for your convenience.

INSTrument:CREate:DUPLicate

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

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

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

Usage: Event

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

Adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 157.

<ChannelName> String containing the name of the channel.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

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

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

Replaces a channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 157.

<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 157).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

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

Usage: Setting only

INSTrument:DELete <ChannelName>

Deletes a channel.

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

Setting parameters:

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

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

Usage: Setting only

INSTrument:LIST?

Queries all active channels. The query is useful to obtain the names of the existing channels, which are required to replace or delete the channels.

Return values:

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

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

Usage: Query only

Table 10-2: Available channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> parameter	Default Channel name*)
Spectrum	SANALYZER	Spectrum
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
802.11ad (R&S FSW-K95)	WIGIG	802.11ad
802.11ay (R&S FSW-K97)	EDMG	802.11ay EDMG
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
AM/FM/PM Modulation Analysis (R&S FSW-K7)	ADEM	Analog Demod
Avionics (R&S FSW-K15)	AVIonics	Avionics
Bluetooth (R&S FSW-K8)	BTO	Bluetooth
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
DOCSIS 3.1 (R&S FSW-K192/193)	DOCSis	DOCSIS 3.1
Fast Spur Search (R&S FSW-K50)	SPUR	Spurious
GSM (R&S FSW-K10)	GSM	GSM
HRP UWB (R&S FSW-K149)	UWB	HRP UWB
I/Q Analyzer	IQ	IQ Analyzer
LTE (R&S FSW-K10x)	LTE	LTE
Multi-Carrier "Group Delay" (R&S FSW-K17)	MCGD	MC "Group Delay"
NB-IoT (R&S FSW-K106)	NIOT	NB-IoT
Noise (R&S FSW-K30)	NOISE	Noise

*) If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.

Application	<ChannelType> parameter	Default Channel name*)
5G NR (R&S FSW-K144)	NR5G	5G NR
OFDM VSA (R&S FSW-K96)	OFDMVSA	OFDM VSA
OneWeb (R&S FSW-K201)	OWEB	OneWeb
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Pulse (R&S FSW-K6)	PULSE	Pulse
"Real-Time Spectrum"	RTIM	"Real-Time Spectrum"
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
Transient Analysis (R&S FSW-K60)	TA	Transient Analysis
Verizon 5GTF Measurement Application (V5GTF, R&S FSW-K118)	V5GT	V5GT
VSA (R&S FSW-K70)	DDEM	VSA
WLAN (R&S FSW-K91)	WLAN	WLAN
*) If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

Renames a channel.

Setting parameters:

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

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

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

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

See also `INSTrument:CREate[:NEW]` on page 156.

For a list of available channel types see INSTrument:LIST? on page 157.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see INSTrument:LIST? on page 157.

DOCSis
DOCSIS 3.1 option, FSW–K192

<ChannelName> String containing the name of the channel.

Example: `INST DOCS`
Activates a measurement channel for the R&S FSW DOCSIS 3.1 application.
`INST 'DOCSIS'`
Selects the measurement channel named 'DOCSIS' (for example before executing further commands for that channel).

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual operation: See "Preset Channel" on page 56

10.4 Selecting a measurement

The following commands are required to define the measurement type in a remote environment. The selected measurement must be started explicitely (see Chapter 10.8, "Starting a measurement", on page 269)!

For details on available measurements see Chapter 3, "Measurements and result display", on page 14.

The DOCSIS 3.1 I/Q measurement captures the I/Q data from the DOCSIS 3.1 signal using a (nearly rectangular) filter with a relatively large bandwidth. This measurement is selected when the DOCSIS 3.1 measurement channel is activated. The commands to select a different measurement or return to the DOCSIS 3.1 I/Q measurement are described here.

Use the `LAYout` commands to change the display (see Chapter 10.7, "Configuring the result display", on page 239).

CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect <PowerSelect>

This command selects the occupied bandwidth measurement and turns the measurement on.

Suffix:

<n>	1..n
<m>	1..n irrelevant

Parameters:

<PowerSelect>	**OBANdwidth | OBWidth** Occupied bandwidth measurement.

Example: For a detailed example see Chapter 10.13.2, "Measurement 2: determining the occupied bandwidth", on page 318

Manual operation: See "Occupied Bandwidth" on page 35

CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] <PowerState>

This command turns a power measurement off. To switch on the power measurement again, use `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 161.

A standard DOCSIS 3.1 I/Q (Modulation Accuracy) measurement is activated.

Suffix:

<n>	irrelevant
<m>	irrelevant

Setting parameters:

<PowerState>	OFF

Usage: Setting only

CALCulate<n>:STATistics:CCDF[:STATe] <State>

Turns the "CCDF" on and off.

If the "CCDF" measurement is deactivated, a standard DOCSIS 3.1 I/Q (Modulation Accuracy) measurement is activated.

Suffix:
<n> irrelevant

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

Example: `CALC:STAT:CCDF ON`
Switches on the "CCDF" measurement.

Manual operation: See "CCDF" on page 36

10.5 Configuring the DOCSIS 3.1 I/Q measurement (modulation accuracy)

The following commands are required to configure the DOCSIS 3.1 I/Q measurement described in Chapter 3.1, "DOCSIS 3.1 I/Q measurement", on page 14.

10.5.1 Signal description

The signal description provides information on the expected input signal.

10.5.1.1 OFDM downstream channel description

CONFigure:CHANNel:CP <CyclicPrefix> (downstream)

Defines the cyclic prefix, which determines where the useful data starts and allows the application to detect delay spreads during transmission. The longer the delay spread, the longer the CP must be.

This command describes the parameters for downstream signals. For upstream signals see `CONFigure:CHANNel:CP` on page 168.

Parameters:

<CyclicPrefix>

AUTO
The length is determined automatically by the R&S FSW DOCSIS 3.1 application and indicated in the dialog box after the next measurement.

S192
Useful symbol period starts after 192 samples or 0.9375µs.

S256
Useful symbol period starts after 256 samples or 1.25µs.

S512
Useful symbol period starts after 512 samples or 2.5µs.

S768
Useful symbol period starts after 768 samples or 3.75µs.

S1024
Useful symbol period starts after 1024 samples or 5.0µs.

*RST: AUTO

Example: `CONF:CHAN:CP S192`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Mode: downstream

Manual operation: See "Cyclic Prefix CP" on page 59

CONFigure:CHANNel:NFFT <NFFTsubcarriers>

Defines the length of the FFT duration, which corresponds to the number of phsyical subcarriers.

Parameters:

<NFFTsubcarriers> FFT2k | FFT4k | FFT8k

FFT2k
Upstream only:
2048 subcarriers at = 50 kHz spacing; FFT length = 2048 samples

FFT4k
Downstream: 4096 subcarriers at = 50 kHz spacing; FFT length = 4096 samples
Upstream: 4096 subcarriers at = 25 kHz spacing; FFT length = 4096 samples

FFT8k
Downstream only:
8192 subcarriers at 25 kHz spacing; FFT length = 8192 samples

*RST: FFT4K

Example: `CONF:CHAN:NFFT FFT8k`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "N_{FFT} (FFT length)" on page 59
See "N_{FFT} (FFT length)" on page 75

CONFigure:CHANnel:ROFF <RollOff>

Defines the roll-off period for the Tukey raised-cosine window which is applied at the beginning (and end) of an OFDM symbol.

The required period depends on the channel bandwidth and the number of excluded carriers within the channel. The larger the roll-off period, the more time transmission takes; however, the more useful subcarriers are available in the frequency domain.

This command describes the parameters for downstream signals. For upstream signals see `CONFigure:CHANnel:ROFF` on page 168.

Parameters:

<RollOff> AMRO | S0 | S32 | S64 | S96 | S128 | S160 | S192 | S224 | S256

AMRO
The maximum possible roll-off period is used automatically.

S0
No samples in the roll-off period (for no transmit windowing)

S64
The roll-off period contains 64 samples and lasts 0.3125 µs.

S128
The roll-off period contains 128 samples and lasts 0.625 µs.

S192
The roll-off period contains 192 samples and lasts 0.9375 µs.

S256
The roll-off period contains 256 samples and lasts 1.25 µs.

*RST: AMRO

Example: `CONF:CHAN:ROFF S64`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Roll-off" on page 60
See "Roll-off" on page 76

CONFigure:DS:CHANnel:NCP:MODulation <NCPModulation>

Defines the modulation used by the Next Codeword Pointer (NCP).

Parameters:
<NCPModulation> QPSK | QAM16 | QAM64
*RST: QAM16

Example: `CONF:DS:CHAN:NCP:MOD QAM16`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "NCP Modulation" on page 61

CONFigure:DS:CHANnel:PLC:CARRiers?

Queries the number of subcarriers used by the PLC. The number of subcarriers depends on the FFT length setting (see `CONFigure:CHANnel:NFFT` on page 163).

Example: `CONF:DS:CHAN:PLC:CARR?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "PLC Number of Subcarriers (N_p)" on page 61

CONFigure:DS:CHANnel:PLC:INDex <PlcIndex>

Defines the start index of the physical link channel (PLC) if automatic detection is disabled (see `CONFigure:DS:CHANnel:PLC:INDex:AUTO` on page 166).

Setting parameters:
<PlcIndex> *RST: -1

Example: `CONF:DS:CHAN:PLC:IND 200`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "PLC Start Index L" on page 61

CONFigure:DS:CHANnel:PLC:INDex:AUTO <PLCAuto>

Determines how the start index of the physical link channel (PLC) is detected.

Parameters:

<PLCAuto> ON | OFF | 0 | 1

OFF | 0
The numeric value defined by CONFigure:DS:CHANnel:PLC:INDex is used.

ON | 1
The start index of the physical link channel (PLC) is detected automatically.

*RST: 0

Example: `CONF:DS:CHAN:PLC:IND:AUTO ON`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "PLC Start Index L" on page 61

CONFigure:DS:CHANnel:PLC:MODulation?

Queries the currently used PLC modulation.

Return values:

<ModType> <char_data>

Example: `CONF:DS:CHAN:PLC:MOD?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "PLC Modulation" on page 61

CONFigure:DS:CHANnel:SPECtrum:FREQuency <StartFreq>

Specifies the center frequency in Hz of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum.

The default value is derived from the current center frequency. If the spectrum location is changed, the center frequency is adapted accordingly (see [SENSe:]FREQuency:CENTer on page 212).

Parameters:

<StartFreq> numeric value

Default unit: Hz

Example: `CONF:DS:CHAN:SPEC:FREQ 1285000`

Manual operation: See "OFDM Spectrum Location" on page 59

CONFigure:DS:CHANnel:TIDepth <TimeInterDepth>

Defines the maximum number of delay lines used for time interleaving. The required depth depends on the symbol duration, that is the subcarrier spacing.

Setting parameters:

<TimeInterDepth> integer

Range: 1 to 16 (for NFFT = 8K mode); 32 (for NFFT = 4K mode)

*RST: 16 (NFFT = 4K mode)

Example: `CONF:DS:CHAN:TID 16`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Time-Interleaving Depth" on page 60

CONFigure:SDIRection <StreamDirection>

Defines the direction of the signal stream to be analyzed. Various configuration parameters for the DOCSIS 3.1 measurement depend on the stream direction.

Parameters:

<StreamDirection> US | DS

DS
Downstream signal (from the base station to the cable modems).
Requires FSW-K192 option.

US
Upstream signal (from the cable modems to the base station).
Requires FSW-K193 option.

*RST: DS

Manual operation: See "Stream Direction" on page 58

10.5.1.2 OFDM upstream channel description

Useful commands for upstream channels described elsewhere:

- `CONFigure:SDIRection` on page 167
- `CONFigure:CHANnel:NFFT` on page 163

Remote commands exclusive to upstream channels

CONFigure:CHANnel:CP <CyclicPrefix> (upstream)

Defines the cyclic prefix, which determines where the useful data starts and allows the application to detect delay spreads during transmission. The longer the delay spread, the longer the CP must be.

This command describes the parameters for upstream signals. For downstream signals see CONFigure:CHANnel:CP on page 163.

Parameters:

<CyclicPrefix>

AUTO
The length is determined automatically by the R&S FSW DOCSIS 3.1 application and indicated in the dialog box after the next measurement.

S96
Useful symbol period starts after 96 samples or 0.9375 µs.

S128
Useful symbol period starts after 128 samples or 1.25 µs.

S160
Useful symbol period starts after 160 samples or 1.5625 µs.

S192
Useful symbol period starts after 192 samples or 1.875 µs.

S224
Useful symbol period starts after 224 samples or 2.1875 µs.

S256
Useful symbol period starts after 256 samples or 2.5µs.

S288
Useful symbol period starts after 288 samples or 2.8125 µs.

S320
Useful symbol period starts after 320 samples or 3.125 µs.

S384
Useful symbol period starts after 384 samples or 3.75 µs.

S512
Useful symbol period starts after 512 samples or 5.0µs.

S640
Useful symbol period starts after 640 samples or 6.25 µs.

*RST: AUTO

Example: `CONF:CHAN:CP S192`

Mode: upstream

Manual operation: See "Cyclic Prefix CP" on page 75

CONFigure:CHANnel:ROFF <RollOff> (upstream)

Defines the roll-off period for the Tukey raised-cosine window which is applied at the beginning (and end) of an OFDM symbol.

The required period depends on the channel bandwidth and the number of excluded carriers within the channel. The larger the roll-off period, the more time transmission takes; however, the more useful subcarriers are available in the frequency domain.

This command describes the parameters for upstream signals. For downstream signals see CONFigure:CHANnel:ROFF on page 164.

Parameters:

<RollOff>

AMRO
The maximum possible roll-off period is used automatically.

S0
No samples in the roll-off period (for no transmit windowing)

S32
The roll-off period contains 32 samples and lasts 0.3125 µs.

S64
The roll-off period contains 64 samples and lasts 0.625 µs.

S96
The roll-off period contains 96 samples and lasts 0.9375 µs.

S128
The roll-off period contains 128 samples and lasts 1.25 µs.

S160
The roll-off period contains 160 samples and lasts 1.5625 µs.

S192
The roll-off period contains 192 samples and lasts 1.875 µs.

S224
The roll-off period contains 224 samples and lasts 2.1875 µs.

*RST: AMRO

Example: `CONF:CHAN:ROFF S64`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

CONFigure:US:CHANnel:SPECtrum:FREQuency <StartFreq>

Specifies the center frequency in Hz of the subcarrier 0 of the OFDM channel (f_{sc0}), which defines the beginning of the OFDM spectrum.

The default value is derived from the current center frequency. If the spectrum location is changed, the center frequency is adapted accordingly (see [SENSe:]FREQuency:CENTer on page 212).

Parameters:

<StartFreq> numeric value
Default unit: Hz

Example: `CONF:US:CHAN:SPEC:FREQ 1285000`

Manual operation: See "OFDM Spectrum Location" on page 75

CONFigure:US:CHANnel:SYMBols <SymbolsPerFrame>

Defines the number of symbols per frame to be expected.

Setting parameters:
<SymbolsPerFrame> integer

The number of symbols per frame varies depending on the used bandwidth and N_{FFT} (FFT length).

Range: 2K mode: 6 to 36; 4K mode: 6 to 18;

Example: `CONF:US:CHAN:SYMB 8`

Manual operation: See "Symbols Per Frame (K)" on page 77

10.5.1.3 Continuous pilots and excluded subcarrier assignment

Useful commands for configuring continuous pilots described elsewhere:

- `[SENSe:]DEMod:CPILots:AUTO` on page 232

Remote commands exclusive to configuring continuous pilots and excluded subcarriers:

CONFigure:DS:CHANnel:CPES<i>:COUNt?

Queries the number of entries in the Continuous pilots and excluded subcarrier assignment table.

Suffix:
<i> 1..n
irrelevant

Example: `CONF:DS:CHAN:CPES:COUN?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "Set Index" on page 63

CONFigure:DS:CHANnel:CPES<i>:DALL

Deletes all rows in the Continuous Pilots and Excluded Subcarrier Table. The command suffix is ignored.

Suffix:

<i> 1..n
irrelevant

Usage: Event

Manual operation: See "Delete All" on page 64

CONFigure:DS:CHANnel:CPES<i>:DELete

Deletes the specified row in the Continuous Pilots and Excluded Subcarrier Table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Example: `CONF:DS:CHAN:CPES2:DEL`

Usage: Event

Manual operation: See "Delete" on page 64

CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:INCRement <SubCarrierInc>

Defines the increment for a series of subcarriers to be configured identically in the Continuous pilots and excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Parameters:

<SubCarrierInc> integer

Range: 1 to 4K mode: 4095; 8K mode: 8191

Example: `CONF:DS:CHAN:CPES2:SUBC:INCR 10`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 63

CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:SET <SubcarrierSet>[, <SubcarrierSet>(8191)]

Defines a comma-separated list of (discrete) subcarriers to be configured identically in the Continuous pilots and excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Parameters:

<SubcarrierSet> integer
Subcarrier number
Range: 1 to 4K mode: 4095; 8K mode: 8191

<SubcarrierSet> integer
Subcarrier number
Range: 1 to 4K mode: 4095; 8K mode: 8191

Example: `CONFigure:DS:CHANnel:CPES2:SUBCarrier:SET 301, 302`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Subcarrier Set" on page 63

CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STARt <SubcarrierStart>

Defines the first subcarrier in a series of subcarriers to be configured identically in the Continuous pilots and excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Parameters:

<SubcarrierStart> integer
Subcarrier number
Must be lower than the parameter used by `CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STOP` on page 173.
Range: 1 to 4K mode: 4095; 8K mode: 8191

Example: `CONF:DS:CHAN:CPES2:SUBC:STAR 100`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 63

CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STOP <SubcarrierStop>

Defines the last subcarrier in a series of subcarriers to be configured identically in the Continuous pilots and excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Parameters:

<SubcarrierStop> integer

Subcarrier number
Must be higher than the parameter used by `CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:STARt` on page 172.

Range: 1 to 4K mode: 4095; 8K mode: 8191

Example: `CONF:DS:CHAN:CPES2:SUBC:STOP 250`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 63

CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:TYPE <SubcarrierType>

Defines the type of configuration for the specified entry in the Continuous pilots and excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Continuous pilots and excluded subcarrier assignment table

Parameters:

<SubcarrierType> **PLC**
Physical link channel
(Query only, always available as first entry.)

CPIL
Continuous pilot

ESUB
Excluded subcarrier

Example: `CONF:DS:CHAN:CPES2:SUBC:TYPE CPIL`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Type" on page 63

CONFigure:US:CHANnel:ESUB<i>:COUNt?

Queries the number of entries in the Excluded subcarrier assignment table.

Suffix:
<i> 1..n
irrelevant

Return values:
<Entries> integer

Example: `CONF:US:CHAN:ESUB:COUN?`

Usage: Query only

Manual operation: See "Set Index" on page 78

CONFigure:US:CHANnel:ESUB<i>:DALL

Deletes all rows in the upstream Excluded Subcarrier Table.

Suffix:
<i> 1..n
irrelevant

Example: `CONF:US:CHAN:ESUB:DALL`

Usage: Event

Manual operation: See "Deleting the entire table" on page 79

CONFigure:US:CHANnel:ESUB<i>:DELete

Deletes the specified row in the upstream Excluded Subcarrier Table.

Suffix:
<i> 1..n
index in the Excluded subcarrier assignment table

Example: `CONF:US:CHAN:ESUB2:DEL`

Usage: Event

Manual operation: See "Deleting a line" on page 79

CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:INCRement <SubCarrierInc>

Defines the increment for a series of subcarriers to be configured identically in the Excluded subcarrier assignment table.

Suffix:
<i> 1..n
index in the Excluded subcarrier assignment table

Parameters:
<SubCarrierInc> integer
Range: 1 to 2K mode: 2047; 4K mode: 4095

Example: `CONF:US:CHAN:ESUB2:SUBC:INCR 10`

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 78

CONFigure:US:CHANNel:ESUB<i>:SUBCarrier:SET <SubcarrierSet>[, <SubcarrierSet>(8191)]

Defines a comma-separated list of (discrete) subcarriers to be configured identically in the Excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Excluded subcarrier assignment table

Parameters:

<SubcarrierSet> integer

Subcarrier number

Range: 1 to 2047 (2k), 4095 (4k)

<SubcarrierSet>

Example: `CONFigure:US:CHANNel:ESUB2:SUBCarrier:SET 301, 302`

Manual operation: See "Subcarrier Set" on page 78

CONFigure:US:CHANNel:ESUB<i>:SUBCarrier:STARt <SubcarrierStart>

Defines the first excluded subcarrier in a series of subcarriers in the Excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Excluded subcarrier assignment table

Parameters:

<SubcarrierStart> integer

Subcarrier number
Must be lower than the parameter used by `CONFigure:US:CHANNel:ESUB<i>:SUBCarrier:STOP` on page 175.

Range: 1 to 2047 (2k), 4094 (4k)

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 78

CONFigure:US:CHANNel:ESUB<i>:SUBCarrier:STOP <SubcarrierStop>

Defines the last excluded subcarrier in a series of subcarriers in the Excluded subcarrier assignment table.

Suffix:

<i> 1..n
index in the Excluded subcarrier assignment table

Parameters:

<SubcarrierStop> integer

Subcarrier number
Must be higher than the parameter used by `CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:STARt` on page 175.

Range: 1 to 2047 (2k), 4095 (4k)

Manual operation: See "Subcarrier Range(Start / Increment / Stop)" on page 78

CONFigure:US:CHANnel:ESUB<i>:SUBCarrier:TYPE?

Queries the type of special subcarrier; for upstream signals, only excluded subcarriers are available.

Suffix:

<i> 1..n
irrelevant

Return values:

<Type> char_data | string

Example: `CONF:US:CHAN:ESUB:SUBC:TYPE?`

Usage: Query only

Manual operation: See "Type" on page 78

10.5.1.4 Profile configuration and modulation subcarrier assignment (downstream)

Useful commands for modulation subcarrier assignment described elsewhere:

- `CONFigure:DS:CHANnel:NCP:MODulation` on page 165

Remote commands exclusive to profile configuration and modulation subcarrier assignment

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:COUNt?

Queries the number of entries in the modulation table for the NCP profile.

Suffix:
<pri> 1..n

Example: `CONF:DS:CHAN:NCP:PCON:COUN?`

Usage: Query only

Manual operation: See "Set Index" on page 70

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:DALL

Deletes all rows of the NCP profile.

Suffix:
<pri> 1..n
irrelevant

Example: `CONF:DS:CHAN:NCP:PCON:DALL`

Usage: Event

Manual operation: See "Delete All" on page 72

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:DELete

Deletes the specified row of the NCP profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Usage: Event

Manual operation: See "Delete" on page 72

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:INCRement <SubCarrierInc>

Defines the increment in a series of subcarriers in the selected row to be configured identically in the NCP profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<SubCarrierInc> integer

Number of subcarriers

Range: 1 to 2K mode: 2047; 4K mode: 4095

Example: `CONF:DS:CHAN:NCP:PCON2:SUBC:INCR 10`

Manual operation: See "Start / Increment / Stop" on page 71

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:MODulation <ModTypeNCPProf>

Defines the modulation used by the specified row in the NCP profile. Note that the modulation for the row 0 is not editable, and for all other rows, the modulation is always zero bit.

Suffix:

<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<ModTypeNCPProf> ZERobit

Example: `CONFigure:DS:CHANnel:NCP:PCONfig2:SUBCarrier:MODulation ZERobit`

Manual operation: See "Modulation" on page 71

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:SET <SubcarrierSet>[, <SubcarrierSet>(8191)]

Defines a comma-separated list of (discrete) subcarriers to be configured identically in the selected row of the NCP profile.

Suffix:

<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<SubcarrierSet> integer

Subcarrier number

Range: 1 to 2K mode: 2047; 4K mode: 4095

<SubcarrierSet> integer

Subcarrier number

Range: 1 to 2K mode: 2047; 4K mode: 4095

Example: `CONF:DS:CHAN:NCP:PCON2:SUBC:SET 100,101,102`

Manual operation: See "Subcarrier Set" on page 71

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STARt <SubcarrierStart>

Defines the first subcarrier in a series of subcarriers in the selected row to be configured identically in the NCP profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:
<SubcarrierStart> integer
Range: 1 to 2K mode: 2047; 4K mode: 4095
Must be lower than the parameter used by `CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STOP` on page 179.

Example: `CONF:DS:CHAN:NCP:PCON2:SUBC:STAR 100`

Manual operation: See "Start / Increment / Stop" on page 71

CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STOP <SubcarrierStop>

Defines the last subcarrier in a series of subcarriers in the selected row to be configured identically in the NCP profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:
<SubcarrierStop> integer
Range: 1 to 2K mode: 2047; 4K mode: 4095
Must be higher than the parameter used by `CONFigure:DS:CHANnel:NCP:PCONfig<pri>:SUBCarrier:STARt` on page 179.

Example: `CONF:DS:CHAN:NCP:PCON2:SUBC:STOP 100`

Manual operation: See "Start / Increment / Stop" on page 71

CONFigure:DS:CHANnel:PCONfig<pri>:COUNt?

Queries the number of entries in the Modulation Subcarrier Assignment table for the selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:
<pri> 1..n
irrelevant

Example: CONF:DS:CHAN:PCON:COUN?

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "Set Index" on page 70

CONFigure:DS:CHANnel:PCONfig<pri>:DELete

This command deletes the currently selected profile.

Use the CONFigure:DS:CHANnel:PCONfig<pri>:SELect command to select a profile.

Suffix:
<pri> 1..n
irrelevant

Example: CONF:DS:CHAN:PCON2:DEL

Usage: Event

Manual operation: See "Delete Profile" on page 70

CONFigure:DS:CHANnel:PCONfig<pri>:SELect <ValidProfType>

This command selects the specified profile for further operation (e.g. configuration).

Suffix:
<pri> 1..n
irrelevant

Parameters:
<ValidProfType> A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P

Example: CONFigure:DS:CHANnel:PCONfig:SELect A
CONFigure:DS:CHANnel:PCONfig:COUNt?
Returns the number of entries in the Modulation Subcarrier Assignment table for the profile A.

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Profile List" on page 69

CONFigure:DS:CHANnel:PCONfig<pri>:STATe?

This command returns the state of the currently selected profile, that is: whether the profile contains configuration entries or not.

Use the CONFigure:DS:CHANnel:PCONfig<pri>:SELect command to select a profile.

Suffix:
<pri> 1..n
irrelevant

Example:
```
CONFigure:DS:CHANnel:PCONfig:SELect A
CONFigure:DS:CHANnel:PCONfig:STATe?
```
Returns the state of the Modulation Subcarrier Assignment table for the profile A.

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:DALL

Deletes the specified subcarrier set in the downstream Modulation Subcarrier Assignment table.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Usage: Event

Manual operation: See "Delete All" on page 72

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:DELete

Deletes the specified subcarrier in the downstream Profile Config Table.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Usage: Event

Manual operation: See "Delete" on page 72

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:INCRement <SubCarrierInc>

Defines the increment for a series of subcarriers to be configured identically in the Modulation Subcarrier Assignment table for the currently selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<SubCarrierInc> integer

Range: 1 to 4095 (4k), 8191 (8k)

Example: `CONF:DS:CHAN:PCON2:SUBC:INCR 10`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Start / Increment / Stop" on page 71

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:MODulation <ModType_DS>

Defines the modulation used by the specified subcarriers in the currently selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:

<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<ModType_DS> ZERobit | QPSK | QAM16 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | QAM8192 | QAM16384

Example: `CONF:DS:CHAN:PCON2:SUBC:MOD QAM16`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Modulation" on page 71

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:SET <SubcarrierSet>[, <SubcarrierSet>(8191)]

Defines a comma-separated list of (discrete) subcarriers to be configured identically in the Modulation Subcarrier Assignment table for the currently selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:

<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:

<SubcarrierSet> integer

Subcarrier number

Range: 1 to 2K mode: 2047; 4K mode: 4095

<SubcarrierSet>

Example: `CONF:DS:CHAN:PCON2:SUBC:SET 100,101,102`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Subcarrier Set" on page 71

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STARt <SubcarrierStart>

Defines the first subcarrier in a series of subcarriers to be configured identically in the Modulation Subcarrier Assignment table for the currently selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:
<SubcarrierStart> integer
Range: 1 to 2K mode: 2047; 4K mode: 4095
Must be lower than the parameter used by `CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STOP` on page 183.

Example: `CONF:DS:CHAN:PCON2:SUBC:STAR 10`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Start / Increment / Stop" on page 71

CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STOP <SubcarrierStop>

Defines the last subcarrier in a series of subcarriers to be configured identically in the Modulation Subcarrier Assignment table for the currently selected profile.

Use the `CONFigure:DS:CHANnel:PCONfig<pri>:SELect` command to select a profile.

Suffix:
<pri> 1..n
index in the Modulation Subcarrier Assignment table for the currently selected profile

Parameters:
<SubcarrierStop> integer
Range: 1 to 2K mode: 2047; 4K mode: 4095
Must be higher than the parameter used by `CONFigure:DS:CHANnel:PCONfig<pri>:SUBCarrier:STARt` on page 183.

Example: `CONF:DS:CHAN:PCON2:SUBC:STOP 100`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Start / Increment / Stop" on page 71

10.5.1.5 Profile configuration (upstream)

The following commands require option FSW-K193.

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:COUNt <MinislotCount>

Defines the number of minislots for which the specified configuration applies.

Suffix:
<pri> 1..n
index in the Profile configuration (upstream) table

Parameters:
<MinislotCount> integer
Number of minislots
Range: 1 to 237
*RST: 10

Example: `CONF:US:CHAN:PCON2:MIN:COUN 4`

Manual operation: See "Number of Minislots" on page 81

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:DALL

Deletes all minislot rows in the US Profile Config Table.

Suffix:
<pri> irrelevant

Usage: Event

Manual operation: See "Delete All Modulations" on page 81

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:DELete

Deletes the specified minislot row in the US Profile Config Table.

Suffix:
<pri> 1..n
Index in the Profile configuration (upstream) table

Usage: Event

Manual operation: See "Delete Modulation" on page 81

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:FIRSt <FirstMinislotUS>

Defines the type of the minislot to determine if it is the first minislot in a transmission PPDU. The first minislot in a transmission burst must be an "Edge" minislot.

Suffix:

<pri> 1..n
index in the Profile configuration (upstream) table

Parameters:

<FirstMinislotUS> EDGE | BODY

EDGE
The first minislot in a transmission burst (minislot 0) or minislot with a zero-valued modulation

BODY
Minislot is not the first minislot in a transmission burst and does not have a zero-valued modulation

*RST: EDGE

Example: `CONFigure:US:CHANnel:PCONfig2:MINislot:FIRSt EDGE`

Manual operation: See "First Minislot" on page 81

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:MODulation <ModType_US>

Defines the modulation used by the specified subcarriers.

Suffix:

<pri> 1..n
index in the Profile configuration (upstream) table

Parameters:

<ModType_US> ZERoval | BPSK | QPSK | QAM8 | QAM16 | QAM32 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | UNUSed

Example: `CONF:US:CHAN:PCON2:MIN:MOD QAM16`

Manual operation: See "Minislot Modulation" on page 81

CONFigure:US:CHANnel:PCONfig<pri>:MINislot:PPATtern <PilotPattern>

Defines the pilot pattern used by the specified minislots. Which patterns are available depends on the FFT mode.

For more information, see "Pilot patterns" on page 46.

Suffix:
<pri> 1..n
index in the Profile configuration (upstream) table

Parameters:
<PilotPattern> integer
The pattern values depend on the selectedN_{FFT} (FFT length).
Range: 2K mode: 1 to 7; 4K mode: 8 to 14

Manual operation: See "Minislot Pilot Pattern" on page 81

10.5.1.6 Codeword/frame configuration

Useful commands for codeword/frame configuration described elsewhere:

- `[SENSe:]DEMod:NCP:AUTO` on page 233

Remote commands exclusive to codeword/frame configuration:

CONFigure:DS:CHANnel:FCONfig<i>:COUNt?

This command returns the number of codewords (rows) in the "Frame Configuration" table.

Suffix:
<i> 1..n
irrelevant

Example: `CONF:DS:CHAN:FCON2:COUN?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "Codeword Index" on page 66

CONFigure:DS:CHANnel:FCONfig<i>:DALL

Deletes all rows in the downlink frame config table.

Suffix:
<i> 1..n
irrelevant

Usage: Event

Manual operation: See "Delete All Codewords" on page 67

CONFigure:DS:CHANnel:FCONfig<i>:DELete

Deletes the specified row in the downlink frame config table.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Usage: Event

Manual operation: See "Delete Codeword" on page 67

CONFigure:DS:CHANnel:FCONfig<i>:PROFile <ProfileType>

Assigns one of the active profiles defined in the "Profile List" on page 69 to the selected codeword.

To determine whether a profile is active or not, use the `CONFigure:DS:CHANnel:PCONfig<pri>:STATe?` query.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Parameters:
<ProfileType> A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | NONE

Example: `CONF:DS:CHAN:FCON2:PROF A`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Profile" on page 66

CONFigure:DS:CHANnel:FCONfig<i>:SUBCarrier:COUNt <SubcarrierStart>

Defines the number of subcarriers to which the selected codeword is assigned.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Parameters:
<SubcarrierStart> integer
Range: 1 to 3745 (4k), 7537 (8k)

Example: `CONF:DS:CHAN:FCON2:SUBC:COUN 200`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Number of Subcarriers" on page 67

CONFigure:DS:CHANnel:FCONfig<i>:SUBCarrier:STARt <SubcarrierStart>

Defines the first subcarrier to which the selected codeword is assigned.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Parameters:
<SubcarrierStart> integer
Subcarrier number
Range: 1 to 3745 (4k), 7537 (8k)

Example: `CONF:DS:CHAN:FCON2:SUBC:STAR 1`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "First Subcarrier" on page 66

CONFigure:DS:CHANnel:FCONfig<i>:SYMBol:COUNt <SubcarrierStart>

Defines the number of symbols to which the selected codeword is assigned.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Parameters:
<SubcarrierStart> integer
Range: 1 to 4

Example: `CONF:DS:CHAN:FCON2:SYMB:COUN 3`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Number of Symbols" on page 67

CONFigure:DS:CHANnel:FCONfig<i>:SYMBol:STARt <SubcarrierStart>

Defines the first symbol to which the selected codeword is assigned.

Suffix:
<i> 1..n
codeword index in the Codeword / frame configuration table

Parameters:
<SubcarrierStart> integer
Range: 0 to 127

Example: `CONF:DS:CHAN:FCON2:SYMB:STAR 1`

Manual operation: See "First Symbol" on page 67

10.5.2 Configuring the data input and output

10.5.2.1 RF input

INPut:ATTenuation:PROTection:RESet

Resets the attenuator and reconnects the RF input with the input mixer for the FSW after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

Example: `INP:ATT:PROT:RES`

INPut:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

Parameters:

<ConnType>

RF
RF input connector

AIQI
Analog Baseband I connector
This setting is only available if the "Analog Baseband" interface (FSW-B71) is installed and active for input. It is not available for the FSW67 or FSW85.
For more information on the "Analog Baseband" interface (FSW-B71), see the FSW I/Q Analyzer and I/Q Input User Manual.

RFPRobe
Active RF probe

*RST: RF

Example: `INP:CONN RF`
Selects input from the RF input connector.

Manual operation: See "Input Connector" on page 86

INPut:COUPling <CouplingType>

Selects the coupling type of the RF input.

Parameters:
<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 84

INPut:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:
<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See "Direct Path" on page 85

INPut:FILTer:HPASs[:STATe] <State>

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

Requires an additional high-pass filter hardware option.

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

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Manual operation: See "High Pass Filter 1 to 3 GHz" on page 86

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

Enables or disables the YIG filter.

Parameters:
<State> ON | OFF | 0 | 1

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 86

INPut:IMPedance <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

For input from the "Analog Baseband" interface, use the `INPut:IQ:IMPedance` command.

Parameters:
<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for the Spectrum application, the I/Q Analyzer, and some optional applications.
(In MSRA mode, primary only)

*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 85
See "Unit" on page 93

INPut:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for RF input.

For input from the "Analog Baseband" interface, use the `INPut:IQ:IMPedance:PTYPe` command.

Parameters:

<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:

```
INP:IMP 100
INP:IMP:PTYP MLP
```

Manual operation: See "Impedance" on page 85

INPut:SELect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the FSW.

If no additional input options are installed, only RF input is supported.

For FSW85 models with two RF input connectors, you must select the input connector to configure first using `INPut:TYPE`.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file
(selected by `INPut:FILE:PATH` on page 208)
Not available for Input2.

AIQ
Analog Baseband signal (only available with optional "Analog Baseband" interface)
Not available for Input2.

*RST: RF

Example:

```
INP:TYPE INP1
```

For FSW85 models with two RF input connectors: selects the 1.00 mm RF input connector for configuration.

```
INP:SEL RF
```

Manual operation: See "Radio Frequency State" on page 84
See "I/Q Input File State" on page 87

INPut:TYPE <Input>

The command selects the input path.

Parameters:
<Input>

INPUT1
Selects RF input 1.
1 mm [RF Input] connector

INPUT2
Selects RF input 2.
For FSW85 models with two RF input connectors:
1.85 mm [RF2 Input] connector
For all other models: not available

*RST: INPUT1

Example:
//Select input path
`INP:TYPE INPUT1`

Manual operation: See "Radio Frequency State" on page 84

10.5.2.2 Configuring digital I/Q input and output

Remote commands exclusive to digital I/Q data input and output

INPut:DIQ:CDEVice

Queries the current configuration and the status of the digital I/Q input from the optional "Digital Baseband" interface.

For details see the section "Interface Status Information" for the optional "Digital Baseband" interface in the FSW I/Q Analyzer User Manual.

Return values:
<Value>

Example:
`INP:DIQ:CDEV?`
Result:
`1,SMW200A,101190,BBMM 1 OUT,`
`100000000,200000000,Passed,Passed,1,1.#QNAN`

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

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

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<Level>	Range: 1 µV to 7.071 V
	*RST: 1 V
	Default unit: DBM

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

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

INPut:DIQ:RANGe[:UPPer]:UNIT <Level>

Defines the unit of the full scale level. The availability of units depends on the measurement application you are using.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<Level>	DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere
	*RST: Volt

INPut:DIQ:SRATe <SampleRate>

Specifies or queries the sample rate of the input signal from the optional "Digital Baseband" interface.

Parameters:

<SampleRate>	Range:	1 Hz to 20 GHz
	*RST:	32 MHz
	Default unit:	HZ

Example: `INP:DIQ:SRAT 200 MHz`

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

10.5.2.3 Configuring input via the optional Analog Baseband interface

The following commands are required to control the optional "Analog Baseband" interface in a remote environment. They are only available if this option is installed.

Useful commands for Analog Baseband data described elsewhere:

- `INP:SEL AIQ` (see `INPut:SELect` on page 192)
- `[SENSe:]FREQuency:CENTer` on page 212

Commands for the Analog Baseband calibration signal are described in the FSW User Manual.

Remote commands exclusive to Analog Baseband data input and output

---

INPut:IQ:BALanced[:STATe] <State>

Defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 single-ended lines.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Differential

OFF | 0
Single ended

*RST: 1

Example: `INP:IQ:BAL OFF`

INPut:IQ:FULLscale:AUTO <State>

Defines whether the full scale level (i.e. the maximum input power on the Baseband Input connector) is defined automatically according to the reference level, or manually.

Parameters:

<State>

ON | 1
Automatic definition

OFF | 0
Manual definition according to `INPut:IQ:FULLscale[:LEVel]` on page 196

*RST: 1

Example: `INP:IQ:FULL:AUTO OFF`

INPut:IQ:FULLscale[:LEVel] <PeakVoltage>

Defines the peak voltage at the Baseband Input connector if the full scale level is set to manual mode (see `INPut:IQ:FULLscale:AUTO` on page 196).

Parameters:

<PeakVoltage> 0.25 V | 0.5 V | 1 V | 2 V

Peak voltage level at the connector.
For probes, the possible full scale values are adapted according to the probe's attenuation and maximum allowed power.

*RST: 1V
Default unit: V

Example: `INP:IQ:FULL 0.5V`

INPut:IQ:IMPedance <Impedance>

Selects the nominal input impedance of the analog baseband input.

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

For input from the RF input, use the `INPut:IMPedance` command.

Parameters:

<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for:
Spectrum application
I/Q Analyzer
Docsis 3.1

*RST: 50
Default unit: OHM

Example: `INP:IQ:IMP 75`

Manual operation: See "Impedance" on page 85

INPut:IQ:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for analog baseband input.

For RF input, use the `INPut:IMPedance:PTYPe` command.

Parameters:

<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:
```
INP:IQ:IMP 100
INP:IQ:IMP:PTYP MLP
```

Manual operation: See "Impedance" on page 85

INPut:IQ:TYPE <DataType>

Defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ
The input signal is filtered and resampled to the sample rate of the application.
Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I
The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the in-phase component of the input signal is down-converted first (Low IF I).

Q
The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example: `INP:IQ:TYPE Q`

CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CAL:AIQ:HAT:STAT ON`

10.5.2.4 Working with power sensors

The following commands describe how to work with power sensors.

These commands require the use of a Rohde & Schwarz power sensor. For a list of supported sensors, see the specifications document.

Configuring power sensors

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

Turns automatic assignment of a power sensor to the power sensor index on and off.

Suffix:

<p> Power sensor index

Parameters:

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

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?

Queries the number of power sensors currently connected to the FSW.

Suffix:
<p> Power sensor index

Return values:
<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

Assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:
<p> Power sensor index

Parameters:

<Placeholder>	Currently not used
<Type>	Detected power sensor type, e.g. "NRP-Z81".
<Interface>	Interface the power sensor is connected to; always "USB"
<SerialNo>	Serial number of the power sensor assigned to the specified index

Example:
`SYST:COMM:RDEV:PMET2:DEF '','NRP-Z81','', '123456'`
Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".
`SYST:COMM:RDEV:PMET2:DEF?`
Queries the sensor assigned to "Power Sensor 2".
Result:
`'','NRP-Z81','USB','123456'`
The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Configuring power sensor measurements

CALibration:PMETer<p>:ZERO:AUTO ONCE

Zeroes the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, results are invalid.

Suffix:

<p> Power sensor index

Example: `CAL:PMET2:ZERO:AUTO ONCE;*WAI`
Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.

Usage: Event

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

Defines the reference value for relative measurements.

Suffix:

<n> Window

<p> Power sensor index

Parameters:

<RefValue>
Range: -200 dBm to 200 dBm
*RST: 0
Default unit: DBM

Example: `CALC:PMET2:REL -30`
Sets the reference value for relative measurements to -30 dBm for power sensor 2.

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

Sets the current measurement result as the reference level for relative measurements.

Suffix:

<n> Window

<p> Power sensor index

Example: `CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

CALCulate<n>:PMETer<p>:RELative:STATe <State>

Turns relative power sensor measurements on and off.

Suffix:

<n> Window

<p> Power sensor index

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

FETCh:PMETer<p>?

Queries the results of power sensor measurements.

Suffix:

<p> Power sensor index

Usage: Query only

READ:PMETer<p>?

Initiates a power sensor measurement and queries the results.

Suffix:
<p> Power sensor index

Usage: Query only

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

Turns the duty cycle correction on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:DCYC:STAT ON`

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

Defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:
<p> Power sensor

Parameters:
<Percentage> Range: 0.001 to 99.999
*RST: 99.999
Default unit: %

Example: `PMET2:DCYC:STAT ON`
Activates the duty cycle correction.
`PMET2:DCYC:VAL 0.5`
Sets the correction value to 0.5%.

[SENSe:]PMETer<p>:FREQuency <Frequency>

Defines the frequency of the power sensor.

Suffix:
<p> Power sensor index

Parameters:
<Frequency> The available value range is specified in the specifications document of the power sensor in use.
*RST: 50 MHz
Default unit: HZ

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

Selects the frequency coupling for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Coupling>

CENTer
Couples the frequency to the center frequency of the analyzer

MARKer1
Couples the frequency to the position of marker 1

OFF
Switches the frequency coupling off

*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

---

[SENSe:]PMETer<p>:MTIMe <Duration>

Selects the duration of power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Duration> SHORt | NORMal | LONG

*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

Sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:
<p> Power sensor index

Parameters:
<NumberReadings> An average count of 0 or 1 performs one power reading.
Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example:
`PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

Turns averaging for power sensor measurements on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
`PMET2:MTIM:AVER ON`
Activates manual averaging.

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

Includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
`PMET2:ROFF OFF`
Takes no offset into account for the measured power.

[SENSe:]PMETer<p>:SOFFset <SensorOffset>

Takes the specified offset into account for the measured power. Only available if `[SENSe:]PMETer<p>:ROFFset[:STATe]` is disabled.

Suffix:
<p> Power sensor index

Parameters:
<SensorOffset> Default unit: DB

Example: `PMET2:SOFF 0.001`

[SENSe:]PMETer<p>[:STATe] <State>

Turns a power sensor on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1 ON`
Switches the power sensor measurements on.

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

Turns continuous update of power sensor measurements on and off.

If on, the results are updated even if a single sweep is complete.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

UNIT<n>:PMETer<p>:POWer <Unit>

Selects the unit for absolute power sensor measurements.

Suffix:
<n> irrelevant

<p> Power sensor index

Parameters:

<Unit> DBM | WATT | W | DB | PCT

*RST: DBM

Example: `UNIT:PMET:POW DBM`

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

Selects the unit for relative power sensor measurements.

Suffix:

<n> irrelevant

<p> Power sensor index

Parameters:

<Unit> DB | PCT

*RST: DB

Example: `UNIT:PMET:POW:RAT DB`

Triggering with power sensors

[SENSe:]PMETer<p>:TRIGger:DTIMe <Time>

Defines the time period that the input signal has to stay below the IF power trigger level before the measurement starts.

Suffix:

<p> Power sensor index

Parameters:

<Time> Range: 0 s to 1 s
Increment: 100 ns
*RST: 100 µs
Default unit: S

Example: `PMET2:TRIG:DTIMe 0.001`

[SENSe:]PMETer<p>:TRIGger:HOLDoff <Holdoff>

Defines the trigger holdoff for external power triggers.

Suffix:

<p> Power sensor index

Parameters:

<Holdoff> Time period that has to pass between the trigger event and the start of the measurement, in case another trigger event occurs.

Range: 0 s to 1 s
Increment: 100 ns
*RST: 0 s
Default unit: S

Example: `PMET2:TRIG:HOLD 0.1`
Sets the holdoff time of the trigger to 100 ms

[SENSe:]PMETer<p>:TRIGger:HYSTeresis <Hysteresis>

Defines the trigger hysteresis for external power triggers.

The hysteresis in dB is the value the input signal must stay below the IF power trigger level to allow a trigger to start the measurement.

Suffix:

<p> Power sensor index

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
Increment: 1 dB
*RST: 0 dB
Default unit: DB

Example: `PMET2:TRIG:HYST 10`
Sets the hysteresis of the trigger to 10 dB.

[SENSe:]PMETer<p>:TRIGger:LEVel <Level>

Defines the trigger level for external power triggers.

Suffix:

<p> Power sensor index

Parameters:

<Level> -20 to +20 dBm

Range: -20 dBm to 20 dBm
*RST: -10 dBm
Default unit: DBM

Example: `PMET2:TRIG:LEV -10 dBm`
Sets the level of the trigger

[SENSe:]PMETer<p>:TRIGger:SLOPe <Edge>

Selects the trigger condition for external power triggers.

Suffix:
<p> Power sensor index

Parameters:
<Edge>

POSitive
The measurement starts in case the trigger signal shows a positive edge.

NEGative
The measurement starts in case the trigger signal shows a negative edge.

*RST: POSitive

Example: `PMET2:TRIG:SLOP NEG`

[SENSe:]PMETer<p>:TRIGger[:STATe] <State>

Turns the external power trigger on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:TRIG ON`
Switches the external power trigger on

10.5.2.5 Input from I/Q data files

The input for measurements can be provided from I/Q data files. The commands required to configure the use of such files are described here.

Useful commands for retrieving results described elsewhere:

- `INPut:SELect` on page 192

Remote commands exclusive to input from I/Q data files:

INPut:FILE:PATH <FileName>[, <AnalysisBW>]

Selects the I/Q data file to be used as input for further measurements.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

Parameters:

<FileName> String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.
Default unit: HZ

Example: `INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'`
Uses I/Q data from the specified file as input.

Example:

```
//Load an IQW file
INP:SEL:FIQ
INP:FILE:PATH 'C:\R_S\Instr\user\data.iqw'
//Define the sample rate
TRAC:IQ:SRAT 10MHz
//Define the measurement time
SENSe:SWEep:TIME  0.001001
//Start the measurement
INIT:IMM
```

Manual operation: See "Select I/Q data file" on page 87

MMEMory:LOAD:IQ:STReam <Channel>

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

Automatic mode (`MMEMory:LOAD:IQ:STReam:AUTO`) is set to OFF.

Parameters:

<Channel> String containing the channel name.

Example:
```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
MMEM:LOAD:IQ:STR 'Channel2'
```

Manual operation: See "Selected Channel" on page 88

MMEMory:LOAD:IQ:STReam:AUTO <State>

Only available for files that contain more than one data stream from multiple channels: automatically defines which data stream in the file is used as input for the channel.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The data stream specified by `MMEMory:LOAD:IQ:STReam` is used as input for the channel.

ON | 1
The first data stream in the file is used as input for the channel. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc.

*RST: 1

Manual operation: See "Selected Channel" on page 88

MMEMory:LOAD:IQ:STReam:LIST?

Returns the available channels in the currently loaded input file.

Example:
```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
```

Usage: Query only

Manual operation: See "Selected Channel" on page 88

TRACe:IQ:FILE:REPetition:COUNt <RepetitionCount>

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

Parameters:

<RepetitionCount> integer

Example: `TRAC:IQ:FILE:REP:COUN 3`

Manual operation: See "File Repetitions" on page 88

10.5.2.6 Configuring the outputs

The following commands are required to provide output from the FSW.

Configuring trigger input/output is described in Chapter 10.5.5.2, "Configuring the trigger output", on page 227.

DIAGnostic:SERVice:NSOurce <State>

Turns the 28 V supply of the BNC connector labeled [noise source control] on the FSW on and off.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source Control" on page 89

OUTPut:IF[:SOURce] <Source>

Defines the type of signal available at one of the output connectors of the FSW.

Parameters:

<Source> **IF**
The measured IF value is available at the IF/VIDEO/DEMOD output connector.
The frequency at which the IF value is provided is defined using the `OUTPut:IF:IFFRequency` command.

*RST: IF

Example: `OUTP:IF VID`
Selects the video signal for the IF/VIDEO/DEMOD output connector.

Manual operation: See "Data Output" on page 89

OUTPut:IF:IFFRequency <Frequency>

Defines the frequency for the IF output of the FSW. The IF frequency of the signal is converted accordingly.

Is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

Parameters:

<Frequency> *RST: 50.0 MHz
Default unit: HZ

Manual operation: See "Data Output" on page 89

SYSTem:SPEaker:VOLume <Volume>

Defines the volume of the built-in loudspeaker for demodulated signals. This setting is maintained for all applications.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

Parameters:

<Volume> Percentage of the maximum possible volume.

Range: 0 to 1
*RST: 0.5

Example: `SYST:SPE:VOL 0`
Switches the loudspeaker to mute.

10.5.3 Frontend configuration

The following commands configure frequency, amplitude and y-axis scaling settings, which represent the "frontend" of the measurement setup.

10.5.3.1 Frequency

[SENSe:]FREQuency:CENTer <Frequency>

Defines the center frequency.

Parameters:

<Frequency> For the allowed range and f_{max}, refer to the specifications document.

*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency" on page 59

[SENSe:]FREQuency:CENTer:STEP <StepSize>

Defines the center frequency step size.

Parameters:

<StepSize> For f_{max}, refer to the specifications document.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example: //Set the center frequency to 110 MHz.

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Center Frequency Stepsize" on page 90

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

Couples or decouples the center frequency step size to the span.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:

```
FREQ:CENT:STEP:AUTO ON
```

Activates the coupling of the step size to the span.

[SENSe:]FREQuency:OFFSet <Offset>

Defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset> Range: -1 THz to 1 THz
*RST: 0 Hz
Default unit: HZ

Example:

```
FREQ:OFFS 1GHZ
```

Manual operation: See "Frequency Offset" on page 91

10.5.3.2 Amplitude settings

The following commands are required to configure the amplitude settings in a remote environment.

Useful commands for amplitude settings described elsewhere:

- `INPut:COUPling` on page 190
- `INPut:IMPedance` on page 191
- `[SENSe:]ADJust:LEVel` on page 238

Remote commands exclusive to amplitude settings:

CALCulate<n>:UNIT:POWer <Unit>

Selects the power unit.

The unit applies to all power-based measurement windows with absolute values.

In addition, the unit of the reference level is adapted to the same unit.

Suffix:

<n> irrelevant

Parameters:

<Unit> *RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Unit" on page 93

CONFigure:POWer:AUTO <Mode>

Is used to switch on or off automatic power level detection.

Note that for sample rates larger than 160 MHz and active B1200 or B2001 bandwidth extension options, auto leveling is not available.

Parameters:

<Mode> **ON**
Automatic power level detection is performed at the start of each measurement sweep, and the reference level is adapted accordingly.

OFF
The reference level must be defined manually (see `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 215)

ONCE
Automatic power level detection is performed once at the start of the next measurement sweep, and the reference level is adapted accordingly.
The command with this parameter corresponds to `[SENSe:]ADJust:LEVel` on page 238.

*RST: ON

Manual operation: See "Reference Level Mode" on page 93

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.

Range: see specifications document
*RST: 0 dBm
Default unit: DBM

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See "Reference Level" on page 93

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:
<Offset>
Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 93

INPut:ATTenuation <Attenuation>

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 specifications document
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)
Default unit: DB

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Manual operation: See "Attenuation Mode / Value" on page 94

INPut:ATTenuation:AUTO <State>

Couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the FSW 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 "Attenuation Mode / Value" on page 94

INPut:EATT <Attenuation>

Defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 217).

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> attenuation in dB

Range: see specifications document
Increment: 1 dB
*RST: 0 dB (OFF)
Default unit: DB

Example: `INP:EATT:AUTO OFF`
`INP:EATT 10 dB`

Manual operation: See "Using Electronic Attenuation" on page 94

INPut:EATT:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation" on page 94

INPut:EATT:STATe <State>

Turns the electronic attenuator on and off.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See "Using Electronic Attenuation" on page 94

INPut:EGAin[:STATe] <State>

Before this command can be used, the external preamplifier must be connected to the FSW. See the preamplifier's documentation for details.

When activated, the FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results.

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

For FSW85 models with two RF inputs, you must enable correction from the external preamplifier for each input individually. Correction cannot be enabled for both inputs at the same time.

When deactivated, no compensation is performed even if an external preamplifier remains connected.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
No data correction is performed based on the external preamplifier

ON | 1
Performs data corrections based on the external preamplifier

*RST: 0

Example: `INP:EGA ON`

Manual operation: See "Ext. PA Correction" on page 96

INPut:GAIN:STATe <State>

Turns the internal preamplifier on and off. It requires the optional preamplifier hardware.

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

Is not available for input from the optional "Digital Baseband" interface.

For FSW85 models, no preamplifier is available.

If option R&S FSW-B22 is installed, the preamplifier is only active below 7 GHz.

If option R&S FSW-B24 is installed, the preamplifier is active for all frequencies.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:

```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```

Switches on 15 dB preamplification.

Manual operation: See "Preamplifier" on page 95

INPut:GAIN[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 218).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> For all FSW models except for FSW85, the following settings are available:
15 dB and 30 dB
All other values are rounded to the nearest of these two.
30 dB
For older FSW43/FSW50/FSW67 models, the input signal is always ampilfied by about 30 dB when the preamplifier is active.
For FSW85 models, no preamplifier is available.

Default unit: DB

Example:
`INP:GAIN:STAT ON`
`INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 95

10.5.4 Signal capturing

The following commands are required to configure how much and how data is captured from the input signal.

INPut:FILTer:ACHannels[:STATe] <State>

This remote control command enables or disables use of the adjacent channel filter.

If activated, only the useful signal is analyzed, all signal data in adjacent channels is removed by the filter. This setting improves the signal to noise ratio and thus the MER results for signals with strong or a large number of adjacent channels. However, for some measurements, information on the effects of adjacent channels on the measured signal may be of interest.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Adjacent channels are filtered.

OFF | 0
Adjacent channels are not filtered.

*RST: 0

Manual operation: See "Filter Out Adjacent Channels" on page 106

[SENSe:]SWAPiq <State>

Defines whether or not the recorded I/Q pairs should be swapped (I<->Q) before being processed. Swapping I and Q inverts the sideband.

This is useful if the DUT interchanged the I and Q parts of the signal; then the FSW can do the same to compensate for it.

Parameters:

<State>

ON | 1
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF | 0
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: 0

Manual operation: See "Swap I/Q" on page 105

[SENSe:]SWEep:LENGth?

Queries the current record length, that is: the number of samples captured during the measurement. The maximum number of samples depends on the specified N_{FFT} (see `CONFigure:CHANnel:NFFT` on page 163).

Example: `SWE:LENG?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "Number of Samples" on page 105

[SENSe:]SWEep:TIME <Time>

Defines or queries the duration (and therefore the amount of data) to be captured during one measurement. The maximum capture time depends on the specified N_{FFT} (see `CONFigure:CHANnel:NFFT` on page 163).

Parameters:

<Time>

Range: 0 s to 4K mode: 6 ms; 8K mode: 12 ms
Default unit: S

Example: `SWE:TIME 0.001`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Capture Time" on page 105

TRACe:IQ:BWIDth?

Queries the currently used analysis bandwidth.

For DOCSIS 3.1 downstream measurements, a fixed bandwidth of 192.0 MHz is used.

For DOCSIS 3.1 upstream measurements, a fixed bandwidth of 96.0 MHz is used.

Example: `TRAC:IQ:BWID?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation: See "Analysis Bandwidth (ABW)" on page 105

TRACe:IQ:SRATe <IQSamplingRate>

Queries or defines the currently used sample rate.

For DOCSIS 3.1 downstream measurements, a fixed sample rate of 204.8 MHz is used.

For DOCSIS 3.1 upstream measurements, a fixed sample rate of 102.4 MHz or 204.8 MHz (oversampling *2) can be used.

Parameters:

<IQSamplingRate> 102400000 | 204800000

Default unit: HZ

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Example: `TRAC:IQ:SRAT?`

Manual operation: See "Sample Rate" on page 105

10.5.5 Configuring triggered measurements

The following commands are required to configure a triggered measurement in a remote environment. The tasks for manual operation are described in Chapter 5.3.4, "Trigger settings", on page 96.

The `*OPC` command should be used after commands that retrieve data so that subsequent commands to change the selected trigger source are held off until after the sweep is completed and the data has been returned.

10.5.5.1 Configuring the triggering conditions

The following commands are required to configure a triggered measurement.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

For input from the "Analog Baseband" interface using the baseband power trigger (BBP), the default drop out time is set to 100 ns to avoid unintentional trigger events (as no hysteresis can be configured in this case).

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Drop-Out Time" on page 101

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

Defines the time offset between the trigger event and the start of the measurement.

Parameters:

<Offset> *RST: 0 s
Default unit: S

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 101

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

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:
<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example:
`TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 102

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

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

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

Example:
`TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 102

TRIGger[:SEQuence]:LEVel:BBPower <Level>

Sets the level of the baseband power trigger.

Is available for the optional "Digital Baseband" interface.

Is available for the optional "Analog Baseband" interface.

Parameters:
<Level> Range: -50 dBm to +20 dBm
*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:BBP -30DBM`

Manual operation: See "Trigger Level" on page 101

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

Defines the level the external signal must exceed to cause a trigger event.

Suffix:
<port>
Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:
<TriggerLevel>
Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 101

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

For compatibility reasons, this command is also available for the "Baseband Power" trigger source when using the "Analog Baseband" interface.

Parameters:
<TriggerLevel>
For details on available trigger levels and trigger bandwidths, see the specifications document.
*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:IFP -30DBM`

TRIGger[:SEQuence]:LEVel:POWer:AUTO <State>

By default, the optimum trigger level for power triggers is automatically measured and determined at the start of each sweep (for Modulation Accuracy, Flatness, Tolerance... measurements).

Is only considered for `TRIG:SEQ:SOUR IFP` and `TRIG:SEQ:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 225

To define the trigger level manually, switch this function off and define the level using `TRIGger[:SEQuence]:LEVel:IFPower` on page 224 or `TRIGger[:SEQuence]:LEVel:RFPower` on page 225.

Parameters for setting and query:
<State>
OFF | 0
Switches the auto level detection function off

ON | 1
Switches the auto level detection function on

*RST: 1

Manual operation: See "Trigger Level Mode" on page 101

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

Defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths, see the specifications document.

*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:RFP -30dBm`

TRIGger[:SEQuence]:SLOPe <Type>

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 102

TRIGger[:SEQuence]:SOURce <Source>

Selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure that this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the "Trigger Input" connector.

EXT2
Trigger signal from the "Trigger Input/Output" connector.
For FSW85 models, Trigger 2 is not available due to the second RF input connector on the front panel. The trigger signal is taken from the "Trigger Input/Output" connector on the rear panel.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the "TRIGGER 3 INPUT/ OUTPUT" connector.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency
(Frequency and time domain measurements only.)
Not available for input from the optional "Analog Baseband" interface.
Not available for input from the optional "Digital Baseband" interface.

IFPower
Second intermediate frequency
Not available for input from the optional "Digital Baseband" interface.
For input from the optional "Analog Baseband" interface, this parameter is interpreted as `BBPower` for compatibility reasons.

TIME
Time interval

BBPower
Baseband power
For input from the optional "Analog Baseband" interface.
For input from the optional "Digital Baseband" interface.

PSEN
External power sensor

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See "Trigger Source" on page 98
See "Free Run" on page 98
See "External Trigger 1/2/3" on page 98
See "Baseband Power" on page 98
See "Digital I/Q" on page 99
See "IF Power" on page 99
See "RF Power" on page 100
See "I/Q Power" on page 100
See "Power Sensor" on page 100
See "Time" on page 100

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

Defines the repetition interval for the time trigger.

Parameters:

<Interval> numeric value

Range: 2 ms to 5000 s
*RST: 1.0 s
Default unit: S

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 5`
The measurement starts every 5 s.

Manual operation: See "Repetition Interval" on page 101

10.5.5.2 Configuring the trigger output

The following commands are required to send the trigger signal to one of the variable "TRIGGER INPUT/OUTPUT" connectors on the FSW.

OUTPut:TRIGger<tp>:DIRection <Direction>

Selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:

<tp> Selects the used trigger port.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear panel)

Parameters:

<Direction> INPut | OUTPut

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 2/3" on page 102

OUTPut:TRIGger<tp>:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with OUTPut:TRIGger<tp>:OTYPe.

Suffix:
<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:
<Level> **HIGH**
5 V
LOW
0 V
*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

Manual operation: See "Level" on page 103

OUTPut:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

Suffix:
<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:
<OutputType> **DEVice**
Sends a trigger signal when the FSW has triggered internally.
TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.
UDEFined
Sends a user-defined trigger signal. For more information, see OUTPut:TRIGger<tp>:LEVel.
*RST: DEVice

Manual operation: See "Output Type" on page 103

OUTPut:TRIGger<tp>:PULSe:IMMediate

Generates a pulse at the trigger output.

Suffix:
<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Manual operation: See "Send Trigger" on page 103

OUTPut:TRIGger<tp>:PULSe:LENGth <Length>

Defines the length of the pulse generated at the trigger output.

Suffix:
<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:
<Length> Pulse length in seconds.
Default unit: S

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See "Pulse Length" on page 103

10.5.6 Synchronization (upstream only)

[SENSe:]DEMod:TXARea <State>

Determines the area within the capture buffer in which the frame start is searched.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The complete "Magnitude Capture" buffer is searched for frame starts. This makes the frame detection more robust in case of existing neighbor signals.

ON | 1
The frame start is only searched in "Magnitude Capture" (time-domain) areas with sufficient power. This improves the measurement speed performance.

*RST: 1

Example: `DDEM:TXAR OFF`

Manual operation: See "Power Interval Search" on page 107

10.5.7 Tracking and channel estimation

[SENSe] (see also SENSe: commands!)
[SENSe:]CHANnel:ESTimation <Estimation>

This command determines how channels are detected and compensated for in the input signal.

Parameters:

<Estimation> DOCSis | PILots | PDATa | OFF | EMER | UMER | PEQ

PILots | DOCSis
(Downstream only:) An optimal channel estimation using all available pilots is performed, as defined in the DOCSIS 3.1 downstream standard.
Note: query returns `DOCS`

PDATa
(Downstream only:) An optimal channel estimation using all available pilots and data is performed.

OFF
(Downstream only:) The channel transfer function is not compensated for in the measurement results.

EMER
(Upstream only, default:) Equalized MER
Measurements with linear distortions are equalized by the R&S FSW DOCSIS 3.1 application equalizer.

UMER
(Upstream only:) Unequalized MER
Measurements with linear distortions are not equalized by the R&S FSW DOCSIS 3.1 application equalizer.
Only one carrier amplitude adjustment common for all subcarriers and OFDM symbols in the burst is performed.
Only one timing adjustment is performed, resulting in phase ramp across subcarriers.

PEQ
Partial Equalization
Upstream: Partial equalization according to the definition in the standardization document *ATP TC1409.4 Procedure 3.1*. The partial equalizer is configured such that it does not correct components of the cable modem's impulse response that are longer than +/-200 ns.
Downstream: Minimal test receiver equalization according to the definition in the physical layer standardization document in section 7.5.9.1. The estimated channel impulse response used by the test receiver is limited to half the length of the smallest transmit cyclic prefix.

*RST: PILots (downstream) / EMER (upstream)

Example:
```
CHAN:EST PIL
CHAN:EST?
//Result: DOCS
```
Query of the parameter PILots returns DOCS (for compatibility reasons).

Manual operation: See "Channel Estimation" on page 108

SENSe:TRACking:PHASe <State>

Activates or deactivates the compensation for phase drifts.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on. The measurement results are compensated for phase drifts on a per-symbol basis.

*RST: 1

Example:
```
SENS:TRAC:PHAS ON
```

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Phase Tracking (downstream only)" on page 109

SENSe:TRACking:TIME <State>

Activates or deactivates the compensation for timing drift.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on. The measurement results are compensated for timing error on a per-symbol basis.
*RST: 0

Example: `SENS:TRAC:TIME ON`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Timing Error Tracking" on page 109

10.5.8 Demodulation

The demodulation settings define which PPDUs are to be analyzed, thus they define a *logical filter*.

Manual configuration is described in Chapter 5.3.9, "Demodulation", on page 109.

[SENSe:]DEMod:CPILots:AUTO <ContPilots>

Defines how continuous pilots are detected in the symbols.

Parameters:
<ContPilots> SIGNal | USER

SIGNAL
Continuous pilots are detected in the signal automatically during demodulation.

USER
The pilots must be configured manually using the `CONFigure:DS:CHANnel:CPES<i>:SUBCarrier:TYPECPIL` command.

Example: `DEM:CPIL:AUTO SIGNAL`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Auto Detection:Continuous Pilots (downstream only)" on page 64

[SENSe:]DEMod:DECode:BITStream <Bitstream>

Determines which bits of the data stream are decoded and then displayed in a Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

Parameters:
<Bitstream> RBITs | RBD | IBLDpc | OBLDpc | IBDPdata

IBDPdata
"Info Bits: Decoded Payload Data"
Only the bits containing the actual information (the payload bits) are decoded and displayed

RBITs
"Raw Bits"
Bits mapped to QAM constellation points, undecoded

RBD
"Raw Bits Descrambled"
Bits mapped to QAM constellation points, randomization undone, undecoded

IBLDpc
"Input Bits LDPC"
Undecoded hard-decisions of the log-likelihood ratio values seen by the LDPC decoder, whole FEC codeword (16200 bits)

OBLDpc
"Output Bits LDPC"
Decoded LDPC decoder output, whole FEC codeword (16200 bits)

*RST: IBDP

Example: `DEM:DEC:BITS IBLD`

Manual operation: See "Bitstream (downstream only)" on page 111

[SENSe:]DEMod:DECode:CODewords <Codewords>

This command determines whether codewords are decoded or not.

Parameters:

<Codewords> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Codewords (downstream only)" on page 111

[SENSe:]DEMod:NCP:AUTO <FrameConfig>

This command determines how frames are configured.

Parameters:

<FrameConfig> SIGNal | USER

SIGNAL
Frames (NCP content) are detected in the signal automatically during demodulation.

USER
Frames must be configured manually (see Chapter 10.5.1.6, "Codeword/frame configuration", on page 186).

Example: `DEM:NCP:AUTO SIGNAL`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Auto Detection: NCP Content (downstream only)" on page 67

[SENSe:]DEMod:US:AUTO <USAutoDetection>

This function determines the auto detection mode for Upstream measurements.

Parameters:
<USAutoDetection> SIGNal | USER

SIGNal
Settings are either auto-detected from the signal.

USER
Settings are user-defined.

Manual operation: See "Auto Detection: Signal description (upstream only)" on page 111

10.5.9 Evaluation range

The evaluation range defines which data is evaluated in the result display.

Note that, as opposed to manual operation, the PPDUs to be analyzed can be defined either by the number of data symbols, the number of data bytes, or the measurement duration.

CONFigure:MEXC:STATe <Mode>

Excludes specific subcarriers from modulation error ratio (MER) calculation.

Parameters:

<Mode>

OFF
All subcarriers are included in MER calculation.

AUTO
The number of excluded subcarriers specified by `CONFigure:MEXC:SUBCarrier:COUNt` with the worst MER are automatically excluded from MER calculation.

USER
The subcarriers specified by the `CONFigure:MEXC:SUBCarrier:SET` command are excluded.

*RST: OFF

Example:
```
CONF:MEXC:STAT USER
CONF:MEXC:SUBC:STAR 100
CONF:MEXC:SUBC:INCR 1
CONF:MEXC:SUBC:STOP 105
```
The subcarriers 100 to 105 are excluded from MER calculation.

Manual operation: See "Excluding Subcarriers from MER Calculation" on page 115

CONFigure:MEXC:SUBCarrier:COUNt <NoExclSC>

Defines the number of subcarriers to be excluded from MER calculation (for `CONFigure:MEXC:STATe` on page 235 `AUTO`). The subcarriers with the worst MER are automatically excluded from MER calculation.

Parameters:

<NoExclSC> integer

Range: 1 to 5
*RST: 5

Example:
```
CONF:MEXC:STAT AUTO
CONF:MEXC:SUBC:COUN 5
```

Manual operation: See "Excluding Subcarriers from MER Calculation" on page 115

CONFigure:MEXC:SUBCarrier:SET <Subcarrier>[, <Subcarrier>]

Defines a comma-separated list of (discrete) subcarriers to be excluded from MER calculation (for `CONFigure:MEXC:STATe` on page 235 `USER`).

Parameters:

<Subcarrier> Subcarrier number

Range: 1 to 8191

Example:
```
CONF:MEXC:STAT USER
CONF:MEXC:SUBC:SET 100,105,112,123,134,145
```

Manual operation: See "Subcarrier Set" on page 115

[SENSe:]FRAMe:COUNt <Count>

If the statistic count is enabled (see [SENSe:]FRAMe:COUNt:STATe on page 236), the specified number of frames is taken into consideration for the statistical evaluation (maximally the number of frames detected in the current capture buffer).

If disabled, all detected frames in the current capture buffer are considered.

Parameters:

<Count> integer

Number of frames

*RST: 1

Example:
```
SENS:FRAM:COUN:STAT ON
SENS:FRAM:COUN 10
```

Manual operation: See "Frame Statistic Count / Number of Frames to Analyze" on page 114

[SENSe:]FRAMe:COUNt:STATe <State>

Activates or deactivates statistic evaluation.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off
All detected frames in the current capture buffer are considered.

ON | 1
Switches the function on
The specified number of frames is taken into consideration for the statistical evaluation (maximally the number of frames detected in the current capture buffer).

*RST: 0

Example:
```
SENS:FRAM:COUN:STAT ON
SENS:FRAM:COUN 10
```

Manual operation: See "Frame Statistic Count / Number of Frames to Analyze" on page 114

[SENSe:]FRAMe:SELect <Value>

If single frame evaluation is enabled (see [SENSe:]FRAMe:SELect:STATe on page 237), the specified frame number is evaluated in all graphical and numeric result displays.

If single frame evaluation is disabled, the first frame to be detected in the capture buffer (frame 0) is automatically selected for evaluation.

The result displays are updated to show the results for the new evaluation range. The selected frame is marked by a blue bar in the capture buffer display (see "Magnitude Capture" on page 23).

Parameters:

<Value> integer

Range: 0 to max no. frames in capture buffer
*RST: 0

Example:

```
SENS:FRAM:SEL:STAT ON
SENS:FRAM:SEL 2
```

Manual operation:

See "Bitstream (downstream only)" on page 20
See "Constellation" on page 21
See "Group Delay" on page 23
See "MER vs Carrier" on page 24
See "MER vs Minislot (upstream only)" on page 25
See "MER vs Symbol" on page 26
See "MER vs Symbol X Carrier" on page 26
See "Phase vs Carrier" on page 27
See "Power vs Carrier (upstream only)" on page 28
See "Power vs Symbol X Carrier" on page 29
See "Power Spectrum" on page 29
See "Signal Content Detailed" on page 31
See "Spectrum Flatness" on page 32
See "Selected Frame" on page 114

[SENSe:]FRAMe:SELect:STATe <State>

Determines which frames are evaluated.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off
All detected frames in the current capture buffer are evaluated for numeric results. For graphical results, the first frame to be detected in the capture buffer (frame 0) is automatically selected for evaluation.

ON | 1
Switches the function on
Only the frame specified by the `[SENSe:]FRAMe:SELect` command is evaluated. Statistic evaluation for numeric results is not performed, as only one result is available for each frame parameter.

*RST: 0

Example:

```
SENS:FRAM:SEL:STAT ON
SENS:FRAM:SEL 1
```

Manual operation: See "Analyzing a single frame (Specified Frame)" on page 113

[SENSe:]SWEep:LIMit:ABORt:STATe <FastModeState>

This command determines the behavior of the application after a limit check fails.

This function is only available for Signal Content Detailed and Signal Content Summary (downstream only) result displays.

The limit check fails if the bit or block error rate after decoding (BER Pre, BER Post, BLER Post, see Table 3-3) is not zero. An error message in the status bar and a status bit in the SYNC register (bit 3) indicate the failure (see Chapter 10.11.1, "The STATus:QUEStionable:SYNC register", on page 310).

Parameters:

<FastModeState> ON | OFF | 0 | 1

OFF | 0
A limit check has no effects on the measurement.

ON | 1
The measurement is stopped if the limit check fails at any time during the measurement.

*RST: 0

Example: `SWE:LIM:ABOR:STAT ON`

Manual operation: See "Stop RUN on Limit Check Fail" on page 114

10.5.10 Automatic settings

[SENSe:]ADJust:LEVel

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The FSW is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

Example: `ADJ:LEV`

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 94

CONFigure:DS:PLC:AUTO <Auto>

Performs an initial measurement in order to determine the required signal description settings automatically from the detected PLC before starting (or continuing) the actual Modulation Accuracy measurement.

This function is **only** available for **downstream**DOCSIS 3.1 signals.

Parameters:

<Auto> **ONCE**
Executes the function once

Example: `CONFigure:DS:PLC:AUTO ONCE`

Manual operation: See "Auto Set from PLC & Run (downstream only)" on page 132

CONFigure:US:AUTO <Auto>

Performs an initial measurement in order to determine the required signal description settings automatically from the detected signal characteristics before starting (or continuing) the actual Modulation Accuracy measurement.

This function is **only** available for **upstream**DOCSIS 3.1 signals.

Parameters:

<Auto> ONCE

Example: `CONFigure:US:AUTO ONCE`

Manual operation: See "Auto Detection & Run (upstream only)" on page 133

10.6 Configuring frequency sweep measurements on DOCSIS 3.1 signals

The R&S FSW DOCSIS 3.1 application uses the functionality of the FSW base system (Spectrum application, see the FSW User Manual) to perform the DOCSIS 3.1 frequency sweep measurements. The R&S FSW DOCSIS 3.1 application automatically sets the parameters to predefined settings as described in Chapter 10.6, "Configuring frequency sweep measurements on DOCSIS 3.1 signals", on page 239.

The DOCSIS 3.1 RF measurements must be activated for a measurement channel in the R&S FSW DOCSIS 3.1 application, see Chapter 10.3, "Activating DOCSIS 3.1 measurements", on page 156.

For details on configuring these RF measurements in a remote environment, see the Remote Commands chapter of the FSW User Manual.

10.7 Configuring the result display

The following commands are required to configure the screen display in DOCSIS 3.1 I/Q measurements in a remote environment. The corresponding tasks for manual operation are described in Chapter 5.2, "Display configuration", on page 53.

The suffix <n> in the following remote commands represents the window (1..16) in the currently selected measurement channel.

10.7.1 General window commands

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

DISPlay:FORMat <Format>

Determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

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

Maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 245).

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

Sets the focus on the selected result display window.

This window is then the active window.

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

Suffix:

<n>	Window
<w>	subwindow Not supported by all applications
Example:	//Put the focus on window 1 `DISP:WIND1:SEL`
Example:	//Put the focus on subwindow 2 in window 1 `DISP:WIND1:SUBW2:SEL`

10.7.2 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.

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

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

Adds a window to the display in the active channel.

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

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

Query parameters:

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

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

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

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 "Bitstream (downstream only)" on page 20
See "Constellation" on page 21
See "Group Delay" on page 23
See "Magnitude Capture" on page 23
See "Marker Table" on page 24
See "MER vs Carrier" on page 24
See "MER vs Minislot (upstream only)" on page 25
See "MER vs Symbol" on page 26
See "MER vs Symbol X Carrier" on page 26
See "Phase vs Carrier" on page 27
See "PLC Messages (downstream only)" on page 27
See "Power vs Carrier (upstream only)" on page 28
See "Power vs Symbol X Carrier" on page 29
See "Power Spectrum" on page 29
See "Result Summary" on page 30
See "Signal Content Detailed" on page 31
See "Signal Content Summary (downstream only)" on page 32
See "Spectrum Flatness" on page 32
See "Synchronous Band Power (upstream only)" on page 33
See "Diagram" on page 36
See "Result Summary" on page 37
See "Marker Peak List" on page 37

For a detailed example, see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Table 10-3: <WindowType> parameter values for DOCSIS application

Parameter value	Window type
BITStream	"Bitstream"
CONStellation	"Constellation"

Parameter value	Window type
GDELay	"Group Delay"
MERCarrier	"MER vs. Carrier"
MERMinislot	"MER vs. Minislot" (upstream only)
MERSymbol	"MER vs. Symbol"
MSCarrier	"MER vs. Symbol X Carrier"
PCARrier	"Power vs. Carrier"
PHACarrier	"Phase vs. Carrier"
PLCMessages	"PLC Messages" (downstream only)
PSCarrier	"Power vs. Symbol X Carrier"
PSPectrum	"Power Spectrum"
RFMagnitude	"Magnitude Capture" RF
RSUMmary	"Result Summary"
SBPower	"Synchronous Band Power"
SCDetailed	"Signal Content Detailed"
SCSummary	"Signal Content Summary" (downstream only)
SFLatness	"Spectrum Flatness"

LAYout:CATalog[:WINDow]?

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

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

Return values:

<WindowName> string

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

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

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

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

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

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

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

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

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:

<WindowName> 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.

<WindowName> 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.

<Direction> 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>

Removes a window from the display in the active channel.

Setting parameters:

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

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

Usage: Setting only

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

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

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

Setting parameters:

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

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 241 for a list of available window types.

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

Usage: Setting only

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

Changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 240 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

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

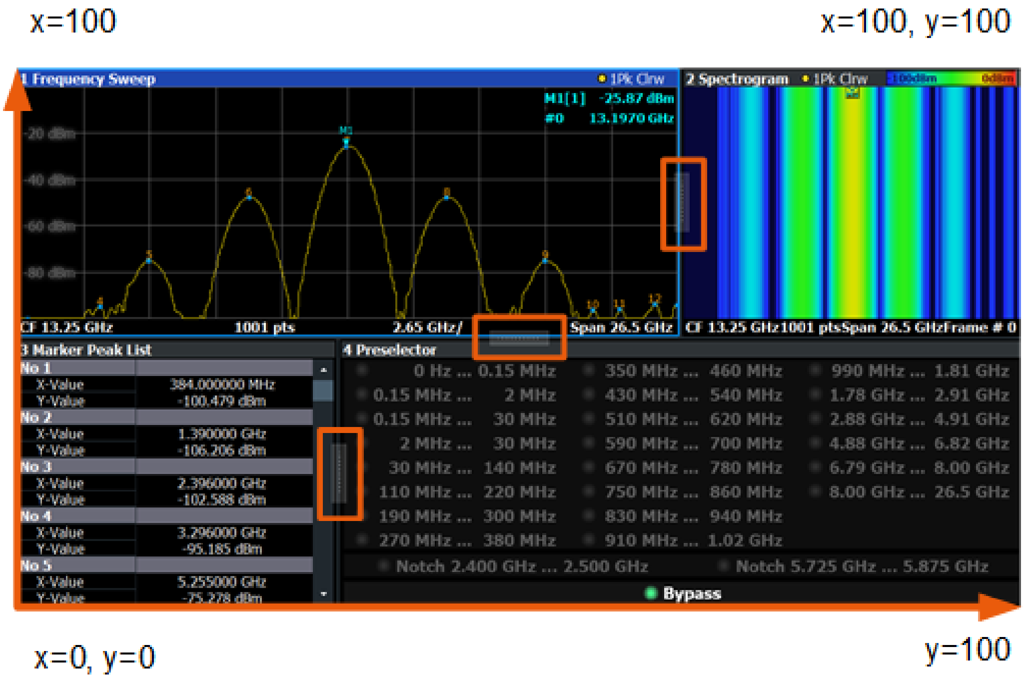


Figure 10-1: SmartGrid coordinates for remote control of the splitters

Setting parameters:

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

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

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 10-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

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

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Peak List"') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

Usage: Setting only

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

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

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

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

Suffix:
<n> Window

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 241 for a list of available window types.

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

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

Usage: Query only

LAYout:WINDow<n>:IDENtify?

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

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

Suffix:
<n> Window

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

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

Usage: Query only

LAYout:WINDow<n>:REMove

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

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

Suffix:
<n> Window

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

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

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

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

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

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 241 for a list of available window types.

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

Usage: Setting only

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see `LAYout:ADD[:WINDow]?` on page 241.

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

Suffix:

<n> 1..n
Window

Parameters:

<WindowType>

Example: `LAY:WIND2:TYPE?`

10.7.3 Configuring specific result displays

The following command configure specific result displays.

CONFigure:US:NORMalize:CM:CERRor:STATe <State>

Defines how the sample clock error is determined.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off
The calculated sample clock error is determined with reference to the 102.4 MHz specified by the DOCSIS 3.1 standard.

ON | 1
Switches the function on
The sample clock error (`CERR`) of the cable modem is normalized with reference to the reference sample clock of the CMTS (see `CONFigure:US:NORMalize:CMTSref:SCLock` on page 250).

*RST: 0

Example:
```
CONF:US:NORM:CM:CERR:STAT ON
CONF:US:NORM:CMTS:SCL:UNIT PPM
CONF:US:NORM:CMTS:SCL 1.2
```

Manual operation: See "Normalize CM Sample Clock Error Result (upstream only)" on page 122

CONFigure:US:NORMalize:CMTSref:SCLock <RefSampleClock>

Defines the reference value used to normalize the CM sample clock error, if normalization is enabled (see `CONFigure:US:NORMalize:CM:CERRor:STATe` on page 249).

Specify the unit (and thus type) of the reference value using `CONFigure:US:NORMalize:CMTSref:SCLock:UNIT` on page 250.

Parameters:

<RefSampleClock> numeric value

Default unit: HZ

Example:
```
CONF:US:NORM:CM:CERR:STAT ON
CONF:US:NORM:CMTS:SCL:UNIT PPM
CONF:US:NORM:CMTS:SCL 1.2
```

Manual operation: See "CMTS Reference Sample Clock (Error) (upstream only)" on page 123

CONFigure:US:NORMalize:CMTSref:SCLock:UNIT <RefSmplClkUnit>

This command configures the unit of the reference value for the CMTS sample clock (see `CONFigure:US:NORMalize:CMTSref:SCLock` on page 250).

Parameters:

<RefSmplClkUnit> HZ | PPM

HZ
The actual sample clock value used by the CMTS is provided as a reference.

PPM
The error of the sample clock value used by the CMTS compared to the specified value of 102.4 MHz is provided as a reference.

Example:
```
CONF:US:NORM:CM:CERR:STAT ON
CONF:US:NORM:CMTS:SCL:UNIT PPM
CONF:US:NORM:CMTS:SCL 1.2
```

Manual operation: See "CMTS Reference Sample Clock (Error) (upstream only)" on page 123

DISPlay[:WINDow<n>]:BITStream:LAYout <State>

Determines how the bits are displayed in the Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

Suffix:
<n> 1..n
Window

Parameters:
<State> COMPact | EXPanded

COMPact
Only the first (max.) 25 bytes are displayed for each codeword, so that one row per codeword is displayed in the table.

EXPanded
Aall bytes for each codeword are displayed, where each row displays a maximum of 20 bytes. Thus, a single codeword can require multiple rows.

Example: `DISP:WIND:BITS:LAYout COMP`

Manual operation: See "Bitstream Layout" on page 121

DISPlay[:WINDow<n>]:TABLe:ITEM <Item>, <State>
DISPlay[:WINDow<n>]:TABLe:ITEM? <Item>

This command specifies which parameters are displayed in the "Result Summary" display. Note that all parameters are calculated, regardless of their visibility.

Suffix:
<n> 1..n
irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the parameter display off

ON | 1
Switches the parameter display on

*RST: 1

Parameters for setting and query:
<Item> MER | MERData | MERPilot | FERRor | CERRor | PERRor | TPLC | TFRame | IQOFfset | GIMBalance | QOFFset | IQTSkew | POWer | PSPLc | AMINislots | PDATa | PSPilots | PCPilots | ZBIT

For details on the individual parameters and the assignment of the parameters to the keywords see Table 3-1.

Example: `DISP:WIND:TABL:ITEM MERD,ON`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

[SENSe:]SWEep:FMODE:STATe <State>

Defines the colors used for modulation display.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Different colors are used for different modulation types (see "Constellation" on page 21). Which modulation types are displayed (depending on the selected object) is configurable.

ON | 1
The constellation uses a single color for all modulations, which improves performance. However, individual modulation types cannot be selected.

*RST: 1

Example: `SENS:SWE:FMOD:STAT ON`

Manual operation: See "Fast Mode (Single Color)" on page 119

[SENSe:]MODulation:SELect <ModFilterType>

Defines the modulation for which the "Constellation" diagram is displayed.

Parameters:

<ModFilterType> ALL | ZEROBIT | BPSK | QPSK | QAM16 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | QAM8192 | QAM16384

Example: `MOD:SEL QAM16`

Manual operation: See "Constellation" on page 21
See "Modulation" on page 119

[SENSe:]OBJect:SELect <ObjectID>

Defines the objects for which the "Constellation" diagram is displayed.

Parameters:

<ObjectID> ALL | ZEROBIT | BPSK | QPSK | QAM16 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | QAM8192 | QAM16384

Information type

ALL
All information types

PILots
Pilots

PLCData
(Downstream only:) PLC Data

PLCPreamble
(Downstream only:) PLC Preamble

NCPA
(Downstream only:) NCP All

A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P
(Downstream only:) Codeword A .. P

CPILots
(Upstream only:) Complementary Pilots

PROFile
(Upstream only:) Current profile

SPILots
(Downstream only:) Scattered pilots

CONPilots
(Downstream only:) Continuous pilots

Example: `OBJ:SEL B`

Manual operation: See "Constellation" on page 21
See "Object" on page 118

[SENSe:]SUBCarrier:SELect <EvaluationRange>

Defines the evaluation range for the "Constellation" diagram.

Parameters:
<EvaluationRange>

numeric value between 0 and 8191
The constellation diagram is restricted to the specified subcarrier.

ALL
The "Constellation" diagram is displayed for all configured or detected subcarriers.

*RST: ALL

Example: `SUBC:SEL 7`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Constellation" on page 21
See "Subcarrier" on page 119

[SENSe:]SYMBol:SELect <EvaluationRange>

Defines the evaluation range for the "Constellation" diagram.

Parameters:
<EvaluationRange>

numeric value between 0 and 127
The constellation diagram is restricted to the specified symbol.

ALL
The "Constellation" diagram is displayed for all symbols.

*RST: ALL

Example: `SYMB:SEL 7`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Constellation" on page 21
See "Symbol" on page 119

[SENSe:]SYMBol:SIZE <SymbolSize>

Defines the size of the individual symbol points in the Constellation diagram.

Parameters:
<SymbolSize> S1 | S2 | S3

S1
One symbol point is displayed by 1 pixel on the x-axis and 1 pixel on the y-axis

S2
One symbol point is displayed by 2 pixels on the x-axis and 2 pixels on the y-axis

S3
One symbol point is displayed by 3 pixels on the x-axis and 3 pixels on the y-axis

*RST: S1

Example: `SENS:SYMB:SIZE S2`

Manual operation: See "Symbol Points Size" on page 119

UNIT:POWer <TablePowerUnit>

Determines whether the power results in the "Result Summary" are calculated as absolute values or relative to the power of the data subcarriers.

Parameters:
<TablePowerUnit> ABSolute | RELative

ABSolute
Power results are provided as absolute values. The unit depends on the `CALCulate<n>:UNIT:POWer` command.

RELative
Power results are provided relative to the power measured in the data subcarriers.

*RST: REL

Example:
```
UNIT:POW ABS
CALC:UNIT:POW DBM
```
Sets the power unit to absolute values in dBm.

Manual operation: See "Power Unit" on page 122

10.7.4 Configuring synchronous band power results

The bands in which power is to be measured can be configured automatically by the R&S FSW DOCSIS 3.1 application or manually.

CONFigure:US:CHANnel:SBPower:CONFigure <SBPConfigure>

Defines how the bands for which the power is calculated are detected.

Parameters:

<SBPConfigure> STANdard | USER

STANdard
The bands are detected strictly according to the DOCSIS 3.1 standard.

USER
The bands are detected by user-defined settings.

*RST: STANdard

Example: `CONFigure:US:CHANnel:SBPower:CONFigure STAN`

Manual operation: See "Band Auto Config" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:AUTO[:STATe] <Auto>

Determines how the bands to be measured are configured - automatically by the R&S FSW DOCSIS 3.1 application, or manually by the user.

For details see "Auto Configuration per Continuous Minislot Block" on page 128.

Parameters:

<Auto> ON | OFF | 0 | 1

OFF | 0
You must define the power bands manually.

ON | 1
The R&S FSW DOCSIS 3.1 application calculates the lower and upper band power for each continuous block of minislots. Each block is detected by its rising and falling edges.

*RST: 1

Example: `CONFigure:US:CHANnel:SBPower:CONFigure:AUTO ON`

Manual operation: See "Auto Configuration per Continuous Minislot Block" on page 128

CONFigure:US:CHANnel:SBPower:CONFigure:AUTO:BANDs <SBPAllMinislots>

This command specifies when auto defined bands are displayed.

Parameters:

<SBPAllMinislots> EDGes | ALL

EDGes
Auto defined bands are displayed only at the first and last edges.

ALL
Auto defined bands are displayed at the start and end of each minislot block.

*RST: EDGes

Example: `CONFigure:US:CHANnel:SBPower:CONFigure:AUTO:BANDs EDGes`

Manual operation: See "Auto Bands are applied to" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:ACHannel:SCARrier <SCarrier>
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:ALTernate:SCARrier <SCarrier>
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:CHANnel<ch>:SCARrier <SCarrier>

This command specifies the bandwidth of the specified channel as the number of sub-carriers it contains.

Suffix:

<ch> 1..n
1: adjacent channel
2: alternate channel

Parameters:

<SCarrier> integer

Number of subcarriers within the channel.
The maximum number of subcarriers (<max. no. subcarriers>) is $2*N_{FFT}-1$ (due to oversampling).

Range: 0 to <max. no. subcarriers>

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
CHAN1:SCAR 10
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
ACH:SCAR 10
```

Both commands have the same result: the adjacent channel bandwidth is set to 10 subcarriers

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
CHAN2:SCAR 10
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
ALT:SCAR 10
```

Both commands have the same result: the alternate channel bandwidth is set to 10 subcarriers

Manual operation: See "Band Configuration Table" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:ACHannel[:FREQuency] <SCFreq>
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:ALTernate[:FREQuency] <SCFreq>
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:CHANnel<ch>[:FREQuency] <SCFreq>

This command specifies the bandwidth of the specified channel as a frequency span.

Suffix:

<ch> 1..n
1: adjacent channel
2: alternate channel

Parameters:

<SCFreq> integer

Default unit: HZ

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
CHAN1:FREQ 40 KHZ
CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:
ACH:FREQ 40 KHZ
```

Both commands have the same result: the adjacent channel bandwidth is set to 40 kHz.

Example:
`CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:CHAN2:FREQ 40 KHZ`
`CONFigure:US:CHANnel:SBPower:CONFigure:BWIDth:ALT:FREQ 40 KHZ`
Both commands have the same result: the alternate channel bandwidth is set to 40 kHz.

Manual operation: See "Band Configuration Table" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:ACHannel:SCARrier <SCarrier>
CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:ALTernate:SCARrier <SCarrier>
CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:CHANnel<ch>:SCARrier <SCarrier>

This command specifies the offset to the specified channel as the number of subcarriers it contains.

Suffix:
<ch> 1..n
1: adjacent channel
2: alternate channel

Parameters:
<SCarrier> integer
Number of subcarriers from the edge of the minislot block at which the band will start.

Example:
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:CHAN1:SCAR 10`
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:ACH:SCAR 10`
Both commands have the same result: the offset to the adjacent channel is set to 10 subcarriers.

Example:
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:CHAN2:SCAR 10`
`CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:ALT:SCAR 10`
Both commands have the same result: the offset to the alternate channel is set to 10 subcarriers.

Manual operation: See "Band Configuration Table" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:ACHannel[:FREQuency] <SCFreq>
CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:ALTernate[:FREQuency] <SCFreq>
CONFigure:US:CHANnel:SBPower:CONFigure:OFFSet:CHANnel<ch>[:FREQuency] <SCFreq>

This command specifies the frequency offset to the specified channel.

Suffix:

<ch> 1..n
1: adjacent channel
2: alternate channel

Parameters:

<SCFreq> integer

Default unit: HZ

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:CHAN1:FREQ 40 KHZ
CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:ACH:FREQ 40 KHZ
```

Both commands have the same result: the offset to the adjacent channel is set to 40 kHz.

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:CHAN2:FREQ 40 KHZ
CONFigure:US:CHANnel:SBPower:CONFigure:OFFS:ALT:FREQ 40 KHZ
```

Both commands have the same result: the offset to the alternate channel is set to 40 kHz.

Manual operation: See "Band Configuration Table" on page 129

CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:BWIDth:SCARrier <SCarrier>

Defines the number of subcarriers in the power band to be measured

Suffix:

<ba> 1 to 20
User-configured power band

Parameters:

<SCarrier> integer

Number of subcarriers within the band to be measured.
The maximum number of subcarriers (<max. no. subcarriers>) is $2*N_{FFT}-1$ (due to oversampling).

Range: 0 to <max. no. subcarriers>

Example:

```
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND1:BWIDth:SCARrier 10
```

Manual operation: See "Bandwidth [SC]" on page 131

CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:BWIDth[:FREQuency] <SCFreq>

Defines the bandwidth of the power band to be measured

Suffix:
<ba> 1 to 20
User-configured power band

Parameters:
<SCFreq> integer
Default unit: HZ

Example: `CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND1:BWIDth:FREQuency 40KHZ`

Manual operation: See "Bandwidth [Hz]" on page 131

CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:LOCation <SCarrier>

Defines the subcarrier at the specified edge of the power band to be measured (see `CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:LREFerence` on page 260).

Suffix:
<ba> 1 to 20
User-configured power band

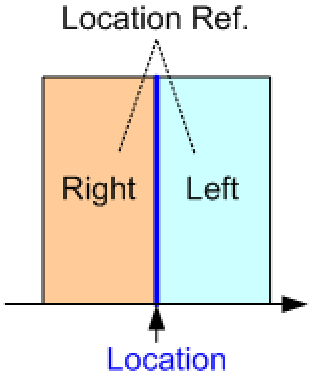
Parameters:
<SCarrier> integer
Number of subcarrier at which the band to be measured starts or ends.
The maximum subcarrier number (<max. sc no.>) is $2*N_{FFT}-1$ (due to oversampling).
Range: 0 to <max. sc no.>

Example:
```
CONF:US:CHAN:SBPO:CONF:USER:BAND:LREF LEFT
CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND1:LOCation 10
```
Defines a band to the right of subcarrier number 10.

Manual operation: See "Location [SC]" on page 131

CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>:LREFerence <SBPReference>

Defines whether the indicated "Location" is located on the left or on the right edge of the band to be measured.



Suffix:
<ba> 1 to 20
User-configured power band

Parameters:
<SBPReference> LEFT | RIGHt
Edge of the band to be measured

Example: `CONF:US:CHAN:SBPO:CONF:USER:BAND:LREF LEFT`

Manual operation: See "Location Reference" on page 131

CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND<ba>[:STATe] <BandState>

This command specifies whether the user configured band will be calculated as part of the Spectrum Band Power measurement results.

Suffix:
<ba> 1 to 20
User-configured power band

Parameters:
<BandState> ON | OFF | 0 | 1

OFF | 0
Switches the band off

ON | 1
Switches the band on

*RST: 0

Example: `CONFigure:US:CHANnel:SBPower:CONFigure:USER:BAND1:STATe ON`

Manual operation: See "State" on page 130
See "All Bands Off" on page 131

CONFigure:US:CHANnel:SBPower:UNIT:POWer <SBPUnit>

Defines the unit for power results.

Parameters:

<SBPUnit> ABSolute | RELative

ABSolute
Power results are provided as absolute values (dBm).

RELative
Power results are provided relative to the carrier (dBc).

*RST: RELative

Example: `CONF:US:CHAN:SBP:UNIT:POW ABS`

Manual operation: See "Power Unit" on page 128

10.7.5 Configuring scaling and units

The following commands are required to configure the scaling for DOCSIS 3.1 I/Q measurement results in a remote environment. The corresponding tasks for manual operation are described in Chapter 5.3.11.3, "Y-Scaling settings", on page 123.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO <Auto>

Activates or deactivates automatic scaling of the y-axis for the specified trace display.

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:

<Auto> ON | OFF | 0 | 1

OFF | 0
The y-axis is scaled according to the specified minimum/maximum values (see DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum/DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum) and number of divisions (see DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:DIVisions).

ON | 1
The R&S FSW DOCSIS 3.1 application automatically scales the y-axis to best fit the measurement results.

*RST: 1

Example: `DISP:WIND2:TRAC:Y:SCAL:AUTO ON`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Automatic Grid Scaling" on page 124

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:FIXed:RANGe <AutoFixRange>

Defines the use of fixed value limits.

Suffix:

<n> Window

<t> Trace

Parameters:

<AutoFixRange> NONE | LOWer | UPPer

NONE
Both the upper and lower limits are determined by automatic scaling of the y-axis.

LOWer
The lower limit is fixed (defined by DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum/DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum), while the upper limit is determined by automatic scaling of the y-axis.

UPPer
The upper limit is fixed, while the lower limit is determined by automatic scaling of the y-axis.

Example:
```
DISP:WIND1:TRAC:Y:AUTO:FIX:RANG LOW
DISP:WIND1:TRAC:Y:MIN 0dBm
```
Sets the lower limit of the y-axis to a fixed value of 0 dBm.

Manual operation: See "Auto Fix Range" on page 124

DISPlay[:WINDow<N>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:LOWer:UPPer <Value>

For automatic scaling based on hysteresis, this command defines the upper limit of the lower hysteresis interval.

If the minimum value in the current measurement exceeds this limit, the y-axis is rescaled automatically.

For details see "Hysteresis Interval Upper/Lower" on page 125.

Suffix:

<n> Window

<t> Trace

Parameters:

<Value> numeric value

Percentage of the currently displayed value range on the y-axis.

Example: `DISP:WIND2:TRAC:Y:SCAL:AUTO:HYST:LOW:UPP 5`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Hysteresis Interval Upper/Lower" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:LOWer:LOWer <Value>

For automatic scaling based on hysteresis, this command defines the lower limit of the lower hysteresis interval.

If the minimum value in the current measurement drops below this limit, the y-axis is rescaled automatically.

For details see "Hysteresis Interval Upper/Lower" on page 125.

Suffix:

<n> Window

<t> Trace

Parameters:

<Value> numeric value

Percentage of the currently displayed value range on the y-axis.

Example: `DISP:WIND2:TRAC:Y:SCAL:AUTO:HYST:LOW:LOW 5`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Hysteresis Interval Upper/Lower" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:UPPer:LOWer <Value>

For automatic scaling based on hysteresis, this command defines the lower limit of the upper hysteresis interval.

If the maximum value in the current measurement drops below this limit, the y-axis is rescaled automatically.

For details see "Hysteresis Interval Upper/Lower" on page 125.

Suffix:

<n> Window

<t> Trace

Parameters:

<Value> numeric value

Percentage of the currently displayed value range on the y-axis.

Example: `DISP:WIND2:TRAC:Y:AUTO:HYST:UPP:LOW 25`

Manual operation: See "Hysteresis Interval Upper/Lower" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:HYSTeresis:UPPer:UPPer <Value>

For automatic scaling based on hysteresis, this command defines the upper limit of the upper hysteresis interval.

If the maximum value in the current measurement exceeds this limit, the y-axis is rescaled automatically.

For details see "Hysteresis Interval Upper/Lower" on page 125.

Suffix:

<n> Window

<t> Trace

Parameters:

<Value> numeric value

Percentage of the currently displayed value range on the y-axis.

Example: `DISP:WIND2:TRAC:Y:AUTO:HYST:UPP:UPP 20`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Hysteresis Interval Upper/Lower" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:MEMory:DEPTh <NoMeas>

For automatic scaling based on memory, this value defines the number <x> of previous results to be considered when determining if rescaling is required.

The minimum and maximum value of each measurement are added to the memory. After <x> measurements, the oldest results in the memory are overwritten by each new measurement.

For details see "Auto Mode" on page 124.

Suffix:

<n> Window

<t> Trace

Parameters:

<NoMeas> integer value

Number of measurement results to be stored for autoscaling

Example: `DISP:WIND2:TRAC:Y:AUTO:MEM:DEPT 16`

Manual operation: See "Memory Depth" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:MODE <AutoMode>

Determines which algorithm is used to determine whether the y-axis requires automatic rescaling.

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:

<AutoMode> **HYSTeresis**
If the minimum and/or maximum values of the current measurement exceed a specific value range (hysteresis interval), the axis is rescaled. The hysteresis interval is defined as a percentage of the currently displayed value range on the y-axis. An upper hysteresis interval is defined for the maximum value, a lower hysteresis interval is defined for the minimum value.

MEMory
If the minimum and/or maximum values of the current measurement exceed the minimum and/or maximum of the <x> previous results, the axis is rescaled.
The minimum and maximum value of each measurement are added to the memory. After <x> measurements, the oldest results in the memory are overwritten by each new measurement.
The number of results in the memory to be considered is configurable (see `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:MEMory:DEPTh`).

*RST: HYSTeresis

Example: `DISP:WIND2:TRAC:Y:AUTO:MODE MEM`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Auto Mode" on page 124

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:DIVisions <Divisions>

Defines the number of divisions to be used for the y-axis in the specified window.

Separate division settings can be configured for individual result displays.

Suffix:

<n>	1..n Window
<t>	1..n Trace

Parameters:

<Divisions>	integer

Example: `DISP:WIND2:TRAC:Y:SCAL:DIV 10`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Number of Divisions" on page 126

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Max>

Defines the maximum value to be displayed on the y-axis of the specified evaluation diagram.

For automatic scaling with a fixed range (see `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:FIXed:RANGe` on page 263), the maximum defines the fixed upper limit.

Suffix:

<n>	1..n Window
<t>	1..n Trace

Parameters:

<Max>	numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MAX 100`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Minimum / Maximum" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Min>

Defines the minimum value to be displayed on the y-axis of the specified evaluation diagram.

For automatic scaling with a fixed range (see `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:FIXed:RANGe` on page 263), the minimum defines the fixed lower limit.

Suffix:

<n>	1..n Window
<t>	1..n Trace

Parameters:

<Min>	numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MIN -20`

Manual operation: See "Minimum / Maximum" on page 125

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <Multiple>[,<Multiple>]

Determines the values shown for each division on the y-axis in the specified window.

One or more multiples of 10^n can be selected. The R&S FSW DOCSIS 3.1 application then selects the optimal scaling from the selected values.

For details see "Scaling per division" on page 126.

Suffix:

<n>	Window
<t>	Trace

Parameters:

<Multiple> 1.0 | 2.0 | 2.5 | 5.0

Each division on the y-axis displays the selected multiple of 10^n.

*RST: 1.0,5.0

Example: `DISP:WIND:TRAC:Y:SCAL:PDIV 2.0,2.5`
Multiples of $2.0*10^n$ or multiples of $2.5*10^n$ are displayed on the y-axis.

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Manual operation: See "Scaling per division" on page 126

UNIT:BITStream <Bitstream>

Determines whether the data is displayed as bits or bytes (default) in a Bitstream result display, if activated (see "Bitstream (downstream only)" on page 20).

Parameters:

<Bitstream> BIT | BYTE

*RST: BYTE

Example: `UNIT:BITS BIT`

Manual operation: See "Bitstream (downstream only)" on page 20
See "Bitstream Format" on page 121

UNIT:CAXes <Caxes>

For result displays that evaluate a parameter per carrier (e.g. MER vs Carrier), this command defines whether the carrier number or the carrier frequency (in Hz) is displayed on the x-axis. Note, however, that this setting applies to *ALL* result displays based on carriers.

Parameters:

<Caxes> CARR | HZ

CARR
The carrier number is displayed on the x-axis of all carrier-based result displays.

HZ
The carrier frequency (in Hz) is displayed on the x-axis of all carrier-based result displays.

*RST: HZ

Example: `UNIT:CAX CARR`

Manual operation: See "Carrier Axes Unit" on page 120

10.8 Starting a measurement

When a DOCSIS 3.1 measurement channel is activated on the FSW, a DOCSIS 3.1 I/Q measurement (Modulation Accuracy, see Chapter 3.1, "DOCSIS 3.1 I/Q measurement", on page 14), is started immediately. However, you can stop and start a new measurement any time.

Furthermore, you can perform a sequence of measurements using the Sequencer (see Chapter 5.1, "Multiple measurement channels and sequencer function", on page 52).

ABORt

Aborts the measurement in the current channel and resets the trigger system.

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

For details on overlapping execution see Remote control via SCPI.

Note on blocked remote control programs:

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

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

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

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

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

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

Usage: Event

INITiate<n>:CONMeas

Restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single measurement mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:
<n> irrelevant

Usage: Asynchronous command

Manual operation: See "Continue Single Sweep" on page 107

INITiate<n>:CONTinuous <State>

Controls the measurement mode for an individual channel.

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

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1 (some applications can differ)

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

Manual operation: See "Continuous Sweep / Run Cont" on page 106

INITiate<n>[:IMMediate]

Starts a (single) new measurement.

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

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Usage: Asynchronous command

Manual operation: See "Single Sweep / Run Single" on page 107

INITiate:REFResh

The data in the capture buffer is re-evaluated by the R&S FSW DOCSIS 3.1 application. This is useful, for example, after evaluation changes have been made.

This function is only available if the Sequencer is deactivated and only in single sweep mode.

Example: `INIT:REFR`

Usage: Event

Manual operation: See "Refresh" on page 107

INITiate:SEQuencer:ABORt

Stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 272.

Usage: Event

Manual operation: See "Sequencer State" on page 53

INITiate:SEQuencer:IMMediate

Starts a new sequence of measurements by the Sequencer.

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

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 273).

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

Manual operation: See "Sequencer State" on page 53

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and channels it contains.

Note: To synchronize to the end of a measurement sequence using `*OPC`, `*OPC?` or `*WAI`, use `SINGle` Sequencer mode.

Parameters:

<Mode>

SINGle
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitly.

*RST: CONTinuous

Manual operation: See "Sequencer Mode" on page 53

SYSTem:SEQuencer <State>

Turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error occurs.

A detailed programming example is provided in the "Operating Modes" chapter in the FSW User Manual.

Parameters:
<State> ON | OFF | 0 | 1

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

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

*RST: 0

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

Manual operation: See "Sequencer State" on page 53

10.9 Retrieving results

The following commands are required to retrieve the results from a DOCSIS 3.1 measurement in a remote environment.

The *OPC command should be used after commands that retrieve data so that subsequent commands to change the trigger or data capturing settings are held off until after the data capture is completed and the data has been returned.

10.9.1 Numeric modulation accuracy results

The following commands describe how to retrieve the numeric results from the standard DOCSIS 3.1 measurements.

The commands to retrieve results from frequency sweep measurements for DOCSIS 3.1 signals are described in Chapter 10.9.2, "Numeric results for frequency sweep measurements", on page 293.

10.9.1.1 Frame statistic results

The following commands are required to determine the basis for statistical frame evaluation (see Table 3-2).

FETCh:FRAMe:COUNt?

This command returns the number of analyzed frames from the current capture buffer. If multiple measurements are required because the number of frames to analyze is greater than the number of frames that can be captured in one buffer, this command only returns the number of captured frames *in the current capture buffer* (as opposed to FETCh:FRAMe:COUNt:ALL?).

Return values:
<NoFrames> integer value

Example: FETC:FRAM:COUN?

Usage: Query only

Manual operation: See "Result Summary" on page 30
See "Signal Content Summary (downstream only)" on page 32

FETCh:FRAMe:COUNt:ALL?

This command returns the number of analyzed frames for the entire measurement. If multiple measurements are required because the number of frames to analyze is greater than the number of frames that can be captured in one buffer, this command returns the number of analyzed frames in *all* measurements (as opposed to `FETCh:FRAMe:COUNt?`).

Return values:
<NoFrames> integer value

Example: `FETC:FRAM:COUN:ALL?`

Usage: Query only

Manual operation: See "Result Summary" on page 30
See "Signal Content Summary (downstream only)" on page 32

10.9.1.2 Error parameter and detailed signal content results

The following commands are required to retrieve individual results from the DOCSIS 3.1 I/Q measurement on the captured I/Q data (see Chapter 3.1.1, "Modulation accuracy parameters", on page 14).

FETCh:BITStream:ALL?

This command returns the decoded payload data stream for each detected codeword in the currently captured I/Q data as a comma-separated list. For each codeword, the following information is displayed:

`<CW_Index>,<Object>,<Modulation>,<NoBits>,<NoEntries>,<Bits>,`

Note: Whether the result display is shown in compact or extended mode is irrelevant for the query results. However, the results do depend on whether bit or byte format is selected (see `UNIT:BITStream` on page 268).

For details see "Bitstream (downstream only)" on page 20.

Return values:

<CW_Index>	integer (0..1535) | nan Codeword index Not available (nan) for PLC, pilots and excluded subcarriers
<Object>	Information type

nan
Invalid data

PLCD
PLC Data

NCPCWA | ... | NCPCWP
NCP Codeword A...P

NCPC24
NCP CRC-24

NCPN
NCP Null

CWA | ... | CWP
Codeword A .. P

<Modulation>
BPSK | QPSK | QAM16 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | QAM8192 | QAM16384 | NONE | MIXED

Modulation (see "Modulation" on page 71)

<NoBits>
integer

Total number of bits in object

<NoEntries>
integer

Number of decoded payload bits
For byte format (see `UNIT:BITStream`): <NoEntries> := <NoBits> / 8
For bit format: <NoEntries> := <NoBits>

<Bits>
numeric value

Decoded payload bits in hexadecimal format

Example:

```
UNIT:BITS BYTE
FETC:BITS:ALL?
```

Result (in byte format):

```
nan,PLCD,QAM16,2880,360,1F,35,B0,FF,B3,58,78,63,47,F8,...
0,NCPCWC,QAM16,24,3,20,00,00,
1,NCPCWC,QAM16,24,3,20,06,54,
2,NCPCWA,QAM16,24,3,01,0C,A8,
0,NCPC24,QAM16,24,3,A4,74,7D,
0,CWC,QAM1024,14232,1779,A0,01,C0,04,80,1B,00,5A,01,DC,...
1,CWC,QAM1024,14232,1779,A0,01,C0,04,80,1B,00,5A,01,DC,...
2,CWA,QAM64,14232,1779,80,01,00,06,00,14,00,78,01,10,...
3,NCPCWD,QAM16,24,3,30,08,E9,
4,NCPCWD,QAM16,24,3,31,0E,2F,
1,NCPC24,QAM16,24,3,7E,E4,A4,
3,CWD,QAM4096,14232,1779,E0,00,40,01,80,05,00,1E,00,44,...
4,CWD,QAM4096,14232,1779,E0,00,40,01,80,05,00,1E,00,44,...
5,NCPCWD,QAM16,24,3,30,05,1D,
6,NCPCWC,QAM16,24,3,21,0A,63,
2,NCPC24,QAM16,24,3,F3,28,22,
5,CWD,QAM4096,14232,1779,E0,00,40,01,80,05,00,1E,00,44,...
```

Usage: Query only

Manual operation: See "Bitstream (downstream only)" on page 20

FETCh:CP?

Queries the automatically determined or specified cyclic prefix for the signal description.

Parameters:

<CyclicPrefix> (downstream)

S192
Useful symbol period starts after 192 samples or 0.9375µs.

S256
Useful symbol period starts after 256 samples or 1.25µs.

S512
Useful symbol period starts after 512 samples or 2.5µs.

S768
Useful symbol period starts after 768 samples or 3.75µs.

S1024
Useful symbol period starts after 1024 samples or 5.0µs.

<CyclicPrefix> (upstream)

S96
Useful symbol period starts after 96 samples or 0.9375 µs.

S128
Useful symbol period starts after 128 samples or 1.25 µs.

S160
Useful symbol period starts after 160 samples or 1.5625 µs.

S192
Useful symbol period starts after 192 samples or 0.9375µs.

S224
Useful symbol period starts after 224 samples or 1.875 µs.

S256
Useful symbol period starts after 256 samples or 2.5µs.

S288
Useful symbol period starts after 288 samples or 2.8125 µs.

S320
Useful symbol period starts after 320 samples or 3.125 µs.

S384
Useful symbol period starts after 384 samples or 3.75 µs.

S512
Useful symbol period starts after 512 samples or 5.0µs.

S640
Useful symbol period starts after 640 samples or 6.25 µs.

Usage: Query only

Manual operation: See "Cyclic Prefix CP" on page 75

FETCh:SCDetailed:ALL:FORMatted?

This command returns the following detailed signal content values as a comma-separated list:

```
<CW_INDEX>,<SYMBOL_START>,<OBJECT>,<MODULATION>,<MER>,<POWER>,
<SUBCARRIERS>,<LDPC_ITER>,<BER_PRE>,<BER_PRE_N>,<BER_POST>,
<BER_POST_N>,<CWERR_POST>,<CWERR_POST_N>,<RESERVED_1>,
<RESERVED_2>,<RESERVED_3>,<RESERVED_4>,
```

In the first rows, the information is provided for the following objects in the specified order:

Downstream:

- Scattered Pilots
- Continuous Pilots
- PLC preamble
- PLC data
- Excluded subcarriers

Upstream:

- Pilots
- Excluded subcarriers

Then, the information for each symbol in the order of the logical subcarriers is provided, with one row each for:

Downstream:

- NCPs
- Codewords

Upstream:

- Minislot sets

Tip: The `FETCh:SCSummary:ALL?` command returns the summarized information for the NCPs and codewords contained in the (downstream) input signal.

For details on individual parameters see Chapter 3.1.2, "Signal content information", on page 16.

Example: `FETC:SCD:ALL:FORM?`
Result: see Table 10-4

Usage: Query only

Manual operation: See "Signal Content Detailed" on page 31

Table 10-4: Sample result for FETC:SCD:ALL:FORM? for downstream signal

nan,nan,PIL,BPSK,53.1588020325,-34.8106689453,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,
nan,nan,PLCP,BPSK,52.8738098145,-40.8754196167,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,
nan,nan,PLCD,QAM16,53.4272041321,-40.8166618347,nan,nan,0,0,nan,nan,0,0,nan,nan,nan,nan,
0,0,NCPCWC,QAM16,53.4041290283,-41.4880905151,12,1,0,0,nan,nan,0,0,nan,nan,nan,nan,
1,0,NCPCWC,QAM16,52.8550567627,-39.9809684753,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
2,0,NCPCWA,QAM16,53.2005882263,-41.4098701477,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
0,0,NCPC24,QAM16,52.7113189697,-40.9022140503,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
0,0,CWC,QAM1024,53.3149108887,-40.9032096863,1620,0,0,0,0,0,0,0,nan,nan,nan,nan,
1,0,CWC,QAM1024,53.2711219788,-40.9649543762,1620,0,0,0,0,0,0,0,nan,nan,nan,nan,
2,0,CWA,QAM64,53.330871582,-40.7523536682,2700,0,0,0,0,0,0,0,nan,nan,nan,nan,
3,1,NCPCWD,QAM16,52.2366638184,-41.4213371277,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
4,1,NCPCWD,QAM16,54.4256401062,-38.9862823486,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
1,1,NCPC24,QAM16,51.8807907104,-40.8682556152,12,2,0,0,nan,nan,0,0,nan,nan,nan,nan,
3,1,CWD,QAM4096,53.1613197327,-41.0502662659,1350,0,0,0,0,0,0,0,nan,nan,nan,nan,
4,1,CWD,QAM4096,53.3801498413,-40.8685874939,1350,0,0,0,0,0,0,0,nan,nan,nan,nan,

Table 10-5: Sample result for FETC:SCD:ALL:FORM? for upstream signal

nan,nan,PIL,BPSK,32.7226867676,-53.2162704468,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,
0,0,CW,QPSK,5.97550678253,-53.2792778015,10,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,
0,nan,CPIL,BPSK,2.58250331879,-53.2162590027,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan,nan

FETCh:SCSummary:ALL?

This command returns the following summarized signal content values for all codewords as a comma-separated list:

```
<OBJECT>,<MODULATION>,<MER>,<OBJECT_COUNT>,<BER_PRE>,
<BER_PRE_N>,<BER_POST>,<BER_POST_N>,<CWERR_POST>,<CWERR_POST_N>,
```

Note: this command is not available for upstream measurements!

For details on individual parameters see Chapter 3.1.2, "Signal content information", on page 16.

The information is provided for the following data elements in the stated order:

- Pilots
- PLC Preamble
- PLC Data
- NCPs (all)
- Profile A
- ...
- Profile P

Example:
`FETC:SCS:ALL?`
Result:
```
PIL,BPSK,53.1570854187,nan,nan,nan,nan,nan,nan,nan,
PLCP,BPSK,52.8738098145,1,nan,nan,nan,nan,nan,nan,
PLCD,QAM16,53.4272041321,1,0,0,nan,nan,0,0,
NCPA,QAM16,53.28358078,387,0,0,nan,nan,0,0,
PROFA,QAM64,53.2824478149,67,0,0,0,0,0,0,
PROFB,QAM1024,53.3110733032,59,0,0,0,0,0,0,
PROFC,QAM1024,53.315738678,63,0,0,0,0,0,0,
PROFD,QAM4096,53.2790908813,64,0,0,0,0,0,0
```

Usage: Query only

Manual operation: See "Signal Content Summary (downstream only)" on page 32

FETCh:SUMMary:ALL?

This command returns all result summary values as a comma-separated list in the order they are displayed in the result display. For details see Chapter 3.1.1, "Modulation accuracy parameters", on page 14.

Return values:

<ResultDownstr> <list>

<ResultDownstr> <list>

Example:
```
FETC:SUMM:ALL?
//Result downstream:
96.1896514893,96.1896514893,nan,96.1896514893,
96.8796691895,96.8796691895,nan,96.8796691895,
96.0657196045,96.0657196045,nan,96.0657196045,
-0.00001588321,-0.00001588321,nan,-0.00001588321,
0.00000242496,0.00000242496,nan,0.00000242496,
0.00260711415,nan,nan,nan,
-23.3121681213,-23.3121681213,nan,-23.3121681213,
-37.5809326172,-37.5809326172,nan,-37.5809326172,
0,0,nan,0,
6.0314707756,6.0314707756,nan,6.0314707756,
6.0314707756,6.0314707756,nan,6.0314707756,
nan,nan,nan,nan
```

Example:

```
FETC:SUMM:ALL?
//Result upstream:
77.3063659668,77.3063659668,nan,77.3063659668,
77.2246017456,77.2246017456,nan,77.2246017456,
78.3213577271,78.3213577271,nan,78.3213577271,
nan,nan,nan,nan,
1.00010681152,1.00010681152,nan,1.00010681152,
2.53933226985E-14,nan,nan,nan,
-20.4491291046,-20.4491291046,nan,-20.4491291046,0,
0,nan,0,0.01217675768,
0.01217675768,nan,0.01217675768,-20.4491291046,
-20.4491291046,nan,-20.4491291046
```

Usage: Query only

Manual operation: See "Result Summary" on page 30

FETCh:SUMMary:CERRor[:AVERage]?
FETCh:SUMMary:CERRor:MAXimum?
FETCh:SUMMary:CERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?
FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:MER[:AVERage]?
FETCh:SUMMary:MER:MAXimum?
FETCh:SUMMary:MER:MINimum?
FETCh:SUMMary:MERData[:AVERage]?
FETCh:SUMMary:MERData:MAXimum?
FETCh:SUMMary:MERData:MINimum?
FETCh:SUMMary:MERPilot[:AVERage]?
FETCh:SUMMary:MERPilot:MAXimum?
FETCh:SUMMary:MERPilot:MINimum?
FETCh:SUMMary:PERRor[:AVERage]?
FETCh:SUMMary:PERRor:MAXimum?
FETCh:SUMMary:PERRor:MINimum?
FETCh:SUMMary:POWer[:AVERage]?
FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer:AMINislots:MAXimum?
FETCh:SUMMary:POWer:AMINislots:MINimum?
FETCh:SUMMary:POWer:AMINislots[:AVERage]?
FETCh:SUMMary:POWer:CONPilots:MAXimum?
FETCh:SUMMary:POWer:CONPilots:MINimum?
FETCh:SUMMary:POWer:CONPilots[:AVERage]?
FETCh:SUMMary:POWer:DATA:MAXimum?
FETCh:SUMMary:POWer:DATA:MINimum?
FETCh:SUMMary:POWer:DATA[:AVERage]?
FETCh:SUMMary:POWer:PILots:MAXimum?
FETCh:SUMMary:POWer:PILots:MINimum?
FETCh:SUMMary:POWer:PILots[:AVERage]?

FETCh:SUMMary:POWer:SPILots:MAXimum?
FETCh:SUMMary:POWer:SPILots:MINimum?
FETCh:SUMMary:POWer:SPILots[:AVERage]?
FETCh:SUMMary:POWer:SPLC:MAXimum?
FETCh:SUMMary:POWer:SPLC:MINimum?
FETCh:SUMMary:POWer:SPLC[:AVERage]?
FETCh:SUMMary:TFRame[:AVERage]?
FETCh:SUMMary:TFRame:MAXimum?
FETCh:SUMMary:TFRame:MINimum?
FETCh:SUMMary:TPLC[:AVERage]?
FETCh:SUMMary:TPLC:MAXimum?
FETCh:SUMMary:TPLC:MINimum?
FETCh:SUMMary:ZBIT[:AVERage]?
FETCh:SUMMary:ZBIT:MAXimum?
FETCh:SUMMary:ZBIT:MINimum?
FETCh:SUMMary:<parameter>:AVERage|MAXimum|MINimum?

These commands return the average, maximum or minimum result of the specified parameter. For details and an assignment of the parameters to the keywords see Table 3-1.

Example: `FETC:SUMM:MER:MAX?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

10.9.1.3 Querying PLC information

The *Physical Link Channel (PLC)* contains general transmission information. The following commands query the information in the PLC from the individual OFDM symbols contained in the input signal.

The PLC information can only be provided for downstream DOCSIS 3.1 signals.

For details on the individual types of information, see Chapter 3.1.3, "PLC information", on page 18.

FETCh:PLCMessages:NCP:ASSignment?

Queries the subcarrier to codeword assignment defined by the Next Codeword Pointer (NCP) from the PLC messages. The result is a comma-separated list of assignments with the following syntax:

<Codeword>,<SubCarriers>

Return values:

<Result> numeric values, separated by comma or colon

Assigned subcarriers with the specified modulation

separated by comma
individual subcarriers

separated by colon
Sequence of subcarriers from <start>:<stop>

Example:
```
FETC:PLCM:NCP:ASS?
//Result:
0:1:1108,2988:1:4095,1145,1218,1291
```

Usage: Query only

FETCh:PLCMessages:NCP:CCCount?

Queries the NCP configuration change count from the PLC messages

Return values:

<Result> integer

Example:
```
FETC:PLCM:NCP:CCC?
//Result:
//0
```

Usage: Query only

FETCh:PLCMessages:NCP:DCID?

Queries the NCP downstream channel ID from the PLC messages

Return values:

<Result> integer

Example:
```
FETC:PLCM:NCP:DCID?
//Result:
//1
```

Usage: Query only

FETCh:PLCMessages:NCP:MODulation?

Queries the modulation used by the Next Codeword Pointer (NCP) from the PLC messages

Return values:

<Result> BPSK | QPSK | QAM16 | QAM64 | QAM128 | QAM256 | QAM512 | QAM1024 | QAM2048 | QAM4096 | QAM8192 | QAM16384 | NONE | MIXED

Example:
```
FETC:PLCM:NCP:MOD?
//Result:
//QAM16
```

Usage: Query only

Manual operation: See "NCP Modulation" on page 61

FETCh:PLCMessages:OCD:CCCount?

Queries the OFDM downstream configuration change count from the PLC messages

Return values:

<Result> integer

Example:
```
FETC:PLCM:OCD:CCC?
//Result:
//0
```

Usage: Query only

FETCh:PLCMessages:OCD:CP?

Queries the length of the configurable cyclic prefix from the PLC messages

Return values:

<Result> <char_data>

S192
Useful symbol period starts after 192 samples or 0.9375µs.

S256
Useful symbol period starts after 256 samples or 1.25µs.

S512
Useful symbol period starts after 512 samples or 2.5µs.

S768
Useful symbol period starts after 768 samples or 3.75µs.

S1024
Useful symbol period starts after 1024 samples or 5.0µs.

*RST: AUTO

Example:
```
FETC:PLCM:OCD:CP?
//Result
S192
```

Usage: Query only

Manual operation: See "Cyclic Prefix CP" on page 59

FETCh:PLCMessages:OCD:CPILots?

Queries the subcarriers used as continuous pilots from the PLC messages

Return values:

<Result> numeric values, separated by comma or colon

Subcarriers used as continuous pilots

separated by comma
individual subcarriers

separated by colon
Sequence of subcarriers from <start>:<stop>

Example:
```
FETC:PLCM:OCD:CPIL?
//Result:
//0:1:1108,2988:1:4095,1145,1218,1291
```

Usage: Query only

FETCh:PLCMessages:OCD:DCID?

Queries the OFDM downstream channel ID from the PLC messages

Return values:

<Result> integer

Example:
```
FETC:PLCM:OCD:DCID?
//Result:
//1
```

Usage: Query only

FETCh:PLCMessages:OCD:DFTSize?

Queries the length of the FFT defining the OFDM transmission from the PLC messages

Return values:

<Result> <char_data>

FFT2k
Upstream only:
2048 subcarriers at = 50 kHz spacing; FFT length = 2048 samples

FFT4k
Downstream: 4096 subcarriers at = 50 kHz spacing; FFT length = 4096 samples
Upstream: 4096 subcarriers at = 25 kHz spacing; FFT length = 4096 samples

FFT8k
Downstream only:
8192 subcarriers at 25 kHz spacing; FFT length = 8192 samples

*RST: FFT4K

Example:
```
FETC:PLCM:OCD:DFTS?
//Result:
//FFT4K
```

Usage: Query only

FETCh:PLCMessages:OCD:ESUBcarriers?

Queries the excluded subcarriers from the PLC messages

Return values:

<Result> numeric values, separated by comma or colon

Excluded subcarriers

separated by comma
individual subcarriers

separated by colon
Sequence of subcarriers from <start>:<stop>

Example:
```
FETC:PLCM:OCD:ESUB?
//Result:
//0:1:1108,2988:1:4095,1145,1218,1291
```

Usage: Query only

FETCh:PLCMessages:OCD:PLC:INDex?

Queries the starting subcarrier index of the PLC from the PLC messages

Return values:

<Result> integer

Subcarrier number

Range: 1 to 8191

Example:
```
FETC:PLCM:OCD:PLC:IND?
//Result:
//2044
```

Usage: Query only

Manual operation: See "PLC Start Index L" on page 61

FETCh:PLCMessages:OCD:ROFF?

Queries the roll-off period for the Tukey raised-cosine window from the PLC messages

Return values:

<Result> <char_data>

AMRO
The maximum possible roll-off period.

S0
No samples in the roll-off period.

S64
The roll-off period contains 64 samples and lasts 0.3125 µs.

S128
The roll-off period contains 128 samples and lasts 0.625 µs.

S192
The roll-off period contains 192 samples and lasts 0.9375 µs.

S256
The roll-off period contains 256 samples and lasts 1.25 µs.

*RST: AMRO

Example:

```
FETC:PLCM:OCD:ROFF?
//Result
S192
```

Usage: Query only

Manual operation: See "Roll-off" on page 60

FETCh:PLCMessages:OCD:SLOCation?

Queries the center frequency of the subcarrier 0 of the OFDM channel (f_{sc0}) from the PLC messages

Return values:

<Result> numeric value

Example:

```
FETC:PLCM:OCD:SLOC?
//Result:
97600000
```

Usage: Query only

Manual operation: See "OFDM Spectrum Location" on page 59

FETCh:PLCMessages:OCD:TIDepth?

Queries the maximum number of delay lines used for time interleaving from the PLC messages

Return values:

<Result> integer

Example:

```
FETC:PLCM:OCD:TID?
//Result:
8
```

Usage: Query only

Manual operation: See "Time-Interleaving Depth" on page 60

FETCh:PLCMessages:PROFile<i>:ASSignment?

Queries the profile to subcarrier assignment from the PLC messages. The result is a comma-separated list of assignments with the following syntax:

<Modulation>,<SubCarriers>

Suffix:

<i> 1..n
currently irrelevant; only profile A is queried

Return values:

<Result> char data | string

Example:
```
FETC:PLCM:PROF:ASS?
//Result:
QAM1024,1108:1:1207,1145,1218,1291,
ZEROBIT,1208:1:1608,
QAM1024,1609:1:2987
```

Usage: Query only

FETCh:PLCMessages:PROFile<i>:CCCount?

Queries the profile configuration change count from the PLC messages

Suffix:

<i> 1..n
currently irrelevant; only profile A is queried

Return values:

<Result> numeric value

Example:
```
FETC:PLCM:PROF:CCC?
//Result:
//0
```

Usage: Query only

FETCh:PLCMessages:PROFile<i>:DCID?

Queries the profile downstream channel ID from the PLC messages

Suffix:

<i> 1..n
currently irrelevant; only profile A is queried

Example:
```
FETC:PLCM:PROF:DCID?
//Result:
//1
```

Usage: Query only

FETCh:PLCMessages:TIMestamp?

Returns the time the PLC was created

Return values:

<Result> numeric value

Example:
```
FETC:PLCM:TIM?
//Result:
//7421932186250235732
```

Usage: Query only

10.9.1.4 Querying limits

The following commands are required to query the limits against which the individual parameter results are checked. The limits are defined in the DOCSIS 3.1 standard.

CALCulate<n>:LIMit<li>:SUMMary:CERRor[:AVERage]?
CALCulate<n>:LIMit<li>:SUMMary:CERRor:MAXimum?

This command queries the average or maximum sample/symbol clock error limit for all frames as determined by the default DOCSIS 3.1 measurement.

Suffix:

<n> 1..n
irrelevant

 1..n

Return values:

<Value> numeric value
Default unit: ppm

Example:
```
CALC:LIM:SUMM:CERR:MAX?
```

Usage: Query only

CALCulate<n>:LIMit<li>:SUMMary:FERRor[:AVERage]?
CALCulate<n>:LIMit<li>:SUMMary:FERRor:MAXimum?

This command queries the average or maximum center frequency error limit for all frames as determined by the default DOCSIS 3.1 measurement.

Suffix:

<n> 1..n
irrelevant

 1..n

Return values:

<Value> numeric value
Default unit: Hz

Example: `CALC:LIM:SUMM:FERR:MAX?`

Usage: Query only

CALCulate<n>:LIMit<li>:SUMMary:MER[:MINimum]?

This command queries the minimum modulation error ratio (MER) limit for all data + pilot carriers as determined by the default DOCSIS 3.1 measurement.

Suffix:

<n> 1..n
irrelevant

 1..n

Return values:

<Value> numeric value
Default unit: dB

Example: `CALC:LIM:SUMM:MER:MIN?`

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

CALCulate<n>:LIMit<li>:SUMMary:MERData[:MINimum]?

This command queries the minimum modulation error ratio (MER) limit for all data carriers as determined by the default DOCSIS 3.1 measurement.

Suffix:

<n> 1..n
irrelevant

 1..n

Return values:

<Value> numeric value
Default unit: dB

Example: `CALC:LIM:SUMM:MERD:MIN?`

Usage: Query only

CALCulate<n>:LIMit<li>:SUMMary:MERPilot[:MINimum]?

This command queries the minimum modulation error ratio (MER) limit for all pilots as determined by the default DOCSIS 3.1 measurement.

Suffix:

<n> 1..n
irrelevant

 1..n

Return values:

<Value> numeric value
Default unit: dB

Example: `CALC:LIM:SUMM:MERP:MIN?`

Usage: Query only

10.9.1.5 Limit check results

The following commands are required to query the results of the limit checks.

CALCulate<n>:LIMit<li>:SUMMary:CERRor:MAXimum:RESult?
CALCulate<n>:LIMit<li>:SUMMary:CERRor[:AVERage]:RESult?
CALCulate<n>:LIMit<li>:SUMMary:FERRor:MAXimum:RESult?
CALCulate<n>:LIMit<li>:SUMMary:FERRor[:AVERage]:RESult?
CALCulate<n>:LIMit<li>:SUMMary:MER[:MINimum]:RESult?
CALCulate<n>:LIMit<li>:SUMMary:MERData[:MINimum]:RESult?
CALCulate<n>:LIMit<li>:SUMMary:MERPilot[:MINimum]:RESult?

This command returns the result of the limit check for the specified parameter. The limit value is defined by the DOCSIS 3.1 standard (see Chapter 10.9.1.4, "Querying limits", on page 290).

For details and an assignment of the parameters to the keywords see Table 3-1.

Suffix:

<n> 1..n
irrelevant

 1..n

Example: `CALC:LIM:SUMM:MERP:MIN:RES?`

Usage: Query only

10.9.1.6 Synchronous power band results

CALCulate<n>:US:CHANnel:SBPower:BAND<n>:RESult?

This command queries the band power result of the specified band.

Suffix:

<n>	irrelevant
<n>	1 to 20 Configured power band
Example:	`CALC:US:CHAN:SBP:BAND2:RES?`
Usage:	Query only
Manual operation:	See "Synchronous Band Power (upstream only)" on page 33

10.9.2 Numeric results for frequency sweep measurements

The following commands are required to retrieve the numeric results of the DOCSIS 3.1 frequency sweep measurements (see Chapter 3.2, "Frequency sweep measurements", on page 34.

In the following commands used to retrieve the numeric results for RF data, the suffixes <n> for CALCulate and <k> for LIMit are irrelevant.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult? <PowerResult>

This command queries the results of power measurements.

Suffix:

<n>	1..n irrelevant
<m>	1..n

Query parameters:

<PowerResult>	**OBANdwidth | OBWidth** Occupied bandwidth. Returns the occupied bandwidth in Hz.
Example:	`CALC:MARK:FUNC:POW:RES?`
Example:	For a detailed example see Chapter 10.13.2, "Measurement 2: determining the occupied bandwidth", on page 318
Usage:	Query only
Manual operation:	See "Occupied Bandwidth" on page 35

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

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

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

Suffix:

<n> Window

<m> Marker

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.
Range: The range depends on the current x-axis range.
Default unit: Hz

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

Manual operation: See "Marker Table" on page 24
See "Marker Peak List" on page 37
See "X-value" on page 140

CALCulate<n>:STATistics:RESult<res>? <ResultType>

Queries the results of a measurement for a specific trace.

Suffix:

<n> Window

<res> Trace

Query parameters:

<ResultType>

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example: `CALC:STAT:RES2? ALL`
Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage: Query only

Manual operation: See "CCDF" on page 36

10.9.3 Retrieving trace results

The following commands describe how to retrieve the trace data from the DOCSIS 3.1 I/Q measurement (Modulation Accuracy).

The traces for frequency sweep measurements are identical to those in the Spectrum application.

FORMat[:DATA] <Format>[, <BitLength>]

Selects the data format that is used for transmission of trace data from the FSW to the controlling computer.

Note that the command has no effect for data that you send to the FSW. The FSW automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats can be.

REAL
Floating-point numbers (according to IEEE 754) in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

<BitLength>

Length in bits for floating-point results

16
16-bit floating-point numbers.
Compared to `REAL,32` format, half as many numbers are returned.

32
32-bit floating-point numbers
For I/Q data, 8 bytes per sample are returned for this format setting.

64
64-bit floating-point numbers
Compared to `REAL,32` format, twice as many numbers are returned.

Example: `FORM REAL,32`

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

This command queries current trace data and measurement results from the selected window.

For details see Chapter 10.9.4, "Measurement results for TRACe<n>[:DATA]? TRACE<n>", on page 297.

Suffix:
<n> Window

Query parameters:
<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

Returns the trace data for the corresponding trace.
For most DOCSIS 3.1 I/Q measurements, only TRACe1 is available (unless specified otherwise in Chapter 10.9.4, "Measurement results for TRACe<n>[:DATA]? TRACE<n>", on page 297).

Example:
```
DISP:WIND2:SEL
TRAC? TRACe3
```
Queries the data of trace 3 in window 2.

Example: For a detailed example see Chapter 10.13.1, "Measurement 1: measuring modulation accuracy", on page 314.

Usage: Query only

Manual operation:
See "Constellation" on page 21
See "Group Delay" on page 23
See "Magnitude Capture" on page 23
See "MER vs Carrier" on page 24
See "MER vs Minislot (upstream only)" on page 25
See "MER vs Symbol" on page 26
See "MER vs Symbol X Carrier" on page 26
See "Phase vs Carrier" on page 27
See "Power vs Carrier (upstream only)" on page 28
See "Power vs Symbol X Carrier" on page 29
See "Power Spectrum" on page 29
See "Spectrum Flatness" on page 32

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

Queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

Suffix:
<n> Window

Query parameters:
<TraceNumber> Trace number.

Return values:
<X-Values>

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

10.9.4 Measurement results for TRACe<n>[:DATA]? TRACE<n>

The evaluation method selected by the `LAY:ADD:WIND` command also affects the results of the trace data query (see `TRACe<n>[:DATA]? TRACE<n>`).

Details on the returned trace data depending on the evaluation method are provided here.

All graphical results are based on a single frame only, namely the currently selected one (see `[SENSe:]FRAMe:SELect` on page 236).

No trace data is available for the following numeric evaluation methods:

- Bitstream
- Signal Content Detail
- Result Summary (Global/Detailed)

For details on the graphical results of these evaluation methods, see Chapter 3.1.4, "Evaluation methods for DOCSIS 3.1 I/Q measurements", on page 20.

10.9.4.1 Constellation

This measurement represents the complex constellation points *for the currently selected frame* as I and Q data. Each I and Q point is returned in floating point format.

Data is returned as a repeating array of interleaved I and Q data in groups of selected carriers per OFDM-Symbol, until all the I and Q data for the analyzed OFDM-Symbols is exhausted.

The following selections are possible:

- **All symbols** ([SENS:]SYMB:SELect ALL, see [SENSe:]SYMBol:SELect on page 253) **+ all subcarriers**
  ([SENS:]SUBC:SEL ALL[SENSe:]SUBCarrier:SELect on page 253
  Number of subcarriers (N_{FFT}) pairs of I and Q data per OFDM-Symbol:
  OFDM-Symbol 0: ($I_{0,0}$, $Q_{0,0}$), ($I_{0,1}$,$Q_{0,1}$),…,($I_{0,Nfft-1}$, $Q_{0,Nfft-1}$)
  OFDM-Symbol 1: ($I_{1,1}$, $Q_{1,1}$), ($I_{1,2}$,$Q_{1,2}$), …,($I_{1,Nfft-1}$, $Q_{1,Nfft-1}$)
  …
  OFDM-Symbol 127:
  ($I_{127,0}$, $Q_{127,0}$), ($I_{127,1}$,$Q_{127,1}$),…,($I_{127,Nfft-1}$, $Q_{127,Nfft-1}$)
- **One symbol only** ([SENS:]SYMB:SEL <x>, see [SENSe:]SYMBol:SELect on page 253) **+ all subcarriers** ([SENS:]SUBC:SEL ALL[SENSe:]SUBCarrier:SELect on page 253
  Number of subcarriers (N_{FFT}) pairs of I and Q data for selected OFDM-Symbol x:
  ($I_{x,0}$, $Q_{x,0}$), ($I_{x,1}$,$Q_{x,1}$), …,($I_{x,Nfft-1}$, $Q_{x,Nfft-1}$)
- **All symbols** ([SENS:]SYMB:SELect ALL, see [SENSe:]SYMBol:SELect on page 253) **+ one subcarrier** ([SENS:]SUBC:SEL <y>[SENSe:]SUBCarrier:SELect on page 253
  One pair of I and Q data (for subcarrier y) per OFDM-Symbol:
  OFDM-Symbol 0: ($I_{0,y}$, $Q_{0,y}$)
  OFDM-Symbol 1: ($I_{1,y}$, $Q_{1,y}$)
  …
  OFDM-Symbol 127:
  ($I_{127,y}$, $Q_{127,y}$)
- **One symbol only** ([SENS:]SYMB:SEL <x>, see [SENSe:]SYMBol:SELect on page 253) **+ one subcarrier** ([SENS:]SUBC:SEL <y>[SENSe:]SUBCarrier:SELect on page 253
  One pair of I and Q data for subcarrier y and selected OFDM-Symbol x:
  ($I_{x,y}$, $Q_{x,y}$)

10.9.4.2 Group delay

Returns one time deviation value per subcarrier (=N_{FFT} values) *for the currently selected frame*.

10.9.4.3 Magnitude capture

Returns the magnitude for each measurement point in all measurements (not only the current capture buffer). The number of measurement points depends on the input sample rate and the capture time (see "Number of Samples" on page 105), as well as the Frame Statistic Count / Number of Frames to Analyze.

10.9.4.4 MER vs carrier

Returns one modulation error ratio (in dB or %) per carrier (=N_{FFT} values), statistically evaluated over *the number of frames to anayze* (see [SENSe:]FRAMe:COUNt on page 236 and [SENSe:]FRAMe:COUNt:STATe on page 236).

Depending on the query parameter, following results are provided:

Query parameter	Result
<TRACe1>	Minimum
<TRACe2>	Average
<TRACe3>	Maximum

10.9.4.5 MER vs minislot (upstream only)

Returns one modulation error ratio (in dB or %) per minislot (= 237 values) *for the currently selected frame*.

Unconfigured minislots (for the upstream signal) return `NAN`.

10.9.4.6 MER vs symbol

Returns one modulation error ratio (in dB or %) per symbol (=128 values) *for the currently selected frame*.

10.9.4.7 MER vs symbol x carrier

Returns the modulation error ratio (in dB or %) for each subcarrier for one symbol at a time (= 128 * N_{FFT} values) *for the currently selected frame*.

$MER_{(0,1)}$, $MER_{(0,2)}$, $MER_{(0,3)}$, ..., $MER_{(0,Nfft-1)}$,

...

$MER_{(127,1)}$, $MER_{(127,2)}$, $MER_{(127,3)}$, ..., $MER_{(127,Nfft-1)}$,

10.9.4.8 Phase vs carrier

Returns one phase value (in ° or rad) per carrier (=N_{FFT} values) *for the currently selected frame*.

10.9.4.9 Power vs carrier (upstream only)

Returns one power value per carrier (=N_{FFT} values) *for the currently selected frame*.

The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

10.9.4.10 Power vs symbol x carrier

Returns the power value for each subcarrier for one symbol at a time (= 128 * N_{FFT} values) *for the currently selected frame*.

The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

$P_{(0,1)}$, $P_{(0,2)}$, $P_{(0,3)}$, …, $P_{(0,Nfft-1)}$,

...

$P_{(127,1)}$, $P_{(127,2)}$, $P_{(127,3)}$, …, $P_{(127,Nfft-1)}$,

10.9.4.11 Power spectrum

Returns one power density value (in power/Hz) for each subcarrier (=N_{FFT} values) *for the currently selected frame*.

The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

10.9.4.12 Spectrum flatness

The spectrum flatness evaluation returns one relative power value (in dB) per subcarrier (=N_{FFT} values) *for the currently selected frame*.

Supported data formats (FORMat:DATA): ASCii|REAL

10.9.4.13 CCDF – complementary cumulative distribution function

The length of the results varies; up to a maximum of 201 data points is returned, following a data count value. The first value in the return data represents the quantity of probability values that follow. Each of the potential 201 data points is returned as a probability value and represents the total number of samples that are equal to or exceed the current mean power level.

Probability data is returned up to the power level that contains at least one sample. It is highly unlikely that the full 201 data values will ever be returned.

Each probability value is returned as a floating point number, with a value between 0 and 1.

The syntax of the result is thus:

N, CCDF(0), CCDF(1/10), CCDF(2/10), …, CCDF((N-1)/10)

10.9.5 Retrieving captured I/Q data

The raw captured I/Q data is output in the form of a list.

TRACe:IQ:DATA?

Initiates a measurement with the current settings and returns the captured data from I/Q measurements.

Corresponds to:

INIT:IMM;*WAI;:TRACe:IQ:DATA:MEMory?

However, the TRACe:IQ:DATA? command is quicker in comparison.

Return values:

<Results> Measured voltage for I and Q component for each sample that has been captured during the measurement.

Default unit: V

Example:

```
TRAC:IQ:STAT ON
```
Enables acquisition of I/Q data
```
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096
```
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 0
Number of Samples = 4096
```
FORMat REAL,32
```
Selects format of response data
```
TRAC:IQ:DATA?
```
Starts measurement and reads results

Usage: Query only

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

Queries the I/Q data currently stored in the capture buffer of the FSW.

By default, the command returns all I/Q data in the memory. You can, however, narrow down the amount of data that the command returns using the optional parameters.

If no parameters are specified with the command, the entire trace data is retrieved.

In this case, the command returns the same results as TRACe:IQ:DATA?. (Note, however, that the TRAC:IQ:DATA? command initiates a new measurement before returning the captured values, rather than returning the existing data in the memory.)

The command returns a comma-separated list of the measured values in floating point format (comma-separated values = CSV). The number of values returned is 2 * the number of complex samples.

The total number of complex samples is displayed in the channel bar in manual operation and can be calculated as:

<SampleRate> * <CaptureTime>

Query parameters:

<OffsetSamples> Selects an offset at which the output of data should start in relation to the first data. If omitted, all captured samples are output, starting with the first sample.

Range: 0 to <# of samples> – 1, with <# of samples> being the maximum number of captured values

*RST: 0

<NoOfSamples> Number of samples you want to query, beginning at the offset you have defined. If omitted, all captured samples (starting at offset) are output.

Range: 1 to <# of samples> - <offset samples> with <# of samples> maximum number of captured values

*RST: <# of samples>

Return values:

<IQData> Measured value pair (I,Q) for each sample that has been recorded.
The first half of the list contains the I values, the second half the Q values.
The data format of the individual values depends on `FORMat[:DATA]` on page 295.

Default unit: V

Example:
// Perform a single I/Q capture.
`INIT;*WAI`
// Determine output format (binary float32)
`FORMat REAL,32`
// Read 1024 I/Q samples starting at sample 2048.
`TRAC:IQ:DATA:MEM? 2048,1024`

Usage: Query only

10.9.6 Importing and exporting I/Q data and results

The I/Q data to be evaluated in the R&S FSW DOCSIS 3.1 application can not only be measured by the R&S FSW DOCSIS 3.1 application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the R&S FSW DOCSIS 3.1 application can be exported for further analysis in external applications.

For details on importing and exporting I/Q data see the FSW User Manual.

MMEMory:LOAD:IQ:STATe 1, <FileName>

Restores I/Q data from a file.

Setting parameters:

<FileName> string

String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

Example: Loads IQ data from the specified file.

Usage: Setting only

MMEMory:STORe<n>:IQ:STATe <1>, <FileName>

Writes the captured I/Q data to a file.

By default, the contents of the file are in 32-bit floating point format.

Suffix:

<n>	1..n

Parameters:

<1>

<FileName>	String containing the path and name of the target file. The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.
Example:	`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'` Stores the captured I/Q data to the specified file.
Usage:	Asynchronous command

10.10 Analysis

The following commands define general result analysis settings concerning the traces and markers in standard DOCSIS 3.1 measurements. Currently, only one (Clear/Write) trace and one marker are available for standard DOCSIS 3.1 measurements.

Analysis for RF measurements

General result analysis settings concerning the trace, markers, lines etc. for RF measurements are identical to the analysis functions in the Spectrum application except for some special marker functions and spectrograms, which are not available in the R&S FSW DOCSIS 3.1 application.

For details see the "General Measurement Analysis and Display" chapter in the FSW User Manual.

10.10.1 Markers

Markers help you analyze your measurement results by determining particular values in the diagram. Currently, only 1 marker per window can be configured for standard DOCSIS 3.1 measurements.

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

Selects a reference marker for a delta marker other than marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<Reference> **1 to 4**
Selects markers 1 to 4 as the reference.
D1
Selects the deltamarker 1 as the reference.

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 141

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

Turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 140
See "Marker Type" on page 141

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

Moves a delta marker to a particular coordinate on the x-axis.

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

Suffix:

<n> Window

<m> Marker

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

Manual operation: See "X-value" on page 140

CALCulate<n>:MARKer<m>:AOFF

Turns off all markers.

Suffix:

<n> Window

<m> Marker

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

Manual operation: See "All Markers Off" on page 141

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

Turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 140
See "Marker Type" on page 141

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

Selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> Window

<m> Marker

Parameters:

<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Assigning the Marker to a Trace" on page 141

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

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Default unit: DBM

Usage: Query only

Manual operation: See "Marker Table" on page 24
See "CCDF" on page 36
See "Marker Peak List" on page 37
See "Y-value" on page 141

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

This command defines the position of a marker on the y-axis (symbol) for 3-dimensional result displays (MER vs Symbol X Carrier, Power vs Symbol X Carrier).

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 271.

Suffix:

<n> 1..n

<m> 1..n

Parameters:
<Value> Symbol at which the marker is placed.

Example: `CALC:MARK2:Y 20`

Manual operation: See "Y-value" on page 141

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

This command queries the value of a marker in 3-dimensional result displays (MER vs Symbol X Carrier, Power vs Symbol X Carrier).

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 271.

Suffix:
<n> Window

<m> Marker

Return values:
<Value> Result at the marker position (symbol, carrier).
For MER vs Symbol X Carrier: modulation error ratio (in dB or %)
For Power vs Symbol X Carrier: power value (in dBm)

Example: `CALC:MARK2:Z?`
Outputs the measured value of marker 2.

Usage: Query only

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

Turns the marker information in all diagrams on and off.

Suffix:
<n> irrelevant

Parameters:
<State> **ON | 1**
Displays the marker information in the diagrams.
OFF | 0
Hides the marker information in the diagrams.
*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 142

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

Turns the marker table on and off.

Suffix:

<n> irrelevant

Parameters:

<DisplayMode>

ON | 1
Turns on the marker table.

OFF | 0
Turns off the marker table.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 142

10.10.2 Trace export

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator.
Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 137

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Manual operation: See "Include Instrument & Measurement Settings" on page 137

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 309).

Parameters:
<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Manual operation: See "Export all Traces and all Table Results" on page 137

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports trace data from the specified window to an ASCII file.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "memory limit reached" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Suffix:
<n> Window

Parameters:
<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See "Export Trace to ASCII File" on page 138

10.11 Status registers

The R&S FSW DOCSIS 3.1 application uses the standard status registers of the FSW (depending on the measurement type). However, some registers are used differently. Only those differences are described in the following sections.

For details on the common FSW status registers refer to the description of remote control basics in the FSW User Manual.

*RST does not influence the status registers.

10.11.1 The STATus:QUEStionable:SYNC register

The `STATus:QUEStionable:SYNC` register contains application-specific information about synchronization errors or errors during pilot symbol detection. If any errors occur in this register, the status bit #11 in the `STATus:QUEStionable` register is set to 1.

Each active channel uses a separate `STATus:QUEStionable:SYNC` register. Thus, if the status bit #11 in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific `STATus:QUEStionable:SYNC` registers. In this case, you must check the register of each channel to determine which channel caused the error. By default, querying the status of a register always returns the result for the currently selected channel. However, you can specify any other channel name as a query parameter.

Table 10-6: Meaning of the bits used in the STATus:QUEStionable:SYNC register

Bit No.	Meaning
0	This bit is not used
1	BIT_SYNC_NOT_FOUND No frames could be detected due to failed synchronization.
2	BIT_DSP_ERROR Signal analysis failed due to a DSP error
3	Limit check failed
4 - 14	These bits are not used.
15	This bit is always 0.

10.11.2 Querying the status registers

The following commands are required to query the status of the FSW and the R&S FSW DOCSIS 3.1 application.

For details on the common FSW status registers refer to the description of remote control basics in the FSW User Manual.

- Chapter 10.11.1, "The STATus:QUEStionable:SYNC register", on page 310

10.11.2.1 General status register commands

STATus:PRESet

Resets the edge detectors and `ENABle` parts of all registers to a defined value. All `PTRansition` parts are set to `FFFFh`, i.e. all transitions from 0 to 1 are detected. All `NTRansition` parts are set to 0, i.e. a transition from 1 to 0 in a `CONDition` bit is not detected. The `ENABle` part of the `STATus:OPERation` and `STATus:QUEStionable` registers are set to 0, i.e. all events in these registers are not passed on.

Usage: Event

STATus:QUEue[:NEXT]?

Queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

Usage: Query only

10.11.2.2 Reading out the EVENt part

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

Reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

10.11.2.3 Reading out the CONDition part

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:SYNC:CONDition? <ChannelName>

Reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

10.11.2.4 Controlling the ENABle part

STATus:OPERation:ENABle <SumBit>
STATus:QUEStionable:ENABle <SumBit>
STATus:QUEStionable:SYNC:ENABle <BitDefinition>, <ChannelName>

Controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

10.11.2.5 Controlling the negative transition part

STATus:OPERation:NTRansition <SumBit>
STATus:QUEStionable:NTRansition <SumBit>
STATus:QUEStionable:SYNC:NTRansition <BitDefinition>[,<ChannelName>]

Controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition>	Range: 0 to 65535
<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.

10.11.2.6 Controlling the positive transition part

STATus:OPERation:PTRansition <SumBit>
STATus:QUEStionable:PTRansition <SumBit>
STATus:QUEStionable:SYNC:PTRansition <BitDefinition>[,<ChannelName>]

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition>	Range: 0 to 65535
<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.

10.12 Deprecated commands

The following commands are provided only for compatibility to remote control programs from R&S FSW DOCSIS 3.1 applications on previous signal analyzers. For new remote control programs use the specified alternative commands.

DISPlay[:WINDow<n>]:TYPE <WindowType>

Selects the results displayed in a measurement window.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see Chapter 10.7.2, "Working with windows in the display", on page 241).

Suffix:

<n>	Window

Parameters:

<WindowType> The parameter values are the same as for `LAYout:ADD[:WINDow]?` on page 241.

FETCh:SCDetailed:ALL?

This command returns all detailed signal content values as a comma-separated list.

Note this command is maintained for compatibility reasons only. For newer programs use the improved command `FETCh:SCDetailed:ALL:FORMatted?` on page 279.

Example: `FETC:SCD:ALL?`

Usage: Query only

10.13 Programming examples for DOCSIS 3.1 measurements

The following programming examples demonstrate how to configure basic DOCSIS measurements in a remote environment.

Note that some commands described in the examples may not actually be necessary, as the default settings are used; however, they are included to demonstrate the use of the commands.

10.13.1 Measurement 1: measuring modulation accuracy

This example demonstrates how to configure a modulation accuracy measurement in a remote environment.

```
//---------- Preparing the application ------------
// Preset the instrument
*RST
//Activate a DOCSIS measurement channel
INST:SEL DOCS

//-----------Configuring the measurement ------------
//Set the center frequency
FREQ:CENT 1.0GHZ

//---------- Signal description ------------
//Define the OFDM spectrum location (frequency of sc0) at 897.6 MHz
CONF:DS:CHAN:SPEC:FREQ 897600000
//Nfft mode is 4K
CONF:CHAN:NFFT FFT4K
//Configure the cyclic prefix to be 256 samples
```

```
CONF:CHAN:CP S256
//Configure roll-off factor of 64 samples
CONF:CHAN:ROFF S64
//Time-interleaving depth is 16
CONF:DS:CHAN:TID 16
//NCP uses 16-QAM modulation
CONF:DS:CHAN:NCP:MOD QAM16
//Set PLC start index to 2044 manually
CONF:DS:CHAN:PLC:IND:AUTO OFF
CONF:DS:CHAN:PLC:IND 2044
//Query the used PLC modulation
CONF:DS:CHAN:PLC:MOD?
//Result: 16-QAM
//Query the number of subcarriers used by the PLC
CONF:DS:CHAN:PLC:CARR?
//Result: 8

//Configure continuous pilots on every 50th subcarrier from 250 to 500
CONF:DS:CHAN:CPES2:SUBC:TYPE CPIL
CONF:DS:CHAN:CPES2:SUBC:STAR 250
CONF:DS:CHAN:CPES2:SUBC:STOP 500
CONF:DS:CHAN:CPES2:SUBC:INCR 50

//Exclude subcarriers 324 to 328 and 356 to 357
CONF:DS:CHAN:CPES3:SUBC:TYPE ESUB
CONF:DS:CHAN:CPES3:SUBC:SET 324,325,326,327,328,356,357

//Query the number of entries in the Continuous Pilots and Excluded
//Subcarrier Assignment table
CONF:DS:CHAN:CPES1:COUN?
//Result: 3 (PLC is default entry 1)

//Configure profile A:
//Assign 16-QAM modulation for excluded subcarriers and pilots
//Assign 4096-QAM for all other subcarriers
CONF:DS:CHAN:PCON:SEL A
CONF:DS:CHAN:PCON1:SUBC:STAR 0
CONF:DS:CHAN:PCON1:SUBC:STOP 8191
CONF:DS:CHAN:PCON1:SUBC:INCR 1
CONF:DS:CHAN:PCON1:SUBC:MOD QAM4096

CONF:DS:CHAN:PCON2:SUBC:SET 324,325,326,327,328,356,357
CONF:DS:CHAN:PCON2:SUBC:MOD QAM16

CONF:DS:CHAN:PCON3:SUBC:STAR 250
CONF:DS:CHAN:PCON3:SUBC:STOP 500
CONF:DS:CHAN:PCON3:SUBC:INCR 50
CONF:DS:CHAN:PCON3:SUBC:MOD QAM16

//Query the number of entries in the Profile configuration table
```

```
CONF:DS:CHAN:PCON:COUN?
//Result: 3
//Query the state of profile B
CONF:DS:CHAN:PCON:SEL B
CONF:DS:CHAN:PCON:STAT?
//Result: 0

//Query the number of entries in the Profile configuration table
CONF:DS:CHAN:FCON:COUN?
//Result: 1

//Configure the codewords in the frames:
// Profile A is used for the first 1620 carriers
CONF:DS:CHAN:FCON1:PROF A
CONF:DS:CHAN:FCON1:SUBC:STAR 0
CONF:DS:CHAN:FCON1:SUBC:COUN 1620
// Profile A is used for the next 2700 carriers (requires 2 symbols)
CONF:DS:CHAN:FCON2:PROF A
CONF:DS:CHAN:FCON2:SUBC:STAR 1620
CONF:DS:CHAN:FCON2:SUBC:COUN 2700
CONF:DS:CHAN:FCON2:SYMB:COUN?
//Result: 2

//---------- Configuring Data Acquisition ---------------------
//Each measurement captures data for 6 ms.
SWE:TIME 6ms
//Query the used sample rate
TRAC:IQ:SRAT?
//Result: 204.8 MHZ
//Query number of samples
SWE:LENG?
// Number of samples captured per measurement: 0.006s * 204.8e6 samples per second
// = 1228800 samples
//Query the analysis bandwidth
TRAC:IQ:BWID?
//Result: 192.0 MHz

//---------- Tracking and channel estimation -----------------
//Disable all tracking and compensation functions
SENS:TRAC:PHAS OFF
SENS:TRAC:TIME OFF

//---------- Demodulation ------------
//Activate codeword decoding
SENS:DEM:DEC:COD ON

//---------- Configuring the result displays ------------
// Activate following result displays:
// 1: Magnitude Capture (default, upper left)
// 2: Power Spectrum (default, upper right)
```

```
// 3: Result Summary (default, lower left)
// 4: Constellation (default, lower right)
// 5: Signal Content Detailed (bottom)
// 6: Bitstream (bottom right)

LAY:REPL '1',RFM
LAY:REPL '2',PSP
LAY:REPL '3',RSUM
LAY:REPL '4',CONS
LAY:ADD:WIND? '3',BEL,SCD
//Result: '5'
LAY:ADD:WIND? '5',RIGH,BITS
//Result: '6'

//Remove the individual MER data and MER Pilot results from the Result Summary table
DISP:WIND3:TABL:ITEM MERD,0
DISP:WIND3:TABL:ITEM MERP,0
//Query the display state of the combined pilot+data MER result
DISP:WIND3:TABL:ITEM? MER
//Result: 1

//Configure the y-axis scaling for the power spectrum:
// Minimum: Automatic scaling according to hyst. interval from -20% to +10%
// Maximum: fixed upper limit at -20dBm
//Display 10 divisions with multiples of 5E10
DISP:WIND2:TRAC:Y:SCAL:AUTO ON
DISP:WIND2:TRAC:Y:SCAL:AUTO:MODE HYST
DISP:WIND2:TRAC:Y:SCAL:AUTO:HYST:LOW:LOW 20
DISP:WIND2:TRAC:Y:SCAL:AUTO:HYST:LOW:UPP 10
DISP:WIND2:TRAC:Y:SCAL:AUTO:FIX:RANG UPP
DISP:WIND2:TRAC:Y:SCAL:MAX 20
DISP:WIND2:TRAC:Y:SCAL:DIV 10
DISP:WIND2:TRAC:Y:SCAL:PDIV 5.0

//Configure constellation for all subcarriers in symbol 1
SENS:SUBC:SEL ALL
SENS:SYMB:SEL 1

//---------- Evaluation range settings -----------------
//Configure statistical evaluation over 10 frames.
SENS:FRAM:COUN:STAT ON
SENS:FRAM:COUN 10

//---------- Performing the Measurements -----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------- Retrieving Results -------------
```

```
//Query the I/Q data from magnitude capture buffer for first ms
// 200 000 samples per second -> 200 samples
TRAC1:IQ:DATA:MEMory? 0,200
//Note: result will be too long to display in IECWIN, but is stored in log file
//Query the I/Q data from magnitude capture buffer for second ms
TRAC1:IQ:DATA:MEMory? 201,400
//Note: result will be too long to display in IECWIN, but is stored in log file

//Query the number of frames detected in the current capture buffer
FETC:FRAM:COUN?
//Query the number of frames detected in all measurements
FETC:FRAM:COUN:ALL?
//Select second frame (frame 1) to be evaluated in graphical results
SENS:FRAM:SEL:STAT ON
SENS:FRAM:SEL 1

//Query constellation data (window 4) in frame 1
TRAC4:DATA? TRACE1
//Note: result will be too long to display in IECWIN, but is stored in log file

//Query detailed signal content in frame 1
FETC:SCD:ALL?
//Note: result will be too long to display in IECWIN, but is stored in log file

//Query maximum MER for pilots and data in frame 1
FETC:SUMM:MER:MAX?

//Query the limit for minimum MER for pilots and data and the result of the limit check
CALC:LIM:SUMM:MER:MIN?
CALC:LIM:SUMM:MER:MIN:RES?

//Query the results for bitstream in byte format in frames 1 and 2
UNIT:BITS BYTE
FETC:BITS:ALL?
SENS:FRAM:SEL 2
FETC:BITS:ALL?


//---------- Exporting Captured I/Q Data-------------
//Store the captured I/Q data to a file.
MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'
```

10.13.2 Measurement 2: determining the occupied bandwidth

This example demonstrates how to determine the occupied bandwidth for the DOCSIS 3.1 channel.

```
//---------- Preparing the application ------------
//Reset the instrument
*RST
//Activate a DOCSIS measurement channel named "OBWMeasurement"
INST:CRE:NEW DOCS,'OBWMeasurement'

//---------- Configuring the measurement ------------

//Select the OBW measurement
CALC:MARK:FUNC:POW:SEL OBW

//---------- Performing the Measurement ----
//Stop continuous sweep
INIT:CONT OFF
//Set the number of sweeps to be performed to 100
SWE:COUN 100
//Start a new measurement with 100 sweeps and wait for the end
INIT;*WAI

//-------------- Retrieving Results ------------
//Query the occupied bandwidth.
CALC:MARK:FUNC:POW:RES? OBW

//-------------- Returning to DOCSIS I/Q measurement --------
//Stop power (OBW) measurement
CALC:MARK:FUNC:POW:STAT OFF
```

Annex

A References

The R&S FSW DOCSIS 3.1 application and User Manual refer to the following documents:

- **[1]:** Data-Over-Cable Service Interface Specifications DOCSIS® 3.1
  MAC and Upper Layer Protocols Interface Specification
  CM-SP-MULPIv3.1-I04-141218
  ©Cable Television Laboratories, Inc., 2013-2014
- **[2]:** Data-Over-Cable Service Interface Specifications DOCSIS® 3.1
  Physical Layer Specification
  CM-SP-PHYv3.1-I04-141218
  ©Cable Television Laboratories, Inc., 2013-2014
- **[3]:** Data-Over-Cable Service Interface Specifications DOCSIS® 3.1
  Physical Layer Acceptance Test Plan
  CM-TP-PHYv3.1-ATP-D04-150630 DRAFT
  ©Cable Television Laboratories, Inc., 2014-2015

The following application note discusses the fundamental technological advances of DOCSIS 3.1 and presents measurement solutions from Rohde & Schwarz: 7MH89: DOCSIS 3.1

List of commands (Docsis 3.1)

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