7 How to Perform Vector Signal Analysis

Using the VSA option you can perform vector signal analysis measurements using predefined standard setting files, or independently of digital standards using user-defined measurement settings. Such settings can be stored for recurrent use.

Thus, configuring VSA measurements requires one of the following tasks:

- Selecting an existing standard settings file and, if necessary, adapting the measurement settings to your specific requirements.
- Configuring the measurement settings and, if necessary, storing the settings in a file.

7.1 How to Perform VSA According to Digital Standards

In order to perform vector signal analysis as specified in digital standards, various predefined settings files for common digital standards are provided for use with the VSA option. In addition, you can create your own settings files for user-specific measurements.

For an overview of predefined standards and settings see chapter A.1, "Predefined Standards and Settings", on page 398.

This section provides instructions for the following tasks:

- "To perform a measurement according to a standard" on page 201
- "To load predefined settings files" on page 202
- "To store settings as a standard file" on page 202
- "To delete standard files" on page 202
- "To restore standard files" on page 202

To perform a measurement according to a standard

1. Press the MODE key on the front panel and select the "VSA" application.
2. Press the MEAS key and select the "Digital Standards" softkey.
3. Select the required settings file and then "Load" (see "To load predefined settings files" on page 202).

   The instrument is adjusted to the stored settings for the selected standard and a measurement is started immediately.
4. Press the RUN SINGLE key to stop the continuous measurement mode and start a defined number of measurements.

   The measured data is stored in the capture buffer and can be analyzed (see chapter 7.3, "How to Analyze the Measured Data", on page 212).

To load predefined settings files

1. In the "Meas" menu, select the "Digital Standards" softkey.
2. In the file selection dialog box, select the standard whose settings you want to load.
   To change the path, press the arrow icons at the right end of the "Path" field and select the required folder from the file system.
3. Press the "Load" button.

   The dialog box is closed and the instrument is adjusted to the stored settings for the selected standard.

To store settings as a standard file

1. Configure the measurement as required (see chapter 7.2, "How to Perform Customized VSA Measurements", on page 203).
2. In the "Meas" menu, select the "Digital Standards" softkey.
3. In the "File Name" field, enter the name of the standard for which you want to store settings.
   To change the path, press the arrow icons at the right end of the "Path" field and select the required folder from the file system.
   To insert a new folder, select the "New Folder" button and enter a name in the "New Folder" dialog box.
4. Press the "Save" button.

   The dialog box is closed and the current measurement settings are stored in a standard file.

To delete standard files

1. In the "Meas" menu, select the "Digital Standards" softkey.
2. In the "Manage VSA Standards" file selection dialog box, select the standard whose settings file you want to delete. Standards predefined by Rohde & Schwarz can also be deleted.
   To change the path, press the arrow icons at the right end of the "Path" field and select the required folder from the file system.
3. Press the "Delete" button.
4. Confirm the message to avoid unintentionally deleting a standard.

   The standard file is removed from the folder.

To restore standard files

1. To restore the predefined standard files, do one of the following:
   - In the "Meas" menu, select the "Digital Standards" softkey.
     The "Manage VSA Standards" file selection dialog box is displayed.
   - In the "Meas" menu, select the "Restore Factory Settings" softkey.

2. Select "Restore Standard Files".

   The standards predefined by Rohde & Schwarz available at the time of delivery are restored to the `Standards` folder.

7.2 How to Perform Customized VSA Measurements

In addition to performing vector signal analysis strictly according to specific digital standards, you can configure the analysis settings for customized tasks. The general process for a typical VSA measurement is described here.

1. Press the MODE key on the front panel and select the "VSA" application.
2. Select the "Overview" softkey to display the "Overview" for VSA.
3. Select the "Signal Description" button and configure the expected signal characteristics.
   If the input data is largely known in advance, define files with the known data to compare the measured data to (see chapter 7.2.3, "How to Manage Known Data Files", on page 208). This can improve demodulation significantly.
4. Select the "Input/Frontend" button to define the input signal's center frequency, amplitude and other basic settings.
5. Select the "Signal Capture" button and define how much and which data to capture: (In MSRA mode, define the application data instead, see chapter 4.9, "VSA in MSRA Operating Mode", on page 118).
   - "Capture length": the duration or number of symbols to be captured
   - "Sample rate": how many points are to be captured for each symbol
6. Optionally, select the "Trigger" tab and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. (In MSRA mode, define a "Capture Offset" instead, see chapter 4.9, "VSA in MSRA Operating Mode", on page 118).
7. For bursted signals, select the "Burst/Pattern" button and define the criteria to detect the individual bursts within the input signal (see chapter 7.2.2, "How to Perform Pattern Searches", on page 204).
8. Select the "Cut Result Ranges" button and define which of the captured data is to be demodulated (see chapter 7.2.4, "How to Define the Result Range", on page 211).
9. Select the "Demodulation" button to configure and optimize the synchronization process.
10. Select the "Meas filter" button to select a different or user-defined measurement filter to improve the accuracy of the error vector (see chapter 7.2.1, "How to Select User-Defined Filters", on page 204).

11. Select the "Evaluation Range" button to define which part of the demodulated data is to be evaluated and displayed.
12. Press the RUN SINGLE key to stop the continuous sweep and start a new sweep with the new configuration.

    The measured data is stored in the capture buffer and can be analyzed (see chapter 7.3, "How to Analyze the Measured Data", on page 212)

7.2.1 How to Select User-Defined Filters

The most frequently required measurement and TX filters required for vector signal analysis according to digital standards are provided by the R&S FSW VSA application. However, you can also load user-defined filters.

To load a user measurement filter

1. In the "Overview", select the "Meas Filter" button.
2. In the "Meas Filter" tab of the "Demodulation & Measurement Filter "dialog box, select "Type": *User*.
3. Select "Load User Filter".
4. Load your `.vaf` file from the USB stick.

To load a user transmit (TX) filter

1. In the "Overview", select the "Signal Description" button.
2. In the "Modulation" tab of the "Signal Description" dialog box, select "Transmit Filter Type": *User*.
3. Select "Load User Filter".
4. Load your `.vaf` file from the USB stick.

7.2.2 How to Perform Pattern Searches

To configure a pattern search

1. In the "Overview", select "Signal Description".
2. Select the "Signal Structure" tab.
3. Select the "Burst Signal" signal type.
4. Enable the "Pattern" option.
5. From the "Name" selection list, select a pattern that is assigned to the currently defined standard.

6. If the pattern you require is not available, continue with "To add a predefined pattern to a standard" on page 205 or chapter 7.2.2.2, "How to Define a New Pattern", on page 206.
7. Optionally, select the "Offset" option and enter the number of symbols in the signal to be ignored during the pattern search.
8. Close the "Signal Description" dialog box.
9. In the "Overview" dialog box, select "Burst / Pattern " and switch to the "Pattern Search" tab.
10. Select "On" to enable the search.
    To enable a search only if a pattern is part of the signal description, enable the "Auto" option.

    The results of the pattern search with the selected pattern on the current measurement data is displayed in the "Preview" area of the dialog box. Whether a pattern was detected or not is indicated in the "Information" area.
11. If necessary, adapt the I/Q correlation threshold. If bursts are not detected, reduce the threshold; if false bursts are detected, increase the threshold.
12. Optionally, enable the "Meas only if pattern symbols correct" option. In this case, measurement results are only displayed if a valid pattern has been detected.
13. Close the dialog box.

    The selected pattern is used for a pattern search in the next measurement.

7.2.2.1 How To Assign Patterns to a Standard

Only patterns that are assigned to the currently selected VSA standard are available for the pattern search.

To add a predefined pattern to a standard

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.
2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. In the list of "All Patterns", select the required pattern.
   If the required pattern is not displayed, see "To change the display for the list of patterns" on page 207.
4. Select "Add to Standard".

   The selected pattern is inserted in the list of "Standard Patterns".
5. Select the pattern to be used for the pattern search from the list of "Standard Patterns".

To remove a predefined pattern from a standard

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.

2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. Select the pattern from the list of "Standard Patterns".
4. Select "Remove from Standard".

   The pattern is removed from the list of "Standard Patterns" and is no longer assigned to the current standard, but is still available for assignment from the list of "All Patterns".

7.2.2.2 How to Define a New Pattern

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.
2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. Select the "New" button.

   The pattern definition dialog box is displayed.
4. Define the following pattern settings:

Setting	Description
Name	Pattern name that will be displayed in selection list
Description	Optional description of the pattern which is displayed in the pattern details
Modulation order	Number of values each symbol can represent, e.g. 8 for 8-PSK
Comment	Optional comment for the pattern, displayed in the pattern details (kept for compatibility with FSQ)

5. Define the format used to define the individual symbols of the pattern.
6. Define the symbols of the pattern.
   a) Select the symbol field you want to define.
   If necessary, add a new symbol field by selecting "Add".
   b) Enter a value using the keyboard. Depending on the "Modulation Order" <*n*>, the value can be in the range 0 to <n>-1.
   c) Select the next symbol field, or insert a new one, and continue to define the other symbols. To scroll through the fields for long patterns, use the scrollbar beneath the input area. The number beneath the scrollbar at the right end indicates the sequential number of the last symbol field, the number in the center indicates the sequential number of the currently selected symbol field.
   To remove a symbol field, select it and press "Remove".
7. Select "Save" to save the pattern under the specified name. The pattern is stored on the instrument as an xml file named `<Name>.xml` under `<Installation directory>\vsa\Pattern`.

If you copy this file to another location, you can restore the pattern at a later time, e.g. after deletion.

Example: Defining a pattern

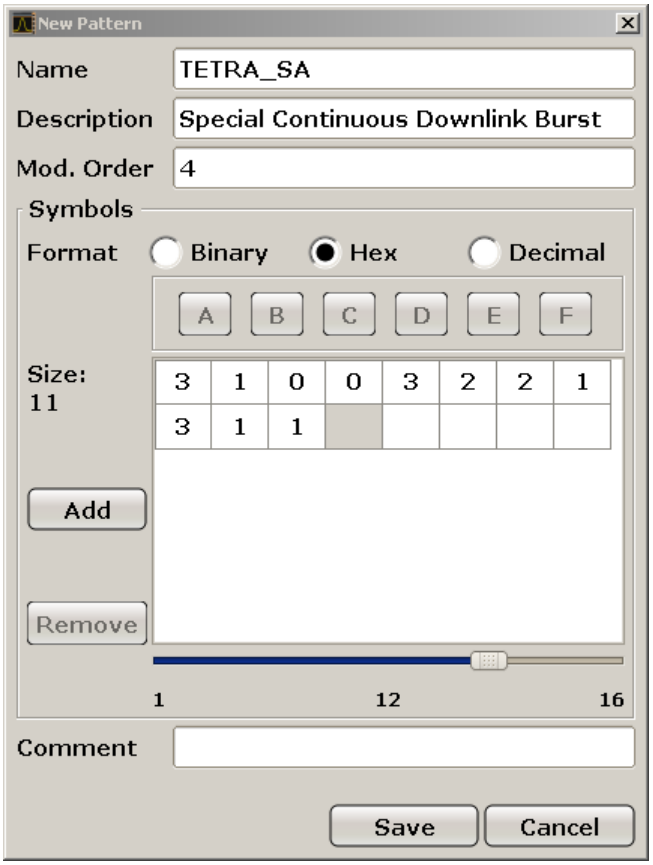


Fig. 7-1: Pattern definition

7.2.2.3 How to Manage Patterns

To change the display for the list of patterns

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.
2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. To display all available patterns, select "Show All".
   To display all patterns that are compatible to the defined standard, select "Show Compatible".
   To display only patterns that contain a specific prefix, enter the "Prefix" in the edit field.

To edit a predefined pattern

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.
2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. Select the pattern from the list of "All Patterns".

4. Press "Edit Pattern".
5. Change the settings as required as described in chapter 7.2.2.2, "How to Define a New Pattern", on page 206.

To delete a predefined pattern

1. In the "Overview", select "Signal Description" and switch to the "Signal Structure" tab.
2. Select "Pattern Config" to display the "Advanced Pattern Settings" dialog box.
3. Select the pattern from the list of "All Patterns".
4. Press "Delete Pattern".

   The pattern is removed from the lists of available and assigned patterns and can no longer be assigned to any standard. Any existing assignments to other standards are removed, as well.

To restore predefined patterns

Default patterns provided by Rohde&Schwarz can be restored.

1. Press the MEAS key.
2. Select the "Restore Factory Settings" softkey.
3. Select the "Restore Pattern Files" softkey.

   The patterns as defined by Rohde & Schwarz at the time of delivery are restored.

Restoring user-defined patterns

User-defined patterns can only be restored if you have a copy of the pattern file created during creation. In this case, copy the file named `<Patternname>.xml` back to the installation directory of the VSA application under `vsa/standards`. After a preset or after performing certain operations (e.g. changing the modulation settings) the pattern will be included in the list of "All Patterns" again.

7.2.3 How to Manage Known Data Files

You can load xml files containing the possible sequences to the VSA application and use them to compare the measured data to. In particular, you can use known data for the following functions:

- Fine synchronization during the demodulation process (see figure 4-43 and "Fine Synchronization" on page 178)
- Calculation of the Bit Error Rate (BER), see chapter 3.2.23, "Bit Error Rate (BER)", on page 42

7.2.3.1 How to Load Known Data Files

Known Data files are loaded in the "Modulation & Signal Description" settings.

To load an existing Known Data file

1. In the "Overview", select "Signal Description".
2. Switch to the "Known Data" tab.
3. Activate the usage of a Known Data file by enabling the "Known Data" option. This enables the "Load Data File" function.
4. Select the "Load Data File" button.
   A file selection dialog box is displayed.
5. Select the xml file which contains the possible data sequences of the input signal. The file must comply with the syntax described in chapter A.4, "Known Data File Syntax Description", on page 408.

   The header information of the xml file is displayed in the dialog box.

   Once a Known Data file has been loaded, the Bit Error Rate result display becomes available.
   If the "Fine Synchronization" setting in the "Demodulation" dialog box is set to "Auto" mode, the known data is also used for synchronization. Otherwise it can be selected manually. Defining a maximum symbol error rate for the known data in reference to the analyzed data avoids using a falsely selected or unsuitable file for synchronization (see also "If SER ≤" on page 179.

7.2.3.2 How to Create Known Data Files

You must create the Known Data files yourself according to the possible data sequences of the input signal. Use any xml editing tool you like, following the rules described in chapter A.4, "Known Data File Syntax Description", on page 408. Before loading the file to the VSA application, make sure the syntax of your file is valid.

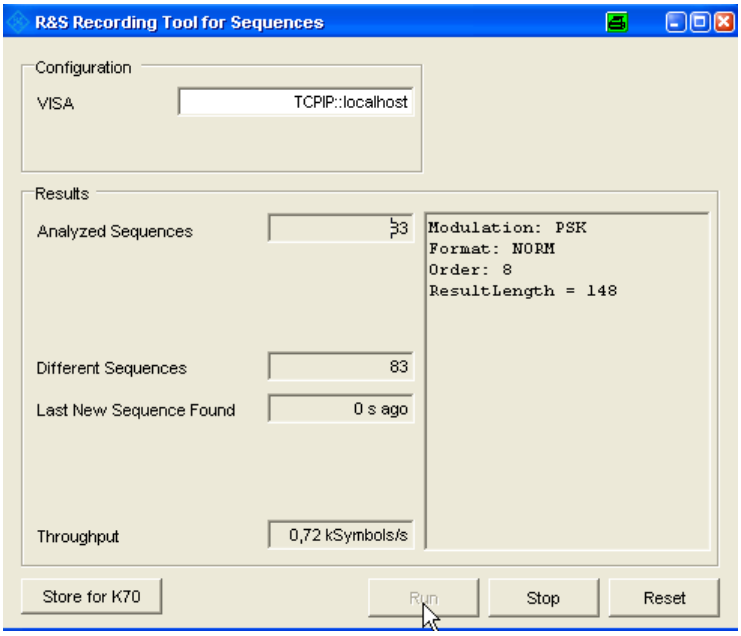
Auxiliary tool to create Known Data files

An auxiliary tool to create Known Data files from data that is already available in the VSA application is provided on the instrument free of charge.

To create a Known Data file using the recording tool for sequences

1. Import or apply input data for which stable demodulation results are available to the VSA application. If necessary, adapt the demodulation settings until the requested results are obtained.
2. Execute the file `RecordingToolforSequences.EXE` from the installation directory on the instrument.

   The "R&S Recording Tool for Sequences" window is displayed.



3. Start a measurement in the VSA application.
4. In the tool window, select "Run".
   The tool records the demodulated data sequences. The following result information is provided by the tool during recording:
   - **Analyzed Sequences**: number of data sequences analyzed since the tool was started
   - **Different Sequences**: number of unique sequences detected in the measured data
   - **Last New Sequence Found**: time that has passed since the most recent unique sequence was detected
   - **Throughput**: current data processing speed of the tool

   Note that while the tool is running, the R&S FSW is set to remote mode, i.e. the manual interface is not available. As soon as the tool is closed, the remote mode is automatically deactivated.
5. When all known possible sequences have been detected, or when a significantly large amount of time has passed so as to assume no more sequences will be detected, stop the tool by selecting "Stop".
6. - If the results are acceptable, select "Store for K70" to store a valid xml file with the recorded data sequences on the instrument.
     A file selection dialog box is displayed in which you can select the storage location and file name.
     You can also add an optional comment to the file.
   - Otherwise, reset the tool to start a new recording, possibly after changing the demodulation settings or input data.
7. Close the tool window to return to normal operation of the VSA application.

The created xml file can now be loaded in the VSA application as described in chapter 7.2.3.1, "How to Load Known Data Files", on page 208.

7.2.4 How to Define the Result Range

You can define which part of the source signal is analyzed ("Result Range") with reference to the captured data, a detected burst or a detected pattern.

(For details on the functions see chapter 5.8, "Result Range Configuration", on page 169.)

1. In the "Overview", select "Range Settings".
2. Select the "Result Range" tab.
3. Define the "Result Length", i.e. the number of symbols from the result that are to be analyzed.
   Note that when you use Known Data files as a reference, the "Result Length" specified here must be identical to the length of the specified symbol sequences in the xml file (<ResultLength> element). See chapter 4.8, "Known Data Files - Dependencies and Restrictions", on page 116.
4. Define the "Reference" for the result range, i.e. the source to which the result will be aligned. The reference can be the captured data, a detected burst or a detected pattern.
5. Define the "Alignment" of the result range to the reference source, i.e. whether the result starts at the beginning of the reference source, ends with the reference source, or is centered with the reference source.
6. Optionally, define an offset of the result range to the reference source, e.g. to ignore the first few symbols of the captured data.
7. Optionally, define the number of the symbol which marks the beginning of the reference source to change the scaling of the x-axis. This offset is added to the one defined for the signal description.

Example: Defining the result range

In figure 7-2, a result range will be defined for the first 100 symbols of the capture buffer, starting at the second symbol, which has the symbol number 1 (the capture buffer starts at symbol number 1, the first symbol to be displayed is the second symbol due to the offset: 1+1=2).

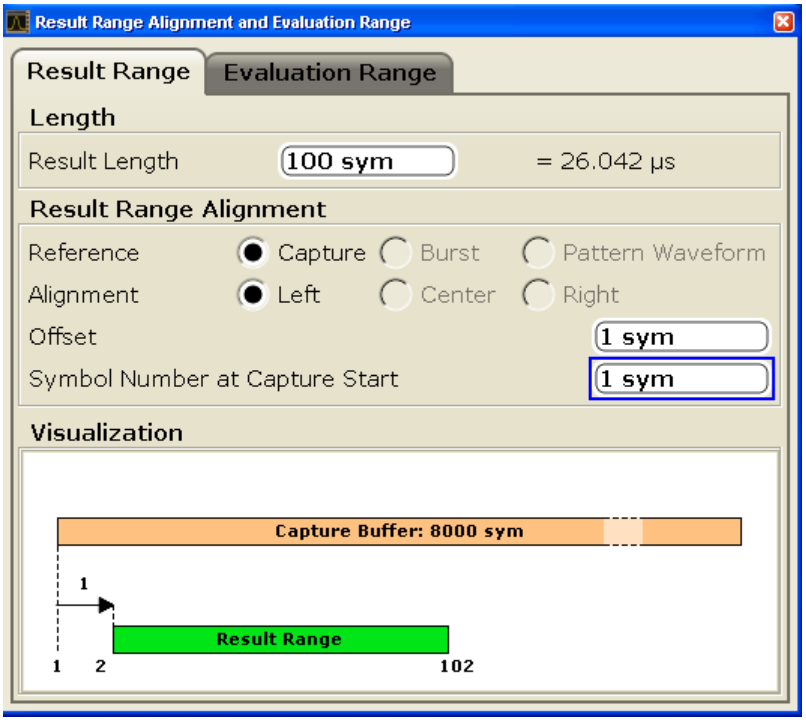


Fig. 7-2: Example: Defining the Result Range

The result range is indicated by a green bar along the time axis in capture buffer result displays, see chapter 4.6, "Measurement Ranges", on page 111.

7.3 How to Analyze the Measured Data

Once the data has been stored in the capture buffer, the results can be analyzed in numerous ways. The following tasks are meant to make you familiar with the most common VSA application features. For a description of all analysis functions and settings see chapter 6, "Analysis", on page 185.

1. Press the MEAS CONFIG key to display the VSA menu.
2. Select the "Display Config" button in the "Overview" or the "Display Config" softkey and select the data sources for evaluation that are of interest to you (see chapter 6.5, "Display and Window Configuration", on page 196).
   Arrange them on the display to suit your preferences.

For each data source, a window with the default result type for that data source is displayed.

3. Exit the SmartGrid mode.
4. Select the "Window Config" softkey to change the result types and other display settings for the selected window. To change the settings in other windows, select a different window from the "Specifics for" list in the "Window Config" dialog box.
5. Select the "Overview" softkey to display the "Overview".
   Enable the "Specifics for" option to access the analysis functions for the selected window.
6. Select the "Analysis" button in the "Overview" to configure special analysis settings for the individual result displays, for example:
   - Configure markers and delta markers to determine deviations and offsets within the results, e.g. when comparing errors or peaks.
   - Configure the trace to display the average over a series of measurements. If necessary, increase the "Statistics Count" defined in the "Sweep" menu.
7. Press the SWEEP key and select the "Selected Result Rng" softkey to select a specific burst to be evaluated.

   The result displays are updated to show the results for the selected burst.
   Tip: You can use a capture buffer display to navigate through the available result ranges, and analyze the individual result ranges in another window. The currently displayed result range is indicated by a blue bar in the capture buffer display.
8. Optionally, zoom into a diagram to enlarge an area of the displayed data.
9. Optionally, change the display scaling for diagrams (see chapter 7.3.1, "How to Change the Display Scaling", on page 213).
10. Optionally, check the modulation accuracy against specified limits (see chapter 7.3.2, "How to Check Limits for Modulation Accuracy", on page 216).
11. Optionally, export the trace data of the measured signal to a file (see chapter 7.3.3, "How to Export the Trace Data to a File", on page 217).

7.3.1 How to Change the Display Scaling

Depending on the type of display (time, spectrum or statistics), various scaling functions are available to adapt the result display to the current data.

7.3.1.1 How to Scale Time and Spectrum Diagrams

The range of the displayed y-axis for time and spectral diagrams can be defined in the following ways:

- manually, by defining the range size, reference values and positions
- automatically, according to the current results

To define the scaling manually using a reference point

With this method, you define a reference value and a position at which this value is to be displayed on the y-axis.

1. Focus the result window.
2. Select "AMPT > YScale Config > Y-Axis Reference Value".
3. Enter a reference value for the y-axis in the current unit.
4. Select "AMPT > YScale Config > Y-Axis Reference Position" .
5. Enter the position at which this value is to be displayed on the y-axis. The position is a percentage of the entire length, where 100 % refers to the top edge.
6. Select "AMPT > YScale Config > Y-Axis Range".

Example:

If you want the to analyze errors greater than 95%, you can define the y-axis range as *5 %* and position the y-axis to start at 95%. To do so, enter the reference value *95 %* and the reference position *0%*.

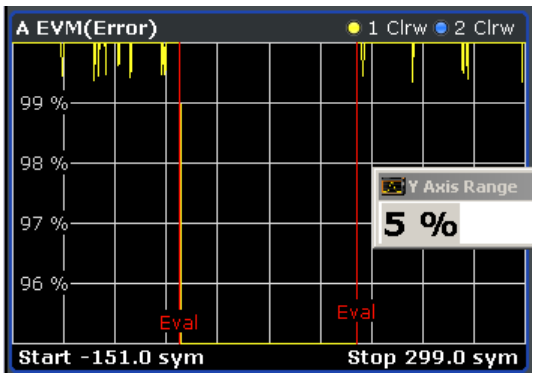


Fig. 7-3: Defining the y-axis scaling using a reference point

To define the scaling automatically

1. Focus the result window.
2. Select "AMPT > Y-Axis Auto Scale".

   The y-axis is adapted to display the current results optimally (only once, not dynamically).

7.3.1.2 How to Scale Statistics Diagrams

Statistic diagrams show the distribution (i.e. probabilities of occurrence) of the values as a set of bars. You can define the number of bars to be displayed, i.e. the granularity of classifications. Additionally, you can specify whether absolute or percentage values are displayed. For statistics measurements, both the x-axis and the y-axis can be scaled to optimize the display.

The range of the displayed x-axis for statistics diagrams can be defined in the following ways:

- manually, by defining a range in dB
- manually, by defining reference values and positions
- automatically, according to the current results

The range of the displayed y-axis can be defined in the following ways:

- manually, by defining the minimum and maximum values to be displayed
- automatically, according to the current results

After changing the scaling you can restore the default settings.

To define the number of bars

1. Focus the result window.
2. Select "AMPT > XScale Config > X-Axis Quantize".
3. Enter the number of bars to be displayed.

   The diagram is adapted to display the specified number of bars.

To define the scaling manually using a reference point

With this method, you define a reference value on the x-axis. The y-axis is adapted so that it crosses the x-axis at the reference value.

1. Focus the result window.
2. Select "AMPT > XScale Config > X-Axis Reference Value".
3. Enter a reference value on the x-axis in the current unit.

   The y-axis is adapted so that it crosses the x-axis at the reference value.

Example:

If you want to analyze the probabilities of occurrence for errors greater than 95 %, enter the reference value *95 %*.

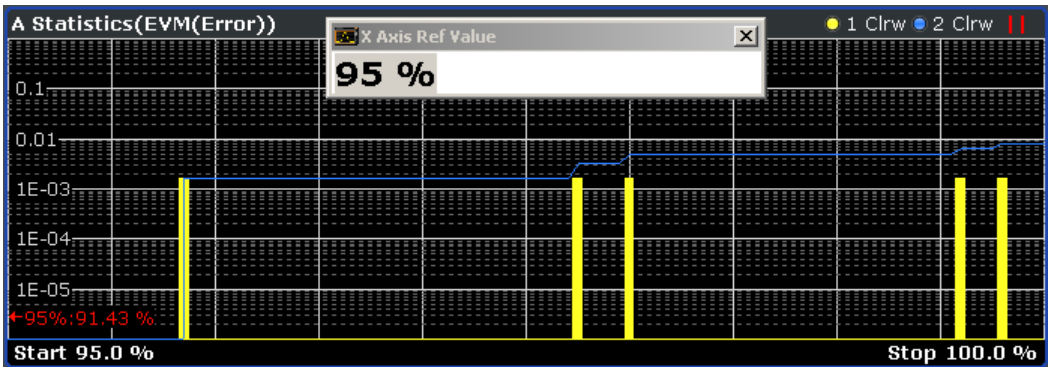


Fig. 7-4: Defining the x-axis scaling using a reference point

To define the x-axis range manually

1. Focus the result window.
2. Select "AMPT > XScale Config > X-Axis Range".
3. Enter the range in the current unit.

   The diagram is adapted to display the probabilities for the specified range.

To define the scaling automatically

1. Focus the result window.
2. Select "AMPT > XScale Config > Auto Scale".

   The x-axis is adapted to display the current results optimally (only once, not dynamically).

To define the y-axis range manually

With this method, you define the upper and lower limits of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. If the y-axis has logarithmic scale, the distance between max and min value must be at least one decade.

1. Focus the result window.
2. Select "AMPT > YScale Config > Y-Axis Min Value".
3. Enter the lower limit in the current unit.
4. Select "AMPT > YScale Config > Y-Axis Max Value".
5. Enter the upper limit in the current unit.

   The y-axis is adapted to display the specified range. Probabilities of occurrence located outside the display area are applied to the bars at the left or right borders of the display.

7.3.2 How to Check Limits for Modulation Accuracy

The results of a modulation accuracy measurement can be checked for violation of defined limits automatically. If limit check is activated and the measured values exceed the limits, those values are indicated in red in the result summary table. If limit check is activated and no values exceed the limits, the checked values are indicated in green.

B Result Summary							
		Current	Mean	Peak	StdDev	95%ile	Unit
*EVM	RMS	100.00*	100.00	100.00	0.00	100.00	%
	Peak	100.00	100.00	100.00	0.00	100.00	%
Phase Error	RMS	0.00	0.00	0.00	0.00	0.00	deg
	Peak	0.00	0.00	0.00	0.00	0.00	deg
Carrier Frequency Error		-0.00	-0.00	-0.00	0.00	-0.00	Hz
Rho		1.000 000	1.000 000	1.000 000	0.000 000	1.000 000	
IQ Offset		---	---	---	---	---	dB
Gain Imbalance		0.00	0.00	0.00	-193.01	0.00	dB
Quadrature Error		0.00	0.00	0.00	0.00	0.00	deg
Amplitude Droop		0.000 000	0.000 000	0.000 000	-193.010300	0.000 000	dB/sym
Power		-200.00	-200.00	-200.00	-200.00	-200.00	dBm

For details on the limit check functions and settings see chapter 6.4, "Modulation Accuracy Limit Lines", on page 194.

To define a limit check

1. Configure a measurement with "Modulation Accuracy" as the "Source" (see chapter 6.5, "Display and Window Configuration", on page 196).
2. Press the LINES key on the front panel.
3. Press the "ModAcc Limits Config" softkey in the "Limits" menu.
4. In the "Current" tab, define limits that the current value should not exceed for any or all of the result types.
   Note: the limits for the current value are automatically also defined for the peak value and vice versa. However, the limit check can be enabled individually for current or peak values.
5. Enable the "Check" option for each result type to be included in the limit check.
6. If necessary, define limits and enable the limit check for the mean values of the different result types on the "Mean" tab.
7. If necessary, enable the limit check for the peak values of the different result types on the "Peak" tab.
8. To reset the limits to their default values, press "Set to Default".
9. Enable the "Limit Checking On" option, or press the "ModAcc Limits On" softkey in the "Limits" menu.

   The limit check is performed immediately on the current modulation accuracy measurement results and for all subsequent measurements until it is disabled. The results of the limit check are indicated by red or green values in the result summary.

7.3.3 How to Export the Trace Data to a File

The measured data can be stored to an ASCII file, either as raw data (directly from the capture buffer) or as displayed in the diagrams (evaluated trace data). Optionally, a header can be included with additional information on the used measurement settings.

1. Press the TRACE key and select the "Trace Export Config" softkey.
2. Define which type of data to export (raw or trace). By default, trace data is exported.
3. Optionally, enable the header information to be included.
4. To export the traces in **all windows**, select "Export Trace to ASCII File for all Windows".
   To export the traces only for **the currently selected window**, select "Export Trace to ASCII File for Specific Window". To export the data from another window, select it from the "Specifics for" list, then export again.
   In either case, **all** traces of the selected window(s) are exported.
5. Define a file name and storage location and select "OK".

   The data is stored in a file and can be analyzed in an external application.

8 Measurement Examples

Some sample measurements for the digital GSM and EDGE standards provide a quick introduction to typical vector analyzer measurements. The individual measurements are in logical order and are meant to familiarize you gradually with the measurements required of general vector signal analysis.

The following equipment is required in addition to the R&S FSW with option R&S FSW-K70:

- 1 test transmitter (GSM-compatible for Measurement 2), preferably R&S SMU (1141.2005.02), with the digital standard option GSM/EDGE (order number 1160.7609.02)
- 1 ParData Adapter R&S SMU-Z5 for R&S SMU (1160.4545.02)
- 1 RF cable with 2 male N connectors
- 2 RF cable with 2 male BNC connectors
- 2 power cables

Transmitter operation is only described as far as required for performing the measurements. For more details on the measurements, refer to the test transmitter documentation.

8.1 Connecting the Transmitter and Analyzer

In order to perform measurements with the R&S FSW-K70, you require a test transmitter to emulate a DUT. For Measurement Example 2: Burst GSM EDGE Signals, the test transmitter needs to be GSM-compatible.

Connect the RF output of the R&S SMU with the RF input of the R&S FSW.

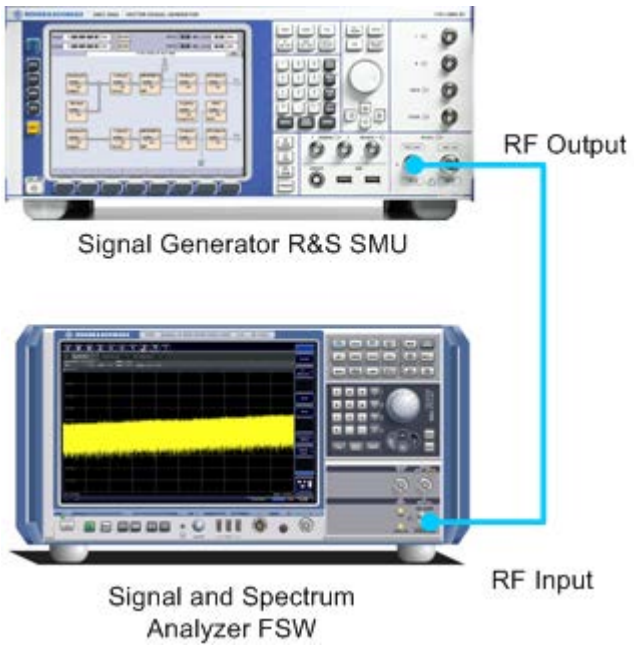


Fig. 8-1: Connection to a test transmitter (for example R&S SMU)

8.2 Measurement Example 1: Continuous QPSK Signal

In this measurement example a continuous QPSK (Quadrature Phase Shift Keying) signal will be measured and evaluated. QPSK is used in several standards such as DVB-S2, APCO25, WCDMA, CDMA2000, etc. For the description (characterization) of a continuous QPSK signal, the following parameters are the most important:

- Carrier Frequency
- Level
- Symbol Rate
- Transmit Filter

8.2.1 Transmitter Settings

This section summarizes the necessary transmitter settings. It contains a list of the parameters and step-by-step instructions for the R&S SMU. If you are interested in a more detailed description or background information, refer to the user manual of the R&S SMU, which can be downloaded from the Rohde&Schwarz website: www.rohde-schwarz.com/downloads/manuals/smu200A.html.

Frequency	1 GHz
Level	0 dBm
Modulation	QPSK

Symbol Rate	1 Msym/s
Filter	Root Raised Cosine with Roll-Off 0.35

To define the settings for the R&S SMU

1. Press the PRESET key to start from a defined state.
2. Press the FREQ key and enter *1 GHz*.
3. Press the LEVEL key and enter *0 dBm*.
4. To define the modulation:
   a) Press the DIAGRAM key.
   b) Select the first block ("Baseband A") in the settings overview and press ENTER.

c) Select "Custom Digital Mod...".

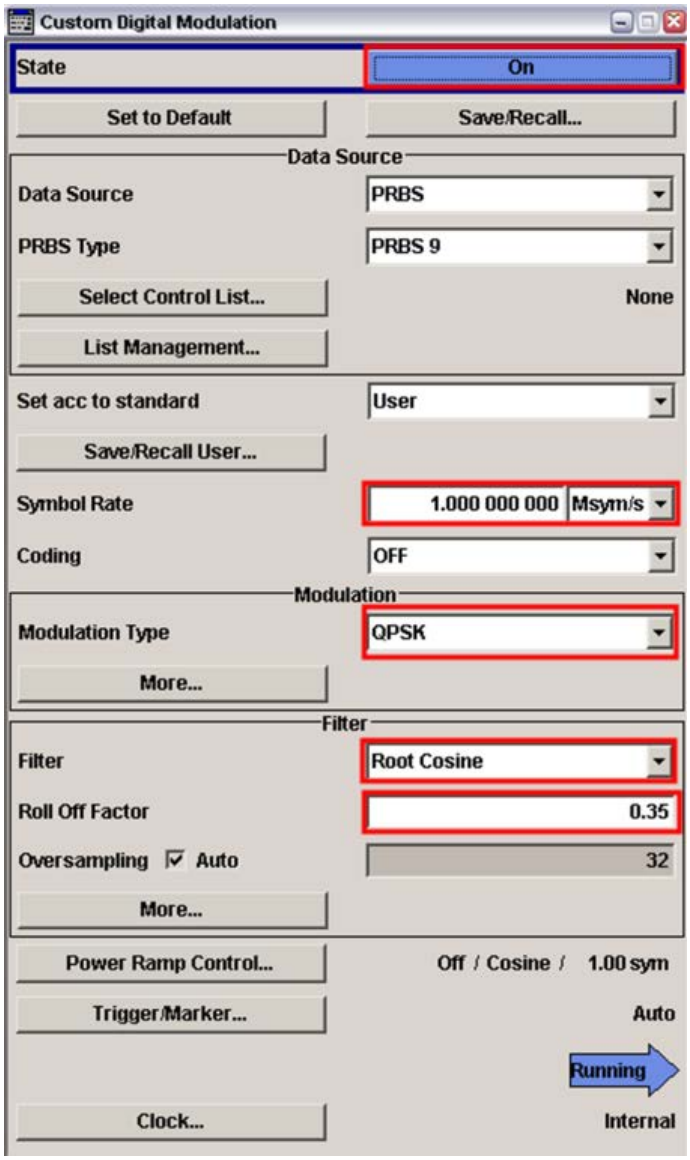


Fig. 8-2: R&S SMU: Custom Digital Modulation Dialog

d) Under "Modulation Type" select "PSK" > "QPSK".

5. In the "Custom Digital Modulation" dialog box:
   a) Enter the "Symbol Rate" *1 MHz*.
   b) Select the "Filter" "Root Cosine".
   c) Enter the "Roll Off Factor" *0.35*.
   d) Toggle the "State" to "On" (at the top of the dialog box) to switch modulation on.
6. Press the RF ON/OFF key to switch the RF transmission on.

8.2.2 Analyzer Settings

This section helps you get your first valid measurement. It starts with step-by-step instructions and continues with a more detailed description of further functionality.

Frequency	1 GHz
Ref Level	4 dBm
Modulation	QPSK
Symbol Rate	1 MHz
Tx Filter	Root Raised Cosine with Alpha BT 0.35

To define the settings on the R&S FSW

1. Press the PRESET key to start from a defined state.
2. Press the FREQ key and enter *1 GHz*.
3. Press the AMPT key, and enter *4 dBm* as the reference level. This corresponds approximately to the peak envelope power of the signal.
4. Start the VSA application by pressing the MODE key and then selecting "VSA".
5. Select the "Overview" softkey to display the "Overview" for VSA.
6. Select the "Signal Description" button and configure the expected signal characteristics.
   a) In the "Modulation Settings" section, ensure that the "Type" is "PSK" and that the "Order" is "QPSK". The "Mapping" defines the mapping of the bits to the QPSK symbols. It is relevant if you are interested in a bit stream measurement but does not affect the other measurement results. Hence, you do not need to change it here.
   b) Enter the "Symbol Rate" *1 MHz*.

c) In the "Transmit Filter" section, select "RRC" as "Type" and enter the "Alpha/BT" value *0.35*. In the preview area of the dialog you should then see a non-distorted QPSK constellation diagram, as shown in figure 8-3.

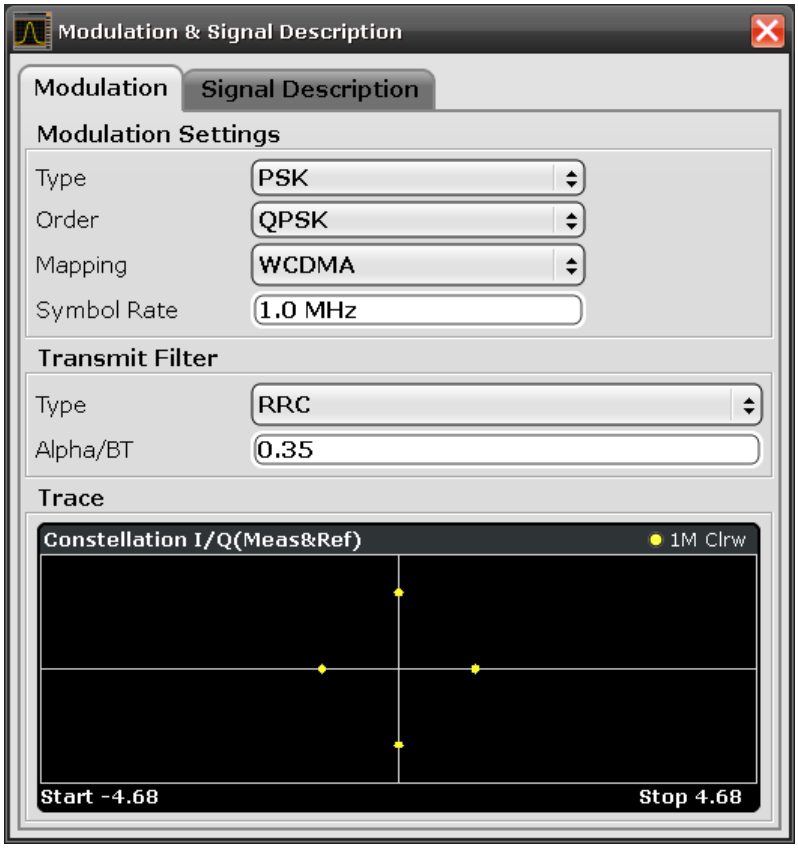


Fig. 8-3: QPSK signal with RRC transmit filter

7. Close all open dialog boxes. By default, four measurement windows showing different measurement results are displayed.

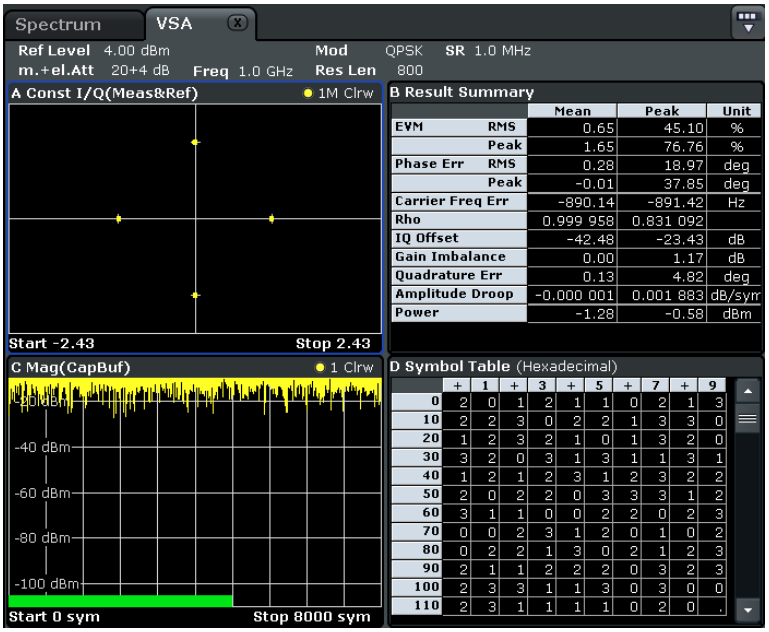


Fig. 8-4: Default window layout for Measurement Example 1

8.2.3 Changing the Display Configuration

1. To change the window layout, i.e. the display configuration, do one of the following:
   - Select the "Display Config" softkey in the main VSA menu.
   - Select the "Display Configuration" block in the "Overview" (only if "Specifics for" option is disabled).
   - 

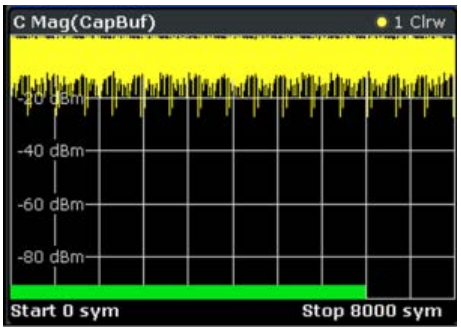
     Select the "SmartGrid" icon from the toolbar.
2. Replace window 1 by an eye diagram of the inphase component of the measurement signal.
   a) Select the "Meas & Ref" data source from the SmartGrid selection bar and drag it over window 1.
   b) 

      Close the SmartGrid mode by tapping the "Close" icon at the top right corner of the toolbar.
   c) Select the "Window Config" softkey.
   d) Select the result type: "Eye Diagram Real (I)".
3. Close the dialog to take a look at your new display configuration.

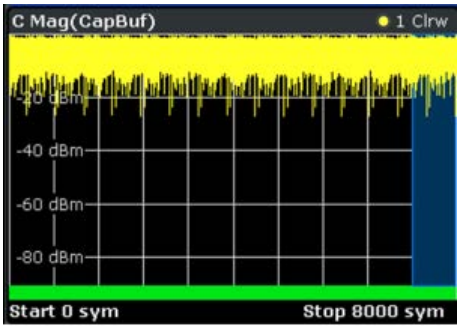
8.2.4 Navigating Through the Capture Buffer

Using the R&S FSW VSA application you can navigate through the capture buffer, i.e. control which part of the capture buffer is currently analyzed. (Note: In the Spectrum application, this functionality is referred to as "gating".)

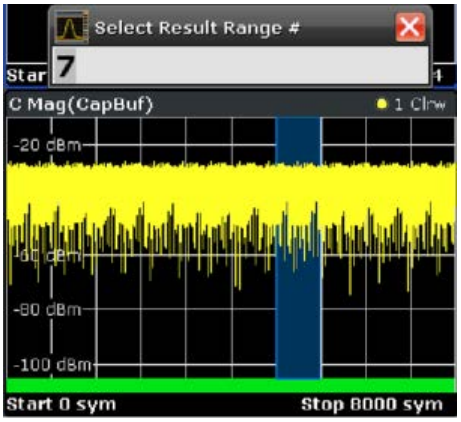
1. In the measurement display, take a closer look at window 3 (magnitude of the capture buffer). The green bar shows how far the current measurement has already proceeded, i.e. how much of the signal has been evaluated.



2. Press the RUN SINGLE key.
   Since the signal you are currently analyzing is continuous (as opposed to containing bursts), the entire capture buffer is analyzed, and hence will be marked with the green bar. The last evaluated result range (i.e. the currently evaluated result range at the time the measurement stopped) is highlighted in blue.



3. To go back to a previously evaluated result range within the same capture buffer, press the SWEEP key and then the "Select Result Rng" softkey. By selecting different result ranges (for example using the rotary knob), you can move the highlighted blue area through the capture buffer and choose your currently demodulated result range.



The results for this range are displayed in the "Current" column in the Result Summary, in the eye diagram and in the symbol table.
Note: Generally, all Clear/Write traces and the are affected by this selection.

8.2.5 Averaging Several Evaluations

By default, all measurement windows are displayed with a single trace, which is the Clear/Write trace. This trace displays the result of the current evaluation, i.e. the highlighted blue area from the example in chapter 8.2.4, "Navigating Through the Capture Buffer", on page 226. However, for most real-world measurement tasks, you need to obtain a result that is averaged over a certain number of evaluations, or a worst-case result of a certain number of evaluations. This section explains how to achieve this.

To evaluate EVM vs. Time

1. Configure window 1 such that it displays the EVM versus time measurement (Source: "Error Vector", Result Type: "EVM", see chapter 8.2.3, "Changing the Display Configuration", on page 225). Tap in the window to set the focus on it.
2. To display the trace averaged over several measurements, or the maximum hold trace over several measurements, press the TRACE key.
3. Add further traces by pressing the TRACE key and then either using the "Trace 2/3..." or the "Trace Config" softkeys.
   Set the second trace to "Average" and the third trace to "Max Hold".
   Note that the configured traces appear in the window title.

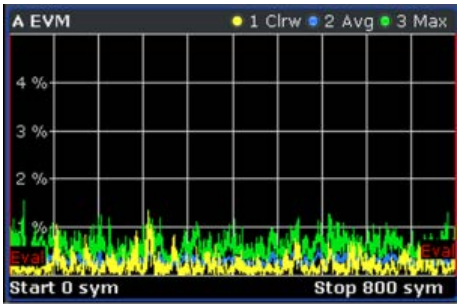
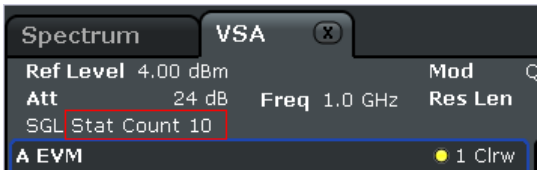


Fig. 8-5: Several traces in one window

4. Press RUN SINGLE again.

   The current capture buffer is evaluated for this trace setup. In the channel information bar you can see the number of completed evaluations ("Stat Count").



5. To change the number of evaluations, press the SWEEP key and select "Statistic Count Config".
   Select "Manual" and enter the desired number of evaluations, e.g. 12. When you press RUN SINGLE, the VSA application will capture I/Q data until 12 evaluations are completed.

8.3 Measurement Example 2: Burst GSM EDGE Signals

In this measurement example a bursted GSM EDGE signal will be measured and evaluated. The goal of this section is to familiarize you with the VSA application features that are relevant specifically for the analysis of bursted signals.

8.3.1 Transmitter Settings

This section summarizes the necessary transmitter settings. It contains a list of the parameters and step-by-step instructions for the R&S SMU. If you are interested in a more detailed description or background information, refer to the user manual of the R&S SMU, which can be downloaded from the Rohde&Schwarz website: www.rohde-schwarz.com/downloads/manuals/smu200A.html.

Frequency	1 GHz
Level	0 dBm
Standard	GSM EDGE Burst with normal symbol rate

To define the settings for the R&S SMU

1. Press the PRESET key to start from a defined state.
2. Press the FREQ key and enter *1 GHz*.
3. Press the LEVEL key and enter *0 dBm*.
4. To define the standard:
   a) Press the DIAGRAM key.
   b) Select the first block ("Baseband A") in the settings overview and press ENTER.
   c) Select "GSM/EDGE...".
   d) Highlight the first slot in the frame diagram and press ENTER.

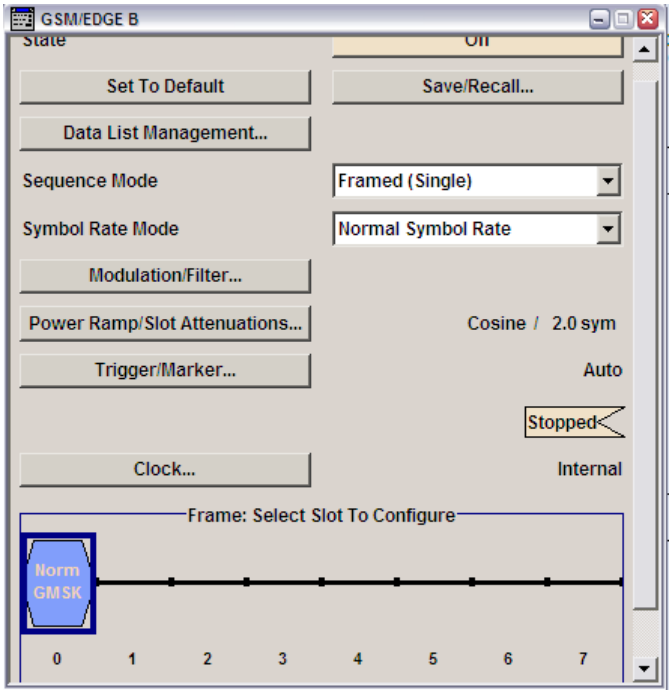
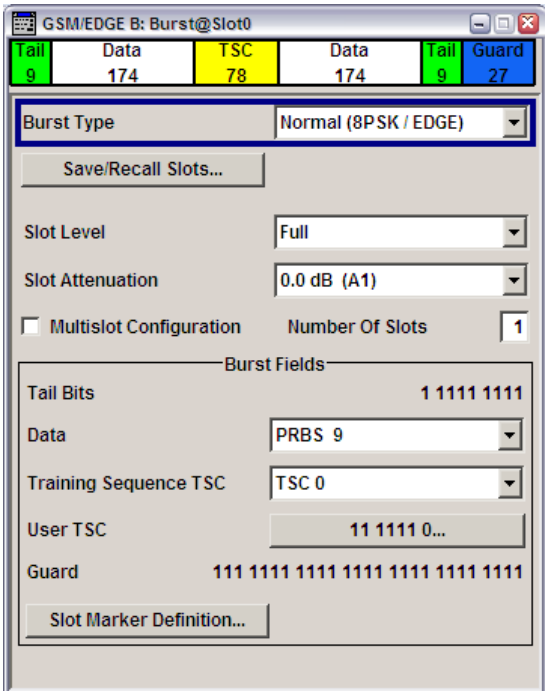


Fig. 8-6: R&S SMU: GSM/EDGE Frame Configuration Dialog

e) Select the "Burst Type" "Normal (8PSK / EDGE)".



f) Close the "GSM/EDGE: Burst@Slot0" dialog box.

5. Toggle the "State" to "On" (at the top of the "GSM/EDGE" dialog box) to switch the modulation on.
6. Press the RF ON/OFF key to switch the RF transmission on.

8.3.2 Analyzer Settings

This section helps you get your first valid measurement with a bursted signal. It starts with step-by-step instructions and continues with a more detailed description of further functionality.

Frequency	1 GHz
Ref Level	4 dBm
Standard	GSM 8PSK EDGE

To define the settings on the R&S FSW

1. Press the PRESET key to start from a defined state.
2. Press the FREQ key and enter *1 GHz*.

3. Press the AMPT key, and enter *4 dBm* as the reference level. This corresponds approximately to the peak envelope power of the signal.
4. Start the VSA application by pressing the MODE key and then selecting "VSA".
5. Select the "Overview" softkey to display the "Overview" for VSA.
6. Press the MEAS key, then select the "Digital Standards" softkey.
7. From the file selection list, select the `GSM` folder and then the file `EDGE_8PSK`. Select "Load".

   Predefined settings corresponding to the selected standard are loaded. The VSA application should show good measurement results.

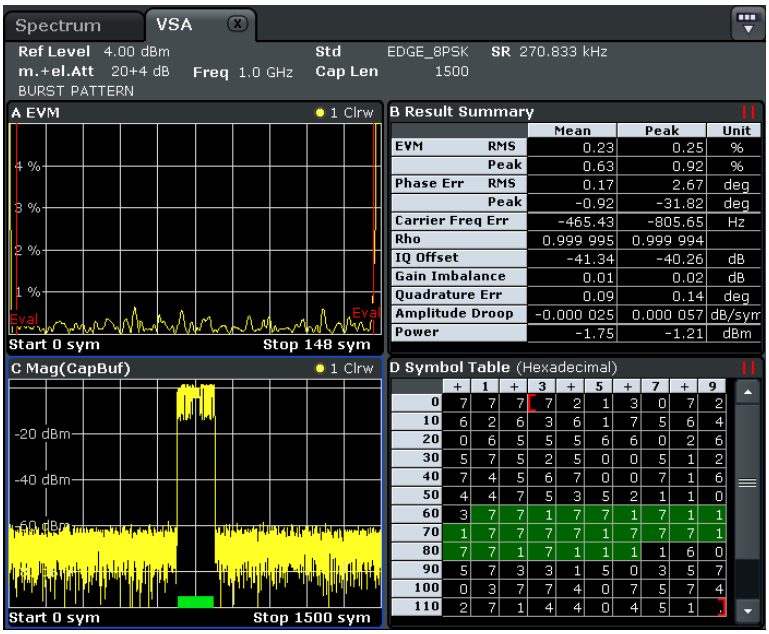


Fig. 8-7: Default display configuration for GSM 8PSK EDGE

8. In window 3, you see the currently evaluated burst marked with a green bar.
   To include more bursts in the display you need to increase the capture length.

   a) Press the MEAS CONFIG key and then the "Overview" softkey.
   b) Select "Signal Capture".
   c) Increase the "Capture Length", e.g. to 10000 symbols.

   In the preview area of the dialog box you see that more bursts are now contained in the capture buffer. They are all marked with a green bar, meaning that they are all evaluated.

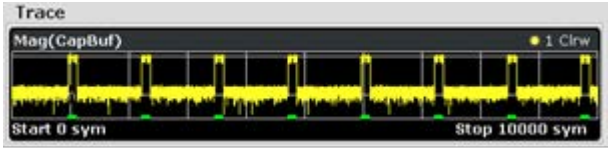


Fig. 8-8: Preview of capture buffer

8.3.3 Navigating Through the Capture Buffer

This example describes how to navigate through the capture buffer for a continuous signal. This navigation feature is especially important for bursted signals. Therefore, we provide a further navigation example for the GSM EDGE signal.

1. In order to see more details in the capture buffer, close window 4.
   a) Press the "Display Config" softkey, or the "Display Configuration" button in the "Overview".
   b) Select the "Delete" icon for window 4.
   c) 

      Close the SmartGrid mode by tapping the "Close" icon at the top right corner of the toolbar.
2. Press the RUN SINGLE key.
3. In the "EVM vs. Time" display (window 1), add a maximum hold trace by pressing the TRACE key and then selecting the "Trace Config" softkey (see chapter 8.2.5, "Averaging Several Evaluations", on page 227).
4. Re-evaluate the whole capture buffer by pressing the SWEEP key and then the "Refresh" softkey.
5. Use the "Select Result Rng" softkey to navigate through your capture buffer. Thus, you can determine which peak was caused by which burst.

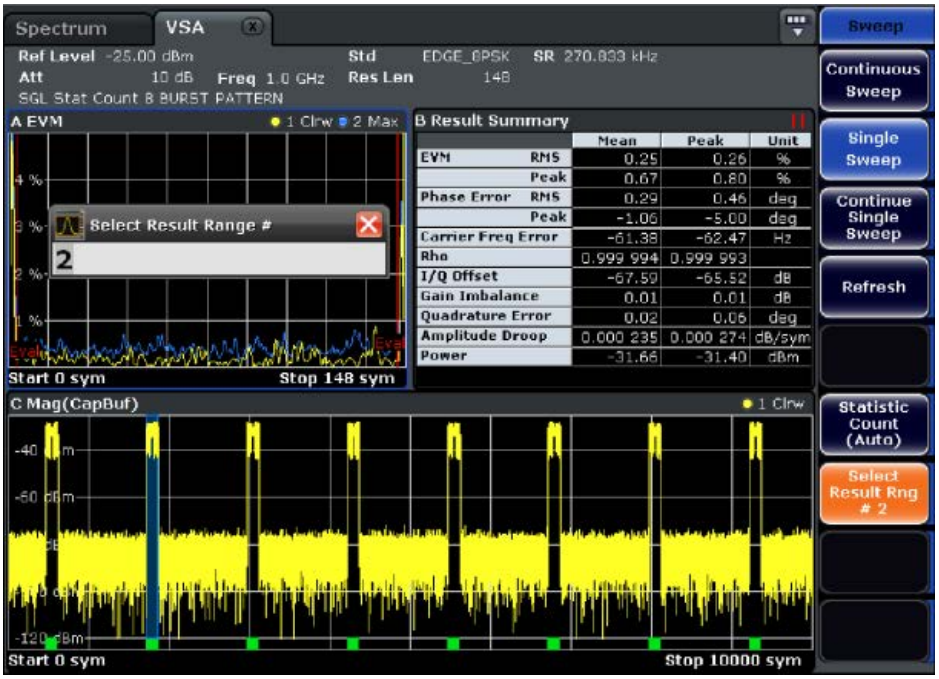


Fig. 8-9: Navigation through the capture buffer

8.3.4 Evaluating the Rising and Falling Edges

The "Result Length" is the number of symbols that are to be demodulated and analyzed together. In most common applications, only the parts of the capture buffer containing the bursts need to be analyzed. Hence, for bursted signals the "Result Length" usually coincides with the burst length. However, there are certain scenarios where the rising and falling edge of a burst are also of interest, e.g. checking the power ramping of the device under test. For this measurement task, it is useful to choose a "Result Length" that exceeds the burst length.

1. In order to include the rising and falling edges of the bursts in the EVM vs Time display (window 1), you need to increase the "Result Length".
   In the "Overview", select "Cut Result Range" and increase the "Result Length" to *200* symbols.
2. To evaluate the rising and falling edges further, display the absolute magnitude values of the measured signal in window 4 (Source: "Meas&Ref Signal", Result type: "Magnitude Absolute", see chapter 8.2.3, "Changing the Display Configuration", on page 225).
3. Press RUN SINGLE.

   The rising and falling edges of the burst in the selected result range are displayed in window 4. You could now add an average trace to evaluate the rising and falling edges further.

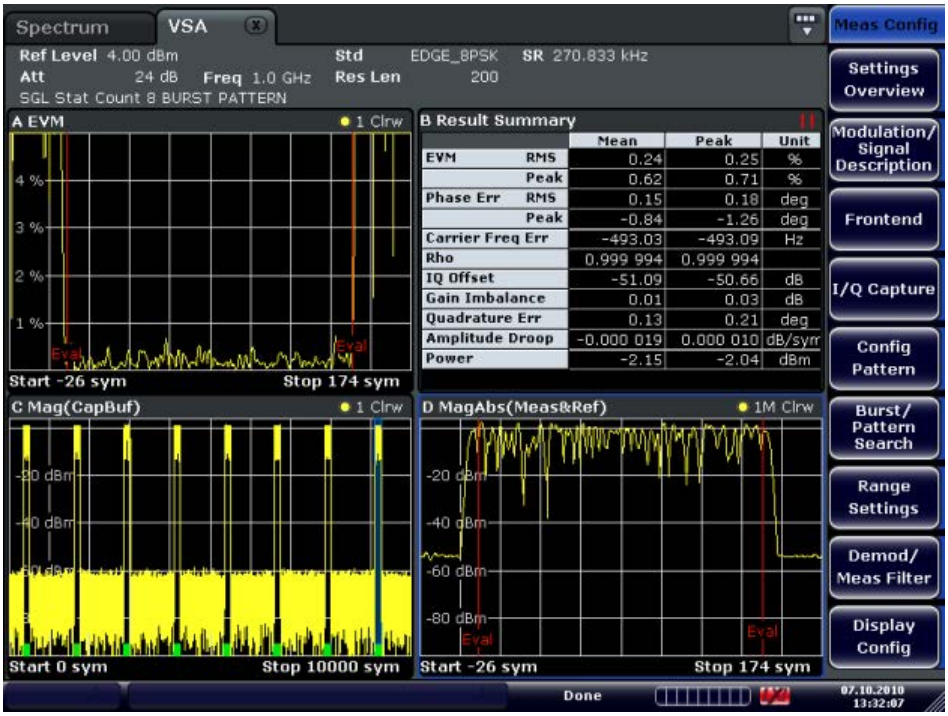


Fig. 8-10: Result range that exceeds the burst length

8.3.5 Setting the Evaluation Range

In some scenarios, such as in Evaluating the Rising and Falling Edges, the result range contains symbols that are not supposed to be considered for the EVM or other calculated parameters that are displayed in the Result Summary. Thus, you would not include them in the evaluation range.

To change the evaluated data

1. Start from the configuration described in chapter 8.3.4, "Evaluating the Rising and Falling Edges", on page 233.
2. Display the I/Q constellation diagram of the signal in window 1(Source: "Meas&Ref Signal", Result type: "Constellation I/Q", see chapter 8.2.3, "Changing the Display Configuration", on page 225).

   A clear 8PSK constellation is displayed.

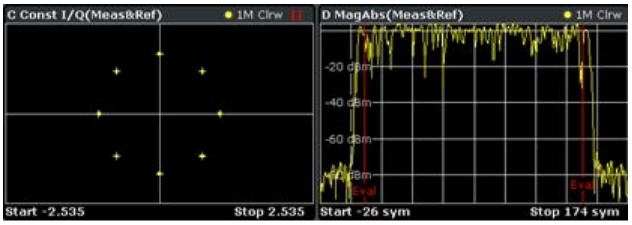


Fig. 8-11: Evaluation lines properly adjusted

3. In order to understand the effect of an incorrectly set evaluation range, change the evaluation range to include the entire result range.

   a) In the "Overview", select "Evaluation Range".
   b) Enable the "Entire Result Range" option.

   The displayed constellation diagram is no longer clear, it contains additional points. This is due to the fact that the constellation diagram now displays symbol instants that are beyond the burst.

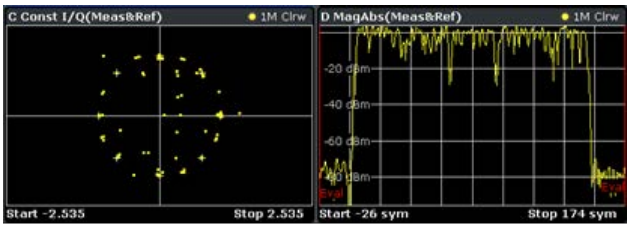
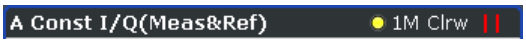


Fig. 8-12: Evaluation lines not properly adjusted

All measurement windows that consider the evaluation range are marked with two small red lines in the title bar.



8.3.6 Comparing the Measurement Signal to the Reference Signal

You have seen that it is possible to add different traces such as maximum hold or average to each window. When evaluating the measurement signal it is also possible to display the ideal reference signal as an additional trace. This can be a significant help when troubleshooting, since it allows for an immediate comparison.

1. Start from the configuration described in chapter 8.3.4, "Evaluating the Rising and Falling Edges", on page 233.
2. Select window 4 to set the focus on it.
3. Press the TRACE key and then the "Trace 2" softkey.
4. Select "Clear Write" as the "Trace Mode" and "Evaluation: Ref". This adds a second trace to your result display. This trace is the ideal reference signal that can now be compared to the measurement signal (see figure 8-13).

5. To view the traces in more detail, enlarge the window using the "Split/Maximize" key ( ), and zoom into the display using the icon in the toolbar (see the dotted rectangle in figure 8-13).

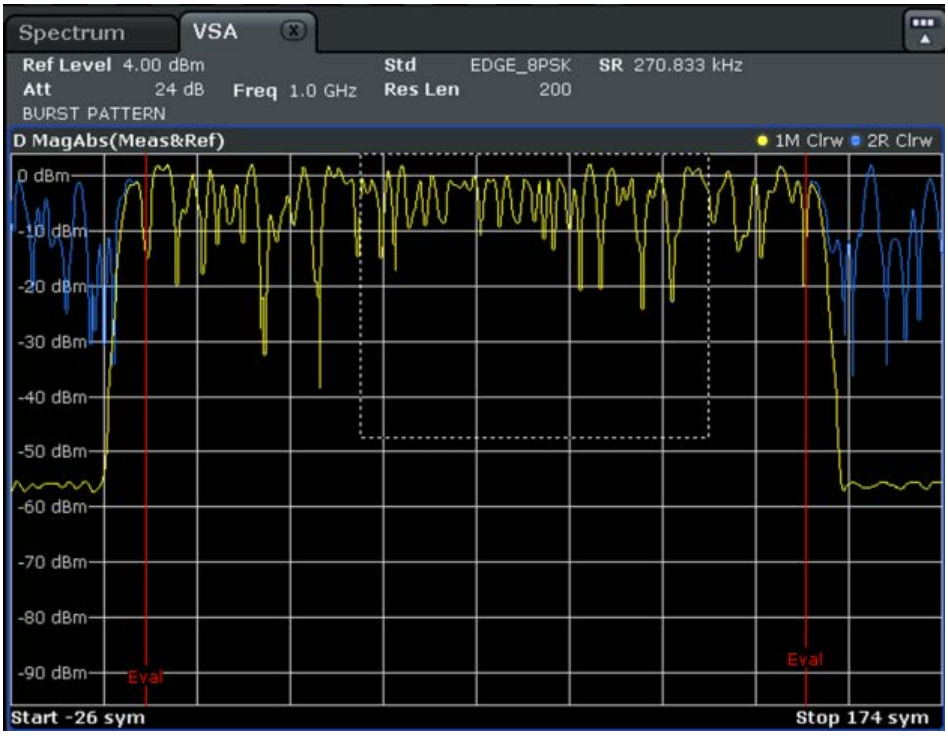


Fig. 8-13: Zooming

Now you can compare the measured and the ideal reference signal.

9 Optimizing and Troubleshooting the Measurement

9.1 Obtaining Technical Support

If problems occur, the instrument generates error messages which in most cases will be sufficient for you to detect the cause of an error and find a remedy.

Error message types are described in chapter 9.2, "Explanation of Error Messages", on page 237.

In addition, our customer support centers are there to assist you in solving any problems that you may encounter with your R&S FSW. We will find solutions more quickly and efficiently if you provide us with the information listed below.

- **System Configuration:** The "System Configuration" dialog box (in the "Setup" menu) provides information on:
  - **Hardware Info:** hardware assemblies
  - **Versions and Options:** the status of all software and hardware options installed on your instrument
  - **System Messages:** messages on any errors that may have occurred

  An .xml file with information on the system configuration ("device footprint") can be created automatically.
- **Error Log:** The `RSError.log` file (in the log directory of the main installation directory) contains a chronological record of errors.
- **Support file:** a *.zip file with important support information can be created automatically. The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display.

To collect the support information

1. Press the SETUP key.
2. Select "Service > R&S Support" and then "Create R&S Support Information".

   The file is stored as `C:\R_S\instr\user\service.zip`.

   Attach the support file to an e-mail in which you describe the problem and send it to the customer support address for your region as listed at the beginning of the R&S FSW Getting Started manual.

9.2 Explanation of Error Messages

The following section describes error messages and possible causes.

Message: 'Burst Not Found'

The "Burst Not Found" error message can have several causes:

- **Burst search is active, but the signal is not bursted**

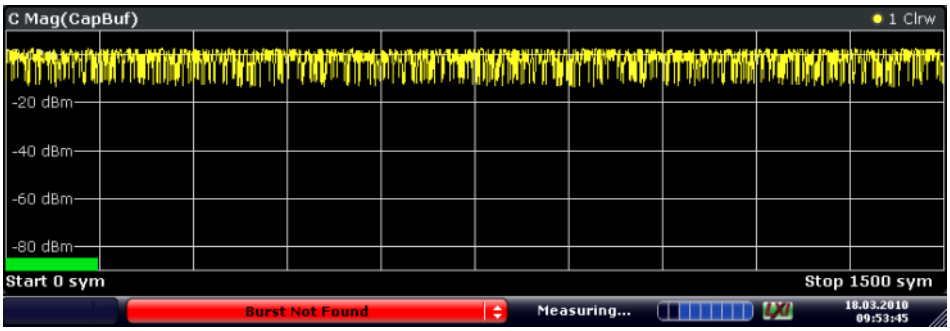


Fig. 9-1: Example for active burst search with continuous signal

Solution: Select "Continuous Signal" as the signal type.
For more information, see
– "Signal Type" on page 131.

- **Signal is bursted, but bursts have not been captured completely**
  The burst search can only find bursts that start and end within the capture buffer. It ignores bursts that are cut off.

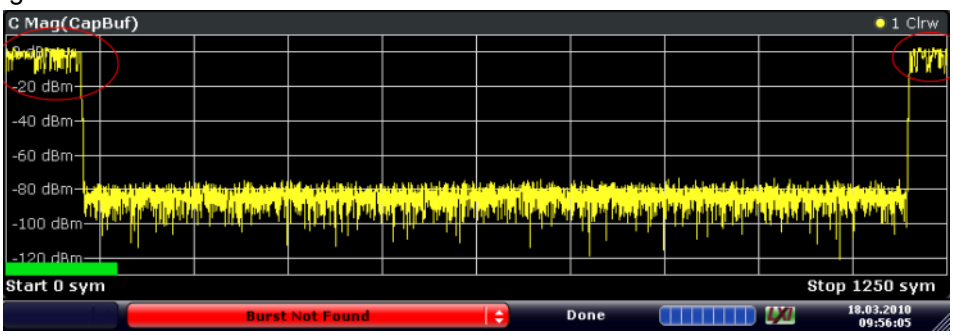


Fig. 9-2: Example for incomplete burst capture

Solution: Change the trigger settings and/or enlarge the capture length.
For more information, see
– chapter 5.6, "Signal Capture", on page 151

- **The current measurement is being performed on a burst that has not been captured completely.**

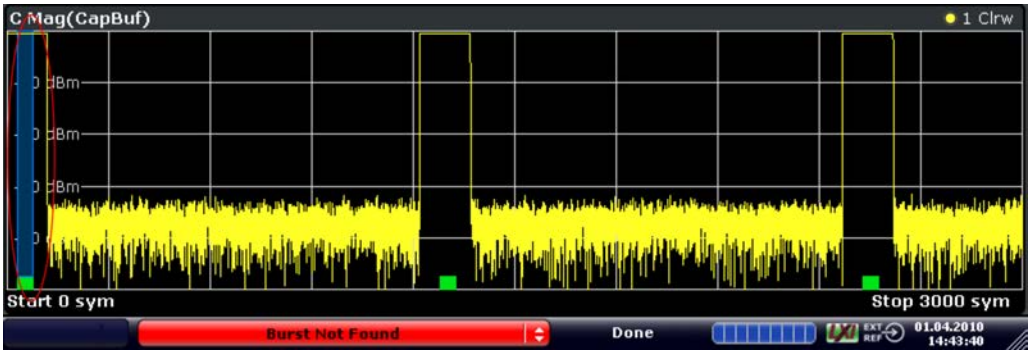


Fig. 9-3: Example for measurement on incomplete burst capture

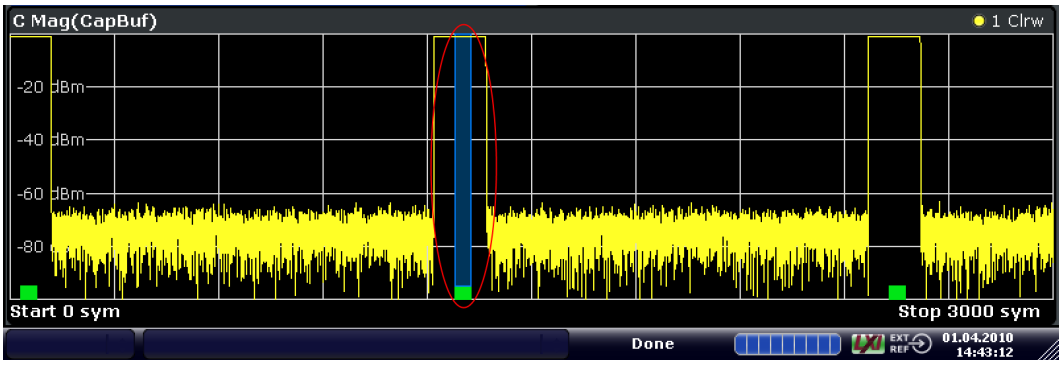


Fig. 9-4: Example for measurement on complete burst capture

Solution:
Change the trigger settings or increase the result length.
Note, however, that in this case, the results are actually correct and the message can be ignored.

- **The settings do not match the signal**
  In order to allow you to select certain bursts, the burst search only searches for bursts that have a length between "Min Length" and "Max Length" (plus a tolerance that you can set in the "Burst Search" Dialog). In case the burst is, e.g. shorter than the "Burst Min Length", the burst search fails.

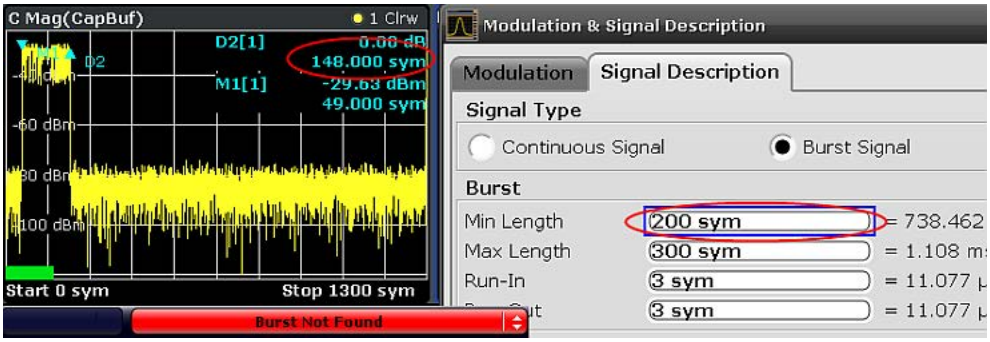


Fig. 9-5: Example for a failed burst search due too a burst that is too short

Solution: try one of the following:
– Switch on the Magnitude (Capture Buffer) result display. Move a marker to the start of the burst. Move a delta marker to the end of the burst and compare the burst length to the settings in the "Signal Description" dialog.
– Increase the search tolerance in the "Burst Search" dialog. Keep an eye on the green/red field. If the burst search succeeds, you can see the length of the found bursts.
– Set the minimum burst length to 50 and the maximum burst length to 5000.

For more information, see:
– "Burst Settings" on page 131
– "Burst Configuration" on page 162

- **The signal is highly distorted and/or has modulation noise**
  One possibility to enhance the robustness of the burst search is to increase the minimum gap length. If the bursts within your capture buffer are not closely spaced, it makes sense to increase the value of this parameter.

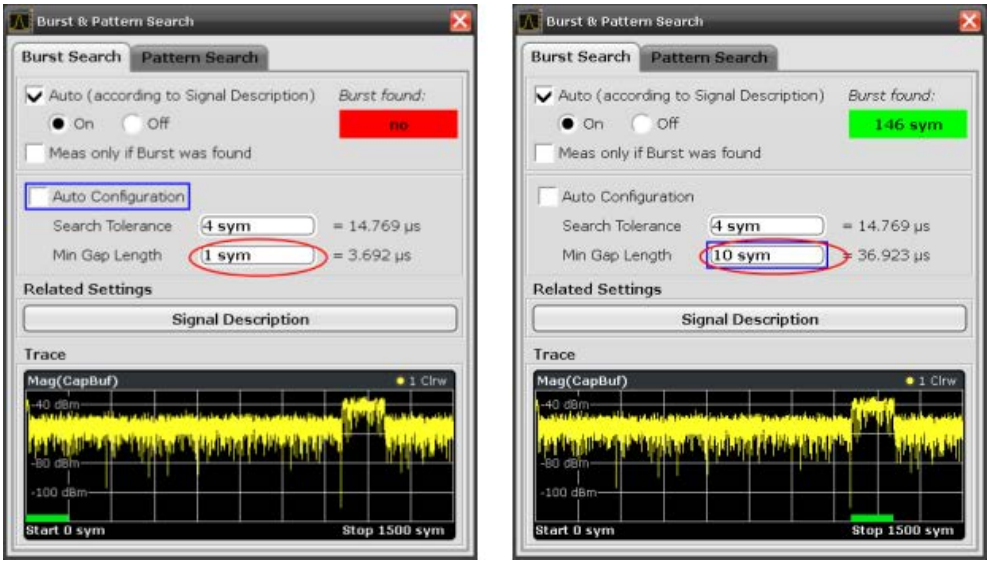


Fig. 9-6: Example for adjusting the minimum gap length

For more information, see "Min Gap Length" on page 162

- **The pattern search is switched on, fails and the alignment is with reference to the pattern.**
  In case the pattern search is switched on and the reference for the alignment is the pattern (and not the burst), a non-detected pattern causes the result range to be positioned at the beginning of the capture buffer. Hence, if a the burst does not start right at the beginning of the capture buffer, you will see a "Burst Not Found" Message.
  Solution:
  – Refer to "Message: 'Pattern Not Found'" on page 240
  – Switch the pattern search off.
  – Choose "Burst" as the reference for the result range alignment.

Message: 'Pattern Not Found'
The "Pattern Not Found" error message can have several causes:

- **The burst search has failed**

If burst and pattern search are active, the application looks for patterns only within the found bursts. Hence, in case the burst search fails, the pattern search will also fail.
Solution: Try one of the following:
– Make sure the burst search is successful.
– Deactivate the burst search but keep the pattern search active.

For more information, see
– "Message: 'Burst Not Found'" on page 238
chapter 5.7.1, "Burst Search", on page 161

- **The offset of the pattern within the burst is incorrectly set**
It is possible to set a pattern offset to speed up the pattern search. The offset of the pattern would be the offset of the pattern start with respect to the start of the useful part of the burst. However, if the entered offset is not correct (within about 4 symbols of tolerance), the pattern will not be found.

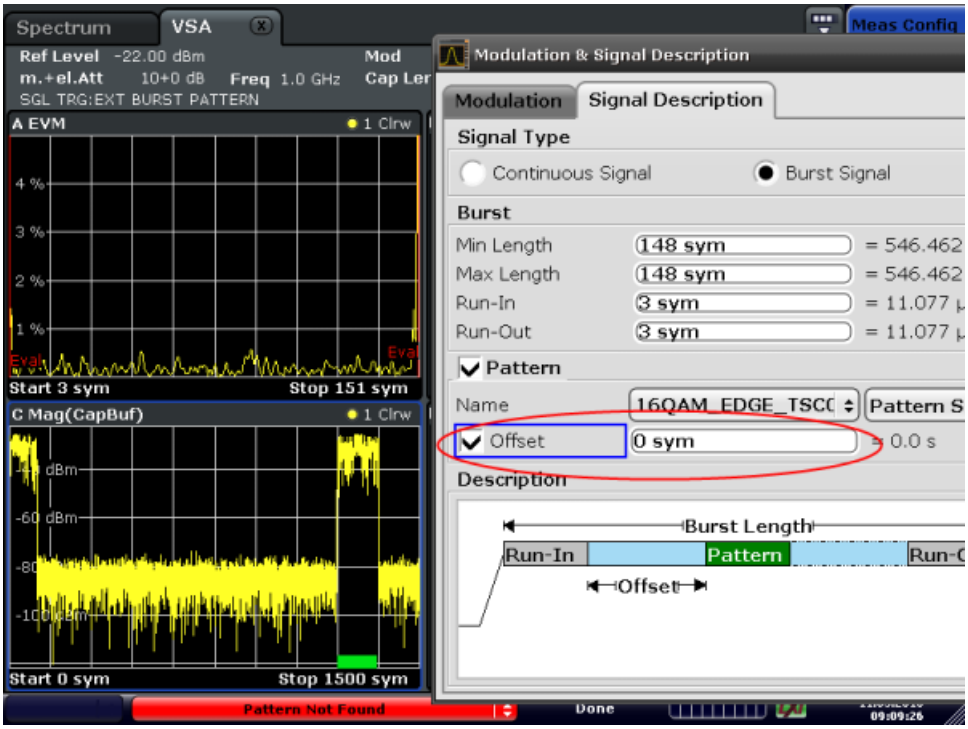


Fig. 9-7: GSM EDGE burst; Pattern is actually located in the middle of the burst. The correct value for "Offset" here would be 58.

Solution: Try one of the following:
– Remove the offset ('unknown').
– Enter the correct offset (within about 4 symbols of tolerance).

For more information, see
– "Offset" on page 132

- The specified pattern does not coincide with the pattern in your signal:
In the R&S FS**Q**-K70 it is possible to search for multiple patterns at the same time. For example, in a GSM measurement, the capture buffer can be checked for all TSCs simultaneously. This is not possible in the R&S FSW-K70.
Solution:
Make sure that the correct pattern is specified in the "Signal Description" dialog.

For more information, see
– chapter 5.4, "Signal Description", on page 126

Message: 'Result Alignment Failed'
The result range alignment is not possible for the patricular capture buffer. The result range needs I/Q data that has not been captured.

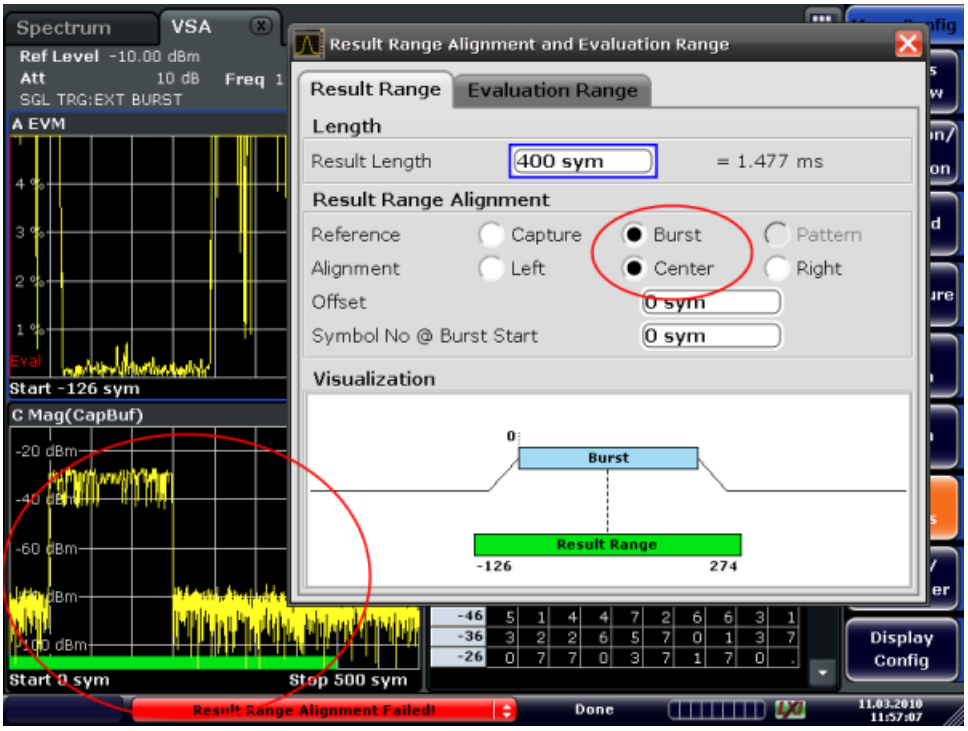


Fig. 9-8: Example for failed alignment

In this windowshot, the alignment of the long result range to the burst center is not possible because there are not enough samples in the capture buffer before the burst starts. In this scenario, the trigger settings should be changed such that the burst is in the middle of the capture buffer.

Solution: Change the trigger settings and/or enlarge the capture length.

For more information, see:
- chapter 5.6, "Signal Capture", on page 151

Message: 'Pattern Search On, But No Pattern Selected'

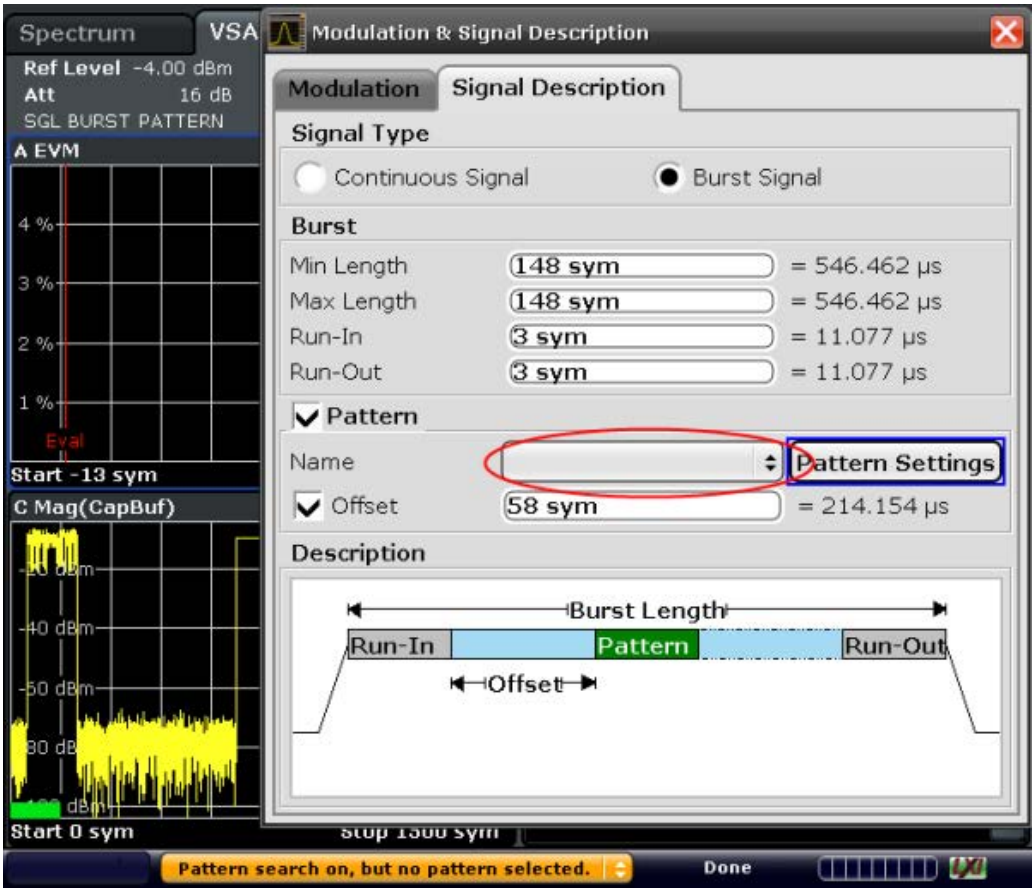


Fig. 9-9: The red circle shows the place where you can specify a pattern

Solution: Select an existing pattern (or create a new pattern) that you expect to be within the signal.

For more information, see

- "Pattern Settings" on page 132
  chapter 7.2.2, "How to Perform Pattern Searches", on page 204

Message: 'Pattern Not (Entirely) Within Result Range

A pattern can only be found, if it is entirely within the result range. Therefore, this error message always occurs with a "Pattern Not Found" error.

Solution: Choose the pattern as reference of your result range alignment. Then, the pattern will be forcefully part of your result range and the pattern search can succeed.

For more information, see

- chapter 5.8, "Result Range Configuration", on page 169
- chapter 7.2.4, "How to Define the Result Range", on page 211

Message: 'Short Pattern: Pattern Search Might Fail'

The R&S FSW performs the pattern search in two stages.

- Stage 1 involves the generation of an I/Q pattern waveform by modulating the pattern symbol sequence. The I/Q pattern is then correlated with the measured signal. At

positions where the correlation metric exceeds the "I/Q Correlation Threshold" the I/Q pattern is found.
- Stage 2 demodulates the measured signal at the I/Q pattern location and the transmitted symbols are checked for correctness against the pattern symbol sequence.

In case of a very short pattern, i.e. a pattern length in the order of the inter-symbol interference (ISI) duration, a number of issues can arise:
- False positive
  The I/Q pattern is found at positions where the transmitted symbols differ from the pattern symbols.
  Solution: Try one of the following:
  – Activate "Meas only if Pattern Symbols Correct".
  – Increase the "I/Q Correlation Threshold"
    (see chapter 5.7.2, "Pattern Search", on page 163).
- False negative
  The I/Q pattern search misses a position where transmitted symbols match the pattern symbols.
  Solution:
  – Decrease the "I/Q Correlation Threshold"
    (see chapter 5.7.2, "Pattern Search", on page 163).

  In case of bursted signals the pattern search finds only the first occurrence of the I/Q pattern within each burst. If a false positive occurs in this situation (cf. case 1.) the use of "Meas only if pattern symbols correct" will not provide a satisfactory solution. In this case do the following:
  – Increase the "I/Q Correlation Threshold".
  – Specify the expected position of the pattern within the burst by adjusting the "Offset" parameter.

Message: 'Sync Prefers More Valid Symbols'
Note: Note that this message does not necessarily indicate a problem. Its purpose is to inform you that you might have the opportunity to get a more stable demodulation and/or better measurement results by improving your setup.

Synchronization in the VSA application is performed in two stages: coarse synchronization that precedes the reference signal generation and fine synchronization based on the reference signal.

- The coarse synchronization stage can work data-aided (i.e. based on a known pattern) or non-data-aided (i.e. based on the unknown data symbols). The default is a non-data-aided coarse synchronization. In the case that a pattern is part of signal, the user can switch to data-aided synchronization.
- The fine synchronization stage always works data-aided.

'Sync Prefers More Valid Symbols' indicates that one of the synchronization stages has too few symbols to ensure that the synchronization is robust.

The message is given if
- Coarse Synchronization = Non-Data-Aided (User Pattern for Sync = Off):
  Estimation range shorter than 40 symbols
  (see chapter 4.5.1.2, "Estimation", on page 97)
- Fine Synchronization:
  Estimation range shorter than 10 symbols
  (see chapter 4.5.1.2, "Estimation", on page 97)

Solution:

- If the signal contains a pattern, set "Coarse Synchronization: Pattern".
  (see "Coarse Synchronization" on page 177).
  Example: measurement of a GSM EDGE pattern that has a length of 26 symbols.

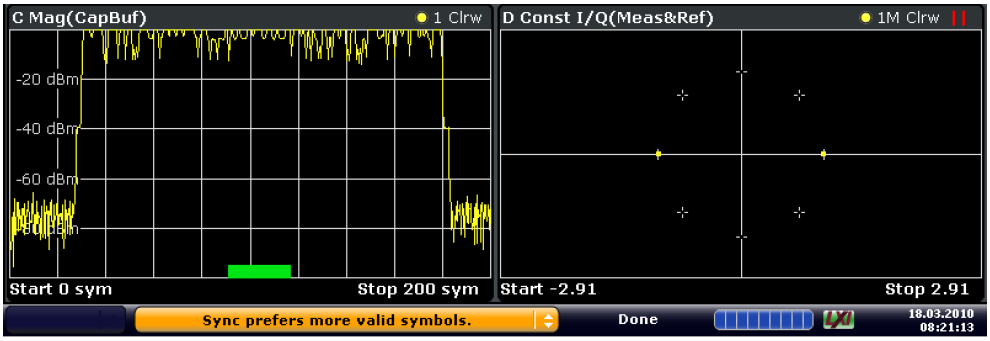


Fig. 9-10: User Pattern for Sync = Off

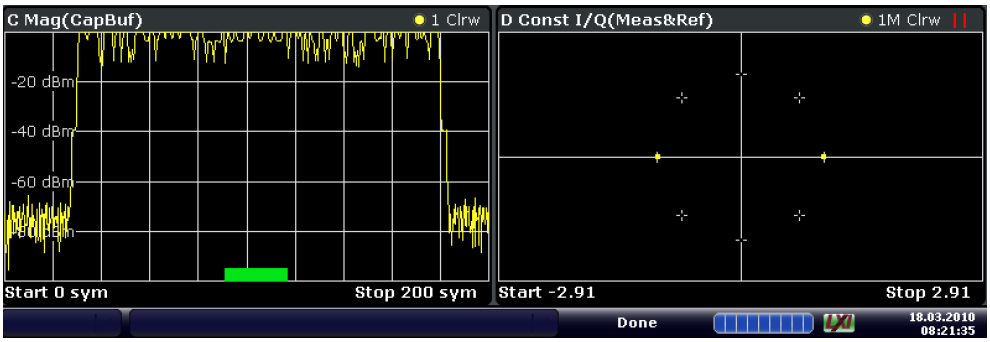


Fig. 9-11: User Pattern for Sync = On

- Choose a longer "Result Range".
- If the signal is bursted and the bursts are short:
  – Make sure your "Result Range" comprises the entire burst.
  – Make sure that "Run-In/Out" is not chosen too large, since the "Run-In/Out" ranges are excluded from the synchronization.
- If the signal is bursted and contains a pattern:
  Only switch off the burst search if absolutely necessary. If you need to switch it off, align your "Result Range" to the pattern, make sure it does not exceed the burst ramps and choose "Continuous Signal" as the "Signal Type" in the "Signal Description" dialog.

For more information, see

- chapter 4.4, "Overview of the Demodulation Process", on page 84

Message: 'Sync Prefers Longer Pattern'

This message can only occur if the coarse synchronization is data-aided, i.e is based on a known pattern. In case the pattern is very short, pattern-based coarse synchronization might be unstable. If demodulation is stable, e.g. you get a reasonable EVM, there is no need to change anything. Otherwise, you have two options:

- Switch to the non-pattern-based mode by setting the parameter "Coarse Synchronization: Data "
  (see "Coarse Synchronization" on page 177

- If possible, use a longer pattern.

For more information, see

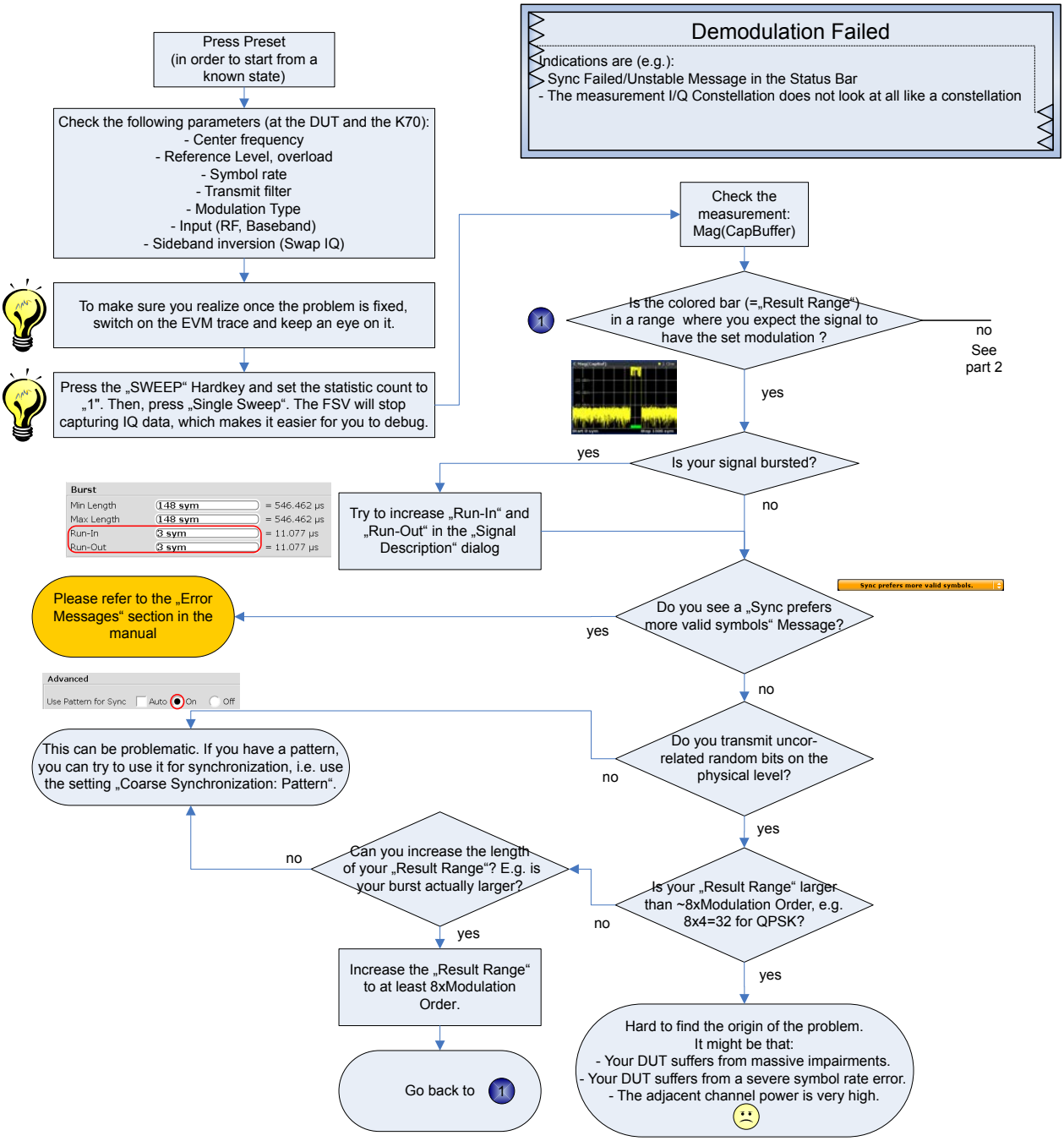
- chapter 4.4, "Overview of the Demodulation Process", on page 84

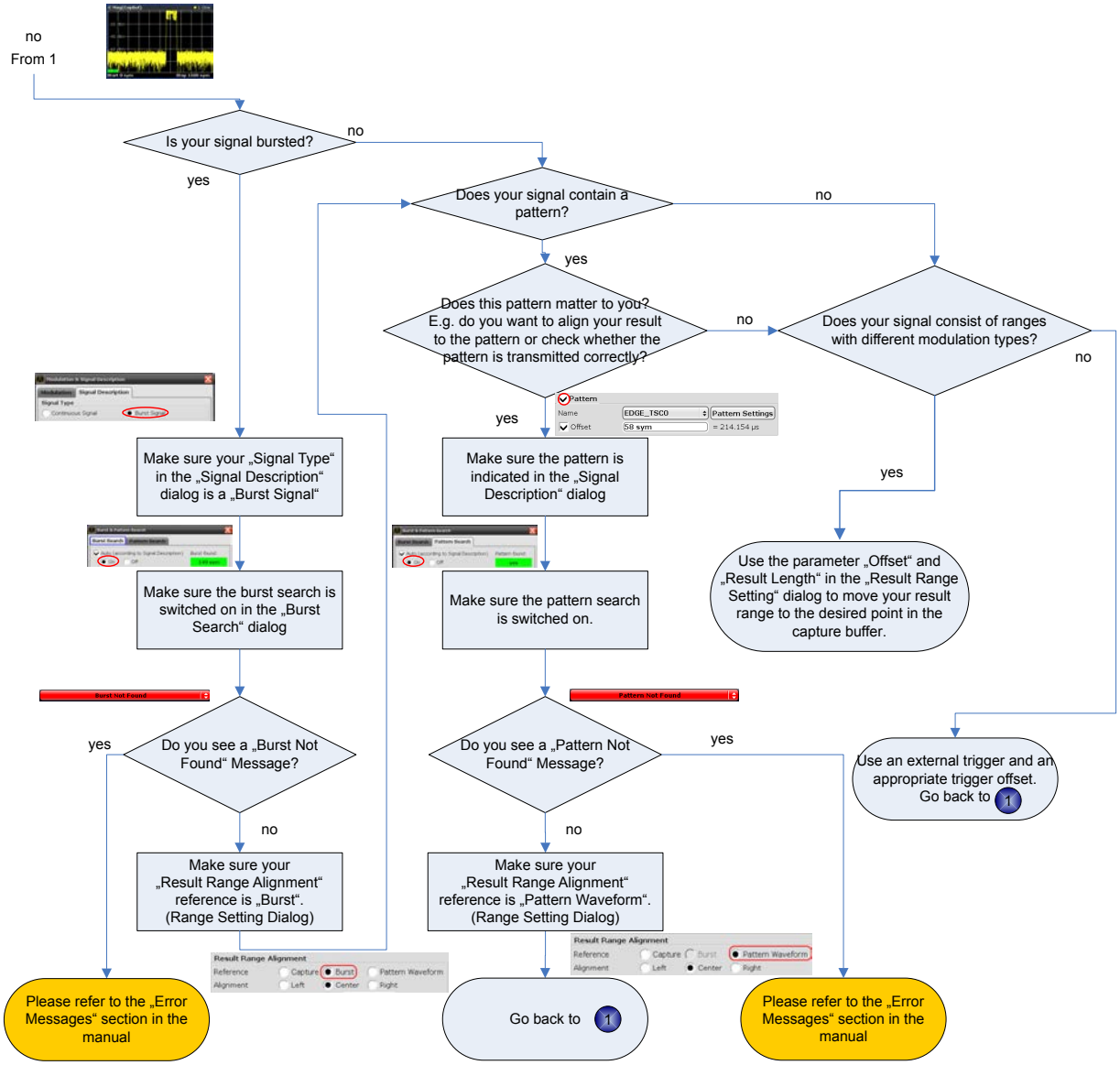
Message: 'Result Ranges Overlap'
This message does not indicate an error. It is merely displayed to inform you that the defined result ranges in the capture buffer overlap. Thus, some captured data is evaluated more than once. For example, the same peak value may be listed several times if it is included in several result ranges, and averaging is performed on (partially) duplicate values. However, a negative influence on the measurement results is not to be expected.

9.3 Flow Chart for Troubleshooting

If you experience a concrete measurement problem, you might want to try solving it with the help of the flow chart.

Troubleshooting Overview





9.4 Frequently Asked Questions

Problem: The trace is not entirely visible within the measurement window
Solution:

- 1. Select the measurement window.
- 2. Press the AUTO key.
- 3. Press the "Y-Axis Auto Scale" softkey.

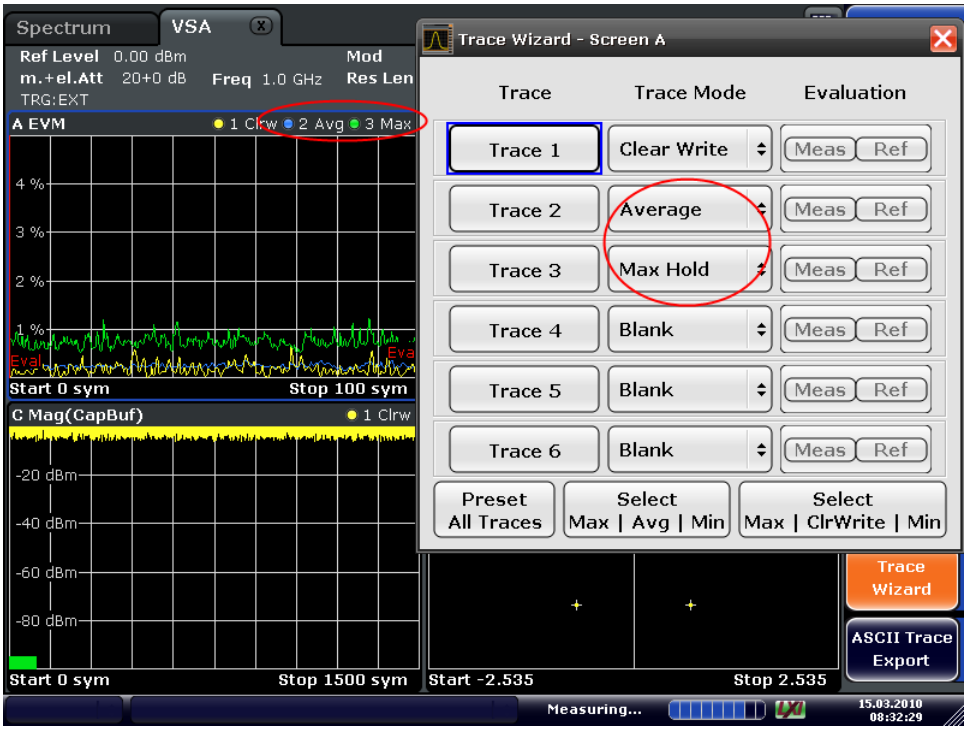
Problem: The trace of the measurement signal is visible in the measurement window; the trace of the reference signal is not
Solution:

- 1.Select the measurement window.
- 2. Press the TRACE key.
- 3. Press the "Trace Config" softkey.
- 4. Select a second trace, choose "Clear Write" as "Trace Mode" and toggle to "Ref" in the "Evaluation" column.

Problem: The measurement window does not show average results
Solution:

- 1. Select the measurement window.
- 2. Press the TRACE key.

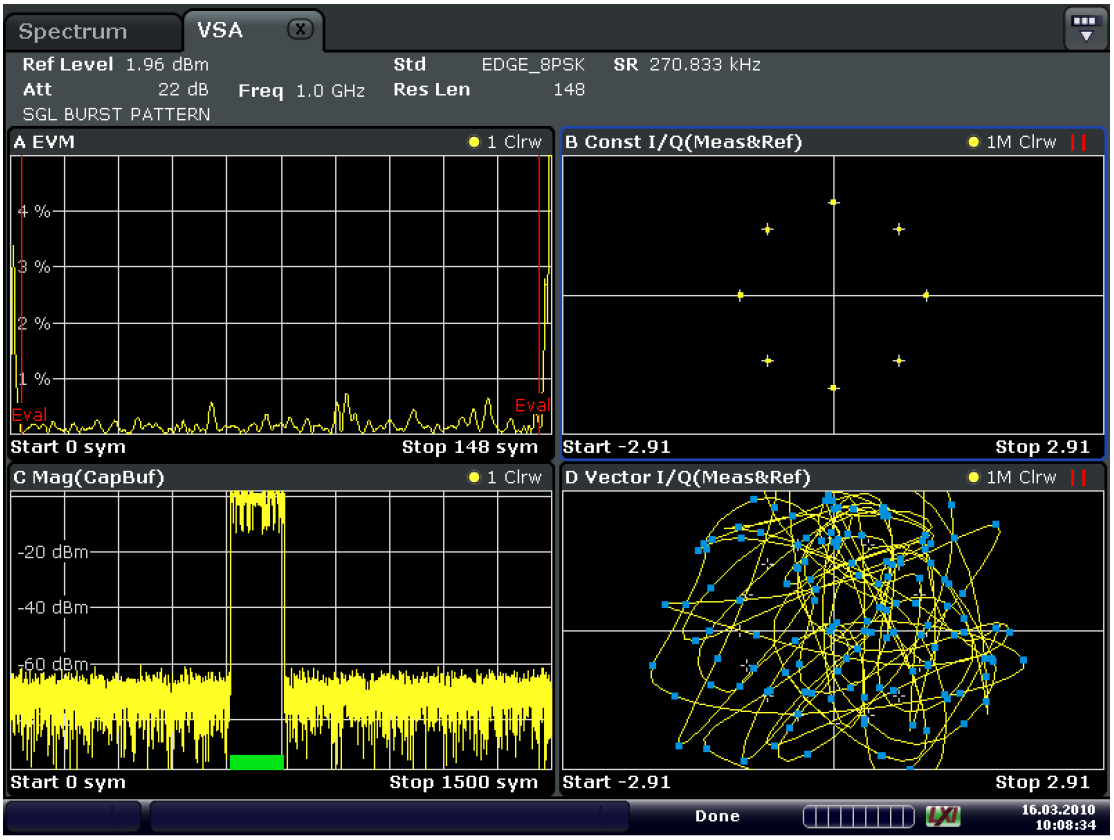
- 3. Press the "Trace Config" softkey.
- 4. Select a second trace and choose the preferred "Trace Mode", e.g. "Max Hold" or "Average".



Problem: The spectrum is not displayed in the logarithmic domain
Solution:

- 1. Select the measurement window.
- 2. Press the AMPT key.
- 3. Press the "Unit" softkey.
- 4. Press the "Y-Axis Unit" softkey.
- 5. Select dB.

Problem: The Vector I/Q result display and the Constellation I/Q result display look different



Date: 16.MAR.2010 10:08:34

Reason:

- The Vector I/Q diagram shows the measurement signal after the measurement filter and synchronization.
- The Constellation I/Q diagram shows the de-rotated constellation (i.e. for a π/4-DQPSK, 4 instead of 8 points are displayed). The inter-symbol interference has been removed.

In case the measurement filter does not remove the inter-symbol interference, the windows show measurements that are significantly different.

Problem: The Constellation I/Q measurement result display has a different number of constellation points in the R&S FSQ-K70 and the R&S FSW-K70

Reason:

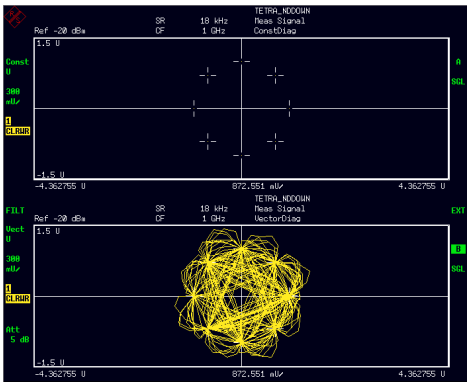
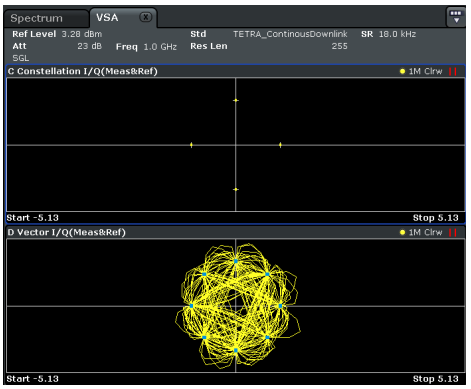
In the FSQ-K70, the Constellation I/Q measurement displays the symbol instants of the Vector I/Q measurement. Hence, this is a rotated constellation, e.g. for a π/4-DQPSK, 8 points are displayed.

In the R&S FSW-K70, the Constellation I/Q diagram shows the de-rotated constellation (i.e. for a π/4-DQPSK, 4 instead of 8 points are displayed). The inter-symbol interference has been removed.

Note: The result display "I/Q Constellation (Rotated)" displays the rotated constellation, as the FSQ-K70 does.

For details on the Constellation I/Q diagram in the R&S FSW-K70, see chapter 3.2.11, "Constellation I/Q", on page 30.

Table 9-1: Constellation I/Q and Vector I/Q for pi/4-DQPSK modulation

	
R&S FSQ-K70	R&S FSW-K70

Problem: the MSK/FSK signal demodulates on the R&S FSQ-K70, but not on the R&S FSW-K70 or: Why do I have to choose different transmit filters in the R&S FSQ-K70 and the R&S FSW-K70?
When generating an MSK/FSK reference signal, the R&S FSQ-K70 automatically replaces the Dirac pulses generated by the frequency mapper with square pulses with the length of one symbol. In the R&S FSW-K70, however, this "replacement" is part of the transmit filter routine. Thus, the R&S FSQ and the R&S FSW require different transmit filters for measuring the same FSK/MSK signal.

Example:

- If your transmit filter for the R&S FSQ-K70 was "NONE", you need to choose "Rectangular" as the transmit filter type in the R&S FSW.
- If your transmit filter for the R&S FSQ-K70 was "GAUSS", you need to choose "GMSK" as the transmit filter type in the R&S FSW.

Problem: The EVM trace looks okay, but the EVM in the result summary is significantly different
Solution:

- Make sure that the position of the "Evaluation Lines" is reasonable. The Result Summary only evaluates sample instants that are within the evaluation lines. Hence, in the case the "Result Range" covers the burst ramps, it is important to adjust the "Evaluation Range" appropriately.

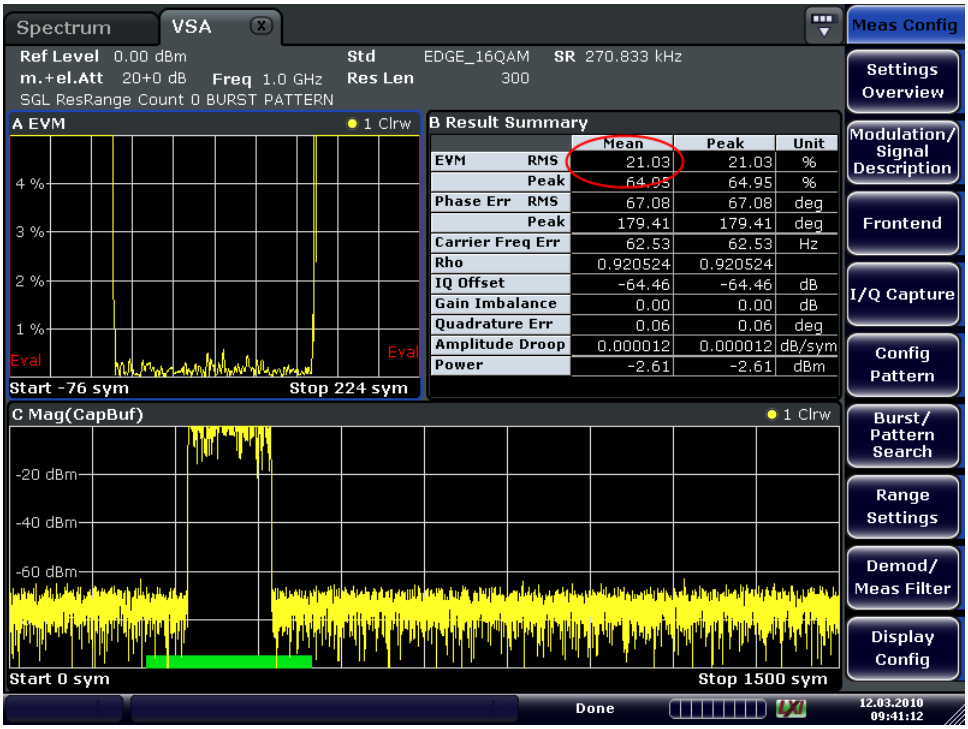


Fig. 9-12: Problem: EVM in result summary does not correspond with trace display

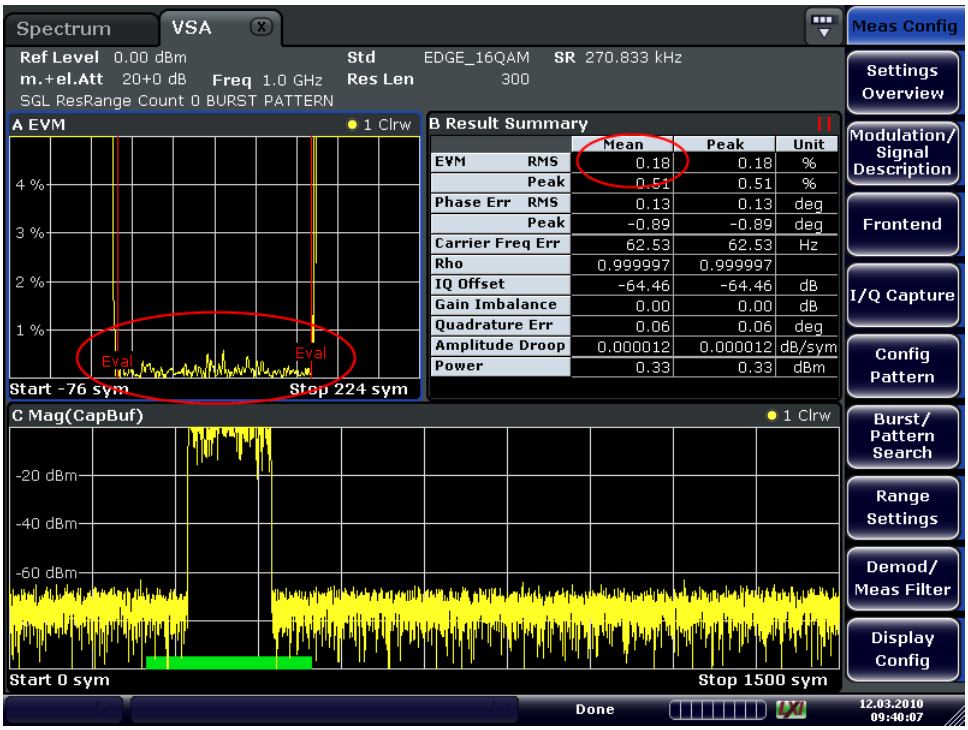
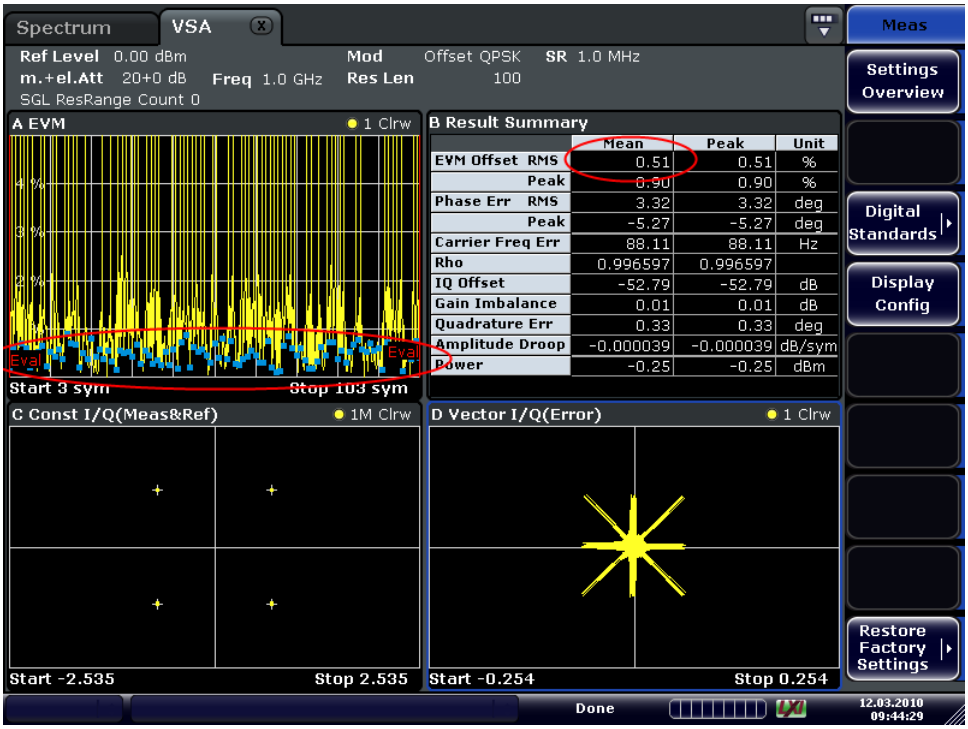


Fig. 9-13: Solution: Result Summary with correct evaluation range setting

- Make sure that the same samples are evaluated. By default, the EVM trace displays all sample instants, e.g. if the sample rate is 4, the EVM trace shows 4 samples per symbol. The Result Summary does not automatically evaluate all sample instants.

E.g. for a PSK modulation, by default only symbol instants contribute to the EVM result.

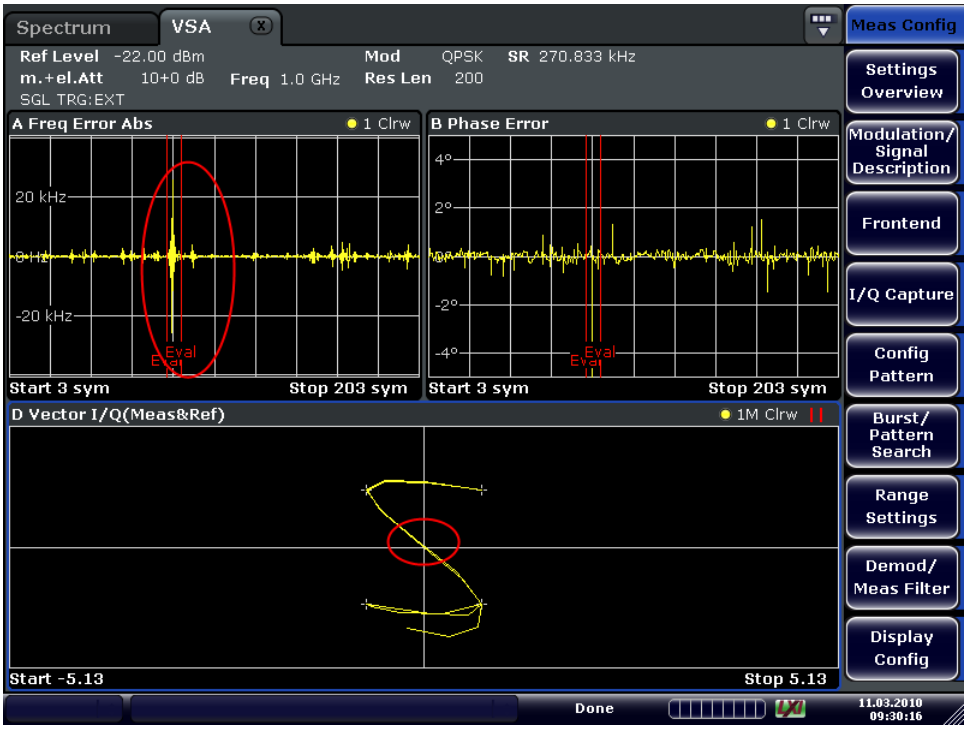


Question: Why isn't the FSK Deviation Error in R&S FSW-K70 identical to the FSK DEV ERROR in R&S FSQ-K70?

Solution:

The FSK deviation error in the R&S FSW-K70 is calculated as the difference between the measured frequency deviation and the reference frequency deviation as entered by the user (see "FSK Ref Deviation (FSK only)" on page 129). What is referred to as the "FSK DEV ERROR" in the R&S FSQ-K70 is calculated differently (see the R&S FSQ-K70 Software Manual) and is comparable to the "Freq Err RMS" in the R&S FSW-K70. However, while the "FSK DEV ERROR" in the R&S FSQ-K70 is given in Hz, the "Freq Err RMS" in the R&S FSW-K70 is given in percent, i.e. relative to the "FSK Meas Deviation".

Problem: The PSK/QAM Signal shows spikes in the Frequency Error result display



Solution:

These spikes are usually uncritical and are caused by zero-transitions in the I/Q Plane.

Question: The y-axis unit for the spectrum of the measurement signal can be chosen to be "dB". What level is this relative to?
Answer:

Spectrum (RealImag, Meas&Ref) calculates the FFT of the result RealImag(Meas&Ref). RealImag(Meas&Ref) has the unit "none". In this case, "none" means the measured signal has been scaled such that it matches the ideal corresponding reference signal as well as possible. The reference signal in turn is scaled such that max(abs(at symbol instants)) = 1.0.

Question: How can I get the demodulated symbols of all my GSM bursts in the capture buffer in remote control?
Answer:

Use the following remote commands:

```
:SENSe1:DDEMod:PRESet 'GSM_NB'
```

Load the GSM standard.

```
:SENSe1:DDEMod:RLENgth 10000 SYM
```

Enlarge the capture buffer length such that all the bursts you want to demodulate can be seen within the capture buffer.

```
:INITiate1:CONTinuous OFF
```

Go to single sweep mode.

```
:SENSe1:SWEep:COUNt 0
```

Set the "Statistic Count" to "Auto" mode.

```
:INITiate1:IMMediate
```

Do single sweep.

```
:SENSe1:SWEep:COUNt:CURRent?
```

Query the number of demodulated bursts within the capture buffer.

```
For n = 1:NumberOfBursts
        :SENSe1:DDEMod:SEARch:MBURst:CALC n
        :TRACe4? TRACe1 'Query the result symbols in window D
End
```

Step through all bursts and query the demodulated symbols.

Question: Why do the EVM results for my FSK-modulated signal look wrong?
Answer:

For an FSK-modulated signal, the signal processing differs to an PSK/QAM/MSK-modulated signal. The estimation model does not minimize the EVM but the error of the instantaneous frequency (see chapter 4.5.2.1, "Error Model", on page 107). Therefore, the measurement value that corresponds to the EVM value for FSK is the the Frequency Error (Absolute/Relative). (Source Type: Modulation Error; Result Type: Frequency Error (Absolute/Relative))

10 Remote Commands for VSA

The following commands are required to perform measurements in VSA in a remote environment. It assumes that the R&S FSW has already been set up for remote operation in a network as described in the base unit manual.

Common Suffixes

In VSA, the following common suffixes are used in remote commands:

Suffix	Value range	Description
<m>	1..4	Marker
<n>	1..16	Window
<t>	1..6	Trace

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

The following tasks specific to VSA are described here:

10.1 Introduction

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

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

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

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

Remote command examples

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

10.1.1 Long and Short Form

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

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

Example:

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

10.1.2 Numeric Suffixes

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

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

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

Example:

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

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

10.1.3 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

10.1.4 Alternative Keywords

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

Example:

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

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

10.1.5 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

10.1.5.1 Numeric Values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

10.1.5.2 Boolean

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

Querying boolean parameters

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

Example:

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

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

10.1.5.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 10.1.1, "Long and Short Form", on page 258.

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`

10.1.5.4 Character Strings

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

Example:

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

10.1.5.5 Block Data

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

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

10.2 Activating Vector Signal Analysis

Vector signal analysis requires a special application on the R&S FSW. A measurement is started immediately with the default settings.

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

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

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 10-1.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 10-1).

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

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

This command replaces a measurement channel with another one.

Parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 10-1.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 10-1).

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

INSTrument:DELete <ChannelName>

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

Parameters:

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

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

INSTrument:LIST?

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

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see table 10-1).
Tip: to change the channel name, use the `INSTrument:REName` command.

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

Usage: Query only

Table 10-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> Parameter	Default Channel Name*)
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

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

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

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

INSTrument[:SELect] <ChannelType>

Selects the application (channel type) for the current channel.

See also `INSTrument:CREate[:NEW]` on page 262.

For a list of available channel types see table 10-1.

Parameters:

<ChannelType> **VSA**
VSA, R&S FSW-K70

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual control: See "Preset Channel" on page 125

10.3 Digital Standards

Various predefined settings files for common digital standards are provided for use with the VSA application. In addition, you can create your own settings files for user-specific measurements.

Manual configuration of digital standards is described in chapter 5.2, "Configuration According to Digital Standards", on page 121.

[SENSe:]DDEMod:FACTory[:VALue] <Factory>

This command restores the factory settings of standards or patterns for the VSA application.

Setting parameters:

<Factory> ALL | STANdard | PATTern

ALL
Restores both standards and patterns.

*RST: ALL

Usage: Setting only

Manual control: See "Restore Factory Settings" on page 121
See "Restore Standard Files" on page 121
See "Restore Pattern Files" on page 121
See "Digital Standards" on page 122

[SENSe:]DDEMod:PRESet[:STANdard] <Standard>

This command selects an automatic setting of all modulation parameters according to a standardized transmission method or a user-defined transmission method. The standardized transmission methods are available in the instrument as predefined standards.

Setting parameters:

<Standard> string

Specifies the file name that contains the transmission method without the extension. For user-defined standards, the file path must be included. Default standards predefined by Rohde&Schwarz do not require a path definition. A list of predefined standards (including short forms) is provided in the annex (see chapter A.1, "Predefined Standards and Settings", on page 398).

Example: `DDEM:PRES 'TETRA_NDDOWN'`
Switches the predefined digital standard "TETRA_Discontinuous-Downlink" on.
`DDEM:PRES 'C:\R_S\Instr\usr\standards\USER_GSM'`
Switches the user-defined digital standard "USER_GSM" on.

Manual control: See "Digital Standards" on page 122
See "Load Standard" on page 122

[SENSe:]DDEMod:STANdard:COMMent <Comment>

This command enters the comment for a new standard. The comment is stored with the standard and is only displayed in the selection menu (manual operation). When remote control is used, the string is deleted after the standard has been stored, allowing a new comment to be entered for the next standard. In this case a blank string is returned when a query is made.

Setting parameters:

<Comment> string

Manual control: See "Digital Standards" on page 122
See "Comment" on page 122

[SENSe:]DDEMod:STANdard:DELete <FileName>

This command deletes a specified digital standard file in the vector signal analysis. The file name includes the path. If the file does not exist, an error message is displayed

Setting parameters:

<FileName> string

File name including the path for the digital standard file

Usage: Setting only

Manual control: See "Digital Standards" on page 122
See "Delete Standard" on page 123

[SENSe:]DDEMod:STANdard:PREset[:VALue]

This command restores the default settings of the currently selected standard.

Usage: Event

[SENSe:]DDEMod:STANdard:SAVE <FileName>

This command stores the current settings of the vector signal analysis as a new user-defined digital standard. If the name of the digital standard is already in use, an error message is output and a new name has to be selected. It is recommended that you define a comment before storing the standard.

Setting parameters:

<FileName> string

The path and file name to which the settings are stored.

Example: `DDEM:STAN:COMM 'GSM_AccessBurst with Pattern'`
Defines a comment for the settings.
`DDEM:STAN:SAVE 'C:\R_S\Instr\usr\standards\USER_GSM'`
Stores the settings in the user-defined digital standard "USER_GSM".

Usage: Setting only

Manual control: See "Digital Standards" on page 122
See "Save Standard" on page 123
See "Save Standard" on page 123

10.4 Configuring VSA

10.4.1 Signal Description

The signal description provides information on the expected input signal, which optimizes pattern and burst detection and the calculation of the ideal reference signal.

Manual configuration of the signal description is described in chapter 5.4, "Signal Description", on page 126.

10.4.1.1 Modulation

The modulation settings vary depending on the selected modulation type; in particular, FSK modulation provides some additional settings.

CALCulate<n>:FSK:DEViation:REFerence:RELative <FSKRefDev>

This command defines the deviation to the reference frequency for FSK modulation as a multiple of the symbol rate.

For details see "FSK Ref Deviation (FSK only)" on page 129.

Setting parameters:

<FSKRefDev> numeric value

Range: 0.1 to 15
*RST: 1
Default unit: NONE

Manual control: See "FSK Ref Deviation (FSK only)" on page 129

CALCulate<n>:FSK:DEViation:REFerence[:VALue] <FSKRefDevAbsRes>

This command defines the deviation to the reference frequency for FSK modulation as an absolute value in Hz.

Setting parameters:
<FSKRefDevAbsRes>numeric value

Range: 10.0 to 64e9
*RST: 100e3
Default unit: Hz

Manual control: See "FSK Ref Deviation (FSK only)" on page 129

[SENSe:]DDEMod:APSK:NSTate <APSKNstate>

This command defines the specific demodulation mode for APSK. The following APSK demodulation modes are possible: DDEMod:APSK:NSTate 16 16APSK 32 32APSK

Setting parameters:
<APSKNstate> numeric value

*RST: 16

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:ASK:NSTate <ASKNstate>

This command defines the specific demodulation mode for ASK. The following ASK demodulation modes are possible: DDEMod:ASK:NSTate 2 OOK 4 4ASK

Setting parameters:
<ASKNstate> numeric value

*RST: 2

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:FILTer:ALPHa <MeasFiltAlphaBT>

This command determines the filter characteristic (ALPHA/BT). The resolution is 0.01.

Setting parameters:
<MeasFiltAlphaBT> numeric value

Range: 0.1 to 1.0
*RST: 0.22
Default unit: NONE

[SENSe:]DDEMod:FILTer[:STATe] <MeasFilterState>

This command defines whether the input signal that is evaluated is filtered by the measurement filter. This command has no effect on the transmit filter.

Setting parameters:

<MeasFilterState> ON | OFF

ON
`[SENSe:]DDEMod:MFILter:AUTO` is activated.

OFF
The input signal is not filtered. `[SENSe:]DDEMod:MFILter:AUTO` is deactivated.

*RST: ON

[SENSe:]DDEMod:FORMat <Group>

This command selects the digital demodulation mode.

Setting parameters:

<Group> MSK | PSK | QAM | QPSK | FSK | ASK | APSK | UQAM

QPSK
Quad Phase Shift Key

PSK
Phase Shift Key

MSK
Minimum Shift Key

QAM
Quadrature Amplitude Modulation

FSK
Frequency Shift Key

ASK
Amplitude Shift Keying

APSK
Amplitude Phase Shift Keying

UQAM
User-defined modulation (loaded from file, see `[SENSe:]DDEMod:USER:NAME` on page 275)

*RST: PSK

Example: `SENS:DDEM:FORM QAM`

Manual control: See "Modulation Type" on page 127
See "Load User Modulation" on page 128

[SENSe:]DDEMod:FSK:NSTate <FSKNstate>

This command defines the demodulation of the FSK modulation scheme.

Setting parameters:

<FSKNstate> 2 | 4 | 8

2
2FSK

4
4FSK

8
8FSK

*RST: 2

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:MAPPing:CATalog?

This command queries the names of all mappings that are available for the current modulation type and order. A mapping describes the assignment of constellation points to symbols.

Return values:

<Mappings> A comma-separated list of strings, with one string for each mapping name.

Example: `:SENSe:DDEMod:MAPPing:CATalog?`
Result:
`'CDMA2K_FWD','DVB_S2','GRAY','NATURAL','WCDMA'`

Usage: Query only

Manual control: See "Modulation Mapping" on page 129

[SENSe:]DDEMod:MAPPing[:VALue] <Mapping>

To obtain a list of available symbol mappings for the current modulation type use the `[SENSe:]DDEMod:MAPPing:CATalog?` query.

Setting parameters:

<Mapping> string

Example: `SENS:DDEM:MAPP 'GSM'`
Sets mapping to GSM.

Manual control: See "Modulation Mapping" on page 129

[SENSe:]DDEMod:MSK:FORMat <Name>

This command defines the specific demodulation mode for MSK.

Setting parameters:
<Name> TYPE1 | TYPE2 | NORMal | DIFFerential

TYPE1 | NORMal
MSK

TYPE2 | DIFFerential
DMSK

*RST: QPSK

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:PSK:FORMat <Name>

Together with `DDEMod:PSK:NST`, this command defines the demodulation order for PSK (see also `[SENSe:]DDEMod:PSK:NSTate` on page 272). Depending on the demodulation format and state, the following orders are available:

NSTATe	<Name>	Order
2	any	BPSK
8	NORMal	8PSK
8	DIFFerential	D8PSK
8	N3Pi8	3pi/8-8PSK (EDGE)
8	PI8D8PSK	Pi/8-D8PSK

Setting parameters:
<Name> NORMal | DIFFerential | N3Pi8 | PI8D8PSK

*RST: QPSK

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:PSK:NSTate <PSKNstate>

Together with `DDEMod:PSK:FORMat`, this command defines the demodulation order for PSK (see also `[SENSe:]DDEMod:PSK:FORMat` on page 272).

Setting parameters:
<PSKNstate> 2 | 8

*RST: 2

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:QAM:FORMat <Name>

This command defines the specific demodulation mode for QAM.

Setting parameters:

<Name> NORMal | DIFFerential | NPI4 | MNPI4

NORMal
QAM

DIFFerential
DQAM

NPI4
π/4-16QAM

MNPI4
-π/4-32QAM

*RST: QPSK

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:QAM:NSTate <QAMNState>

This command defines the demodulation order for QAM.

<QAMNSTate>	Order
16	16QAM
16	Pi/4-16QAM
32	32QAM
32	Pi/4-32QAM
64	64QAM
128	128QAM
256	256QAM

Setting parameters:

<QAMNState> numeric value

*RST: 16

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:QPSK:FORMat <Name>

This command defines the demodulation order for QPSK.

Setting parameters:

<Name> NORMal | DIFFerential | NPI4 | DPI4 | OFFSet | N3PI4

NORMal
QPSK

DIFFerential
DQPSK

NPI4
π/4 QPSK

DPI4
π/4 DQPSK

OFFSet
OQPSK

N3PI4
3π/4 QPSK

*RST: NORMal

Example: `DDEM:FORM QPSK`
Switches QPSK demodulation on.
`DDEM:QPSK:FORM DPI4`
Switches π4 DQPSK demodulation on.

Manual control: See "Modulation Order" on page 128

[SENSe:]DDEMod:SRATe <SymbolRate>

This command defines the symbol rate.

The minimum symbol rate is 25 Hz. The maximum symbol rate depends on the defined Sample Rate (see chapter 4.2.1, "Sample Rate and Symbol Rate", on page 57).

Setting parameters:

<SymbolRate> numeric value

Range: 25 to 250e6
*RST: 3.84e6
Default unit: Hz

Manual control: See "Symbol Rate" on page 129

[SENSe:]DDEMod:TFILter:ALPHa <Alpha>

This command determines the filter characteristic (ALPHA/BT). The resolution is 0.01.

Setting parameters:

<Alpha> numeric value

Range: 0.1 to 1.0
*RST: 0.22
Default unit: NONE

Manual control: See "Alpha/BT" on page 130
See "Type" on page 180
See "Alpha/BT" on page 181

[SENSe:]DDEMod:TFILter:NAME <Name>

This command selects a transmit filter and automatically switches it on.

For more information on transmit filters, refer to chapter A.2.1, "Transmit Filters", on page 404.

Setting parameters:

<Name> string

Name of the Transmit filter; an overview of available transmit filters is provided in chapter A.2.1, "Transmit Filters", on page 404.

Manual control: See "Transmit Filter Type" on page 130
See "Load User Filter" on page 130

[SENSe:]DDEMod:TFILter[:STATe] <TXFilterState>

Use this command to switch the transmit filter off. To switch a transmit filter on, use the `[SENSe:]DDEMod:TFILter:NAME` command.

Setting parameters:

<TXFilterState> ON | OFF

OFF
Switches the transmit filter off.

ON
Switches the transmit filter specified by `[SENSe:]DDEMod:TFILter:NAME` on. However, this command is not necessary, as the `[SENSe:]DDEMod:TFILter:NAME` command automatically switches the filter on.

*RST: ON

Manual control: See "Transmit Filter Type" on page 130

[SENSe:]DDEMod:TFILter:USER <FilterName>

This command selects a user-defined transmit filter file.

Setting parameters:

<FilterName> The name of the transmit filter file.

Manual control: See "Transmit Filter Type" on page 130
See "Load User Filter" on page 130

[SENSe:]DDEMod:USER:NAME <Name>

Selects the file that contains the user-defined modulation to be loaded.

Setting parameters:

<Name> string

Path and file name of the `*.vam` file

Example: `SENS:DDEM:FORM UQAM`
Define the use of a user-defined modulation
`SENS:DDEM:USER:NAME 'D:\MyModulation.vam'`
Select the file name to be loaded

Manual control: See "Modulation Type" on page 127
See "Load User Modulation" on page 128

10.4.1.2 Signal Structure

The signal structure commands describe the expected input signal and determine which settings are available for configuration. You can define a pattern to which the instrument can be synchronized, thus adapting the result range.

[SENSe:]DDEMod:SEARch:BURSt:LENGth:MAXimum <MaxLength>

This command defines the maximum length of a burst. Only those bursts will be recognized that fall below this length. The default unit is symbols. The value can also be given in seconds.

Setting parameters:

<MaxLength> numeric value

Range: 0 to 15000
*RST: 1600
Default unit: SYM

Manual control: See "Burst Settings" on page 131
See "Min Length / Max Length" on page 132

[SENSe:]DDEMod:SEARch:BURSt:LENGth[:MINimum] <UsefulLength>

This command defines the minimum length of a burst. Only those bursts will be recognized that exceed this length. The default unit is symbols. The value can also be given in seconds.

Setting parameters:

<UsefulLength> numeric value

Range: 10 to 15000
*RST: 98
Default unit: SYM

Manual control: See "Burst Settings" on page 131
See "Min Length / Max Length" on page 132

[SENSe:]DDEMod:SEARch:BURSt:SKIP:FALLing <RunOut>

This command defines the length of the falling burst edge which is not considered when evaluating the result. The default unit is symbols. The value can also be given in seconds.

Setting parameters:

<RunOut> numeric value

Range: 0 to 15000
*RST: 1
Default unit: SYM

Manual control: See "Burst Settings" on page 131
See "Run-Out" on page 132

[SENSe:]DDEMod:SEARch:BURSt:SKIP:RISing <RunIn>

This command defines the length of the rising burst edge which was not considered when evaluating the result. The default unit is symbols. The value can also be given in seconds

Setting parameters:

<RunIn> numeric value

Range: 0 to 15000
*RST: 1
Default unit: SYM

Manual control: See "Burst Settings" on page 131
See "Run-In" on page 132

[SENSe:]DDEMod:SEARch:SYNC:CATalog <Patterns>

This command reads the names of all patterns stored on the hard disk. The file names are returned as a comma-separated list of strings, one for each file name (without the file extension).

Setting parameters:

<Patterns> CURRent | ALL

CURRent
Only patterns that belong to the current standard

ALL
All patterns

*RST: ALL

Example: `:DDEM:SEAR:SYNC:CAT? CURR`
Result:
`'GSM_AB0','GSM_AB1','GSM_AB2','GSM_TSC1'`

[SENSe:]DDEMod:SIGNal:PATTern <PatternedSignal>

This command specifies whether the signal contains a pattern or not.

Setting parameters:
<PatternedSignal> ON | OFF
*RST: OFF

Manual control: See "Pattern Settings" on page 132
See "Name" on page 132

[SENSe:]DDEMod:SIGNal[:VALue] <SignalType>

This command specifies whether the signal is bursted or continuous.

Setting parameters:
<SignalType> CONTinuous | BURSted
*RST: CONTinuous

Manual control: See "Signal Type" on page 131

[SENSe:]DDEMod:STANdard:SYNC:OFFSet:STATe <PattOffsState>

This command (de)activates the pattern offset.

Setting parameters:
<PattOffsState> ON | OFF
*RST: OFF

Manual control: See "Pattern Settings" on page 132
See "Offset" on page 132

[SENSe:]DDEMod:STANdard:SYNC:OFFSet[:VALue] <PatternOffset>

This command defines a number of symbols which are ignored before the comparison with the pattern starts.

Setting parameters:
<PatternOffset> numeric value
Range: 0 to 15000
*RST: 0
Default unit: SYM

Manual control: See "Pattern Settings" on page 132
See "Offset" on page 132

10.4.2 Input and Frontend Settings

The R&S FSW can analyze signals from different input sources. The frequency and amplitude settings represent the "frontend" of the measurement setup.

Manual configuration of the input and frontend is described in chapter 5.5, "Input and Frontend Settings", on page 134.

10.4.2.1 RF Input

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occured 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.

(For details on the status register see the R&S FSW User Manual).

The command works only if the overload condition has been eliminated first.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

The command is unavailable for measurements with the Digital Baseband Interface (R&S FSW-B17).

Parameters:

<CouplingType>
AC
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP:DC`

Usage: SCPI confirmed

Manual control: See "Input Coupling" on page 135
See "Input Settings" on page 145

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 R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires option R&S FSW-B13.

(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 filter.)

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

Usage: SCPI confirmed

Manual control: See "High-Pass Filter 1...3 GHz" on page 135

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

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 136.

Parameters:
<State> ON | OFF
*RST: ON (OFF for I/Q Analyzer, GSM and MC Group Delay measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual control: See "YIG-Preselector" on page 136

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSW. If no additional options are installed, only RF input is supported.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

DIQ
Digital IQ data (only available with optional Digital Baseband Interface R&S FSW-B17)
For details on I/Q input see the R&S FSW I/Q Analyzer User Manual.

*RST: RF

Manual control: See "Radio Frequency State" on page 135
See "Digital I/Q Input State" on page 137

10.4.2.2 Configuring Digital I/Q Input and Output

Useful commands for digital I/Q data described elsewhere:

- `TRIG:SEQ:LEV:BBPTRIGger[:SEQuence]:LEVel:BBPower` on page 300

Remote commands for the R&S DigIConf software

Remote commands for the R&S DigIConf software always begin with `SOURce:EBOX`. Such commands are passed on from the R&S FSW to the R&S DigIConf automatically which then configures the R&S EX-IQ-BOX via the USB connection.

All remote commands available for configuration via the R&S DigIConf software are described in the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Example 1:

```
SOURce:EBOX:*RST
SOURce:EBOX:*IDN?
```

Result:

"Rohde&Schwarz,DigIConf,02.05.436 Build 47"

Example 2:

```
SOURce:EBOX:USER:CLOCk:REFerence:FREQuency 5MHZ
```

Defines the frequency value of the reference clock.

Remote commands exclusive to digital I/Q data input and output

INPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital I/Q input from the optional Digital Baseband Interface (R&S FSW-B17).

For details see the section "Interface Status Information" for the Digital Baseband Interface (R&S FSW-B17) in the R&S FSW I/Q Analyzer User Manual.

Return values:

<ConnState> Defines whether a device is connected or not.

0
No device is connected.

1
A device is connected.

<DeviceName> Device ID of the connected device

<SerialNumber> Serial number of the connected device

<PortName> Port name used by the connected device

<SampleRate> Maximum or currently used sample rate of the connected device in Hz (depends on the used connection protocol version; indicated by <SampleRateType> parameter)

<MaxTransferRate> Maximum data transfer rate of the connected device in Hz

<ConnProtState> State of the connection protocol which is used to identify the connected device.

Not Started

Has to be Started

Started

Passed

Failed

Done

<PRBSTestState> State of the PRBS test.

Not Started

Has to be Started

Started

Passed

Failed

Done

<SampleRateType> **0**
Maximum sampling rate is displayed

1
Current sampling rate is displayed

<FullScaleLevel> The level (in dBm) that should correspond to an I/Q sample with the magnitude "1" (if transferred from connected device);
If not available, `9.97e37` is returned

Example: INP:DIQ:CDEV?
Result:
1,SMU200A,103634,Out
A,70000000,100000000,Passed,Not Started,0,0

Manual control: See "Connected Instrument" on page 138

INPut:DIQ:RANGe:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

This command is only available if the optional Digital Baseband interface (option R&S FSW-B17) is installed.

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

Manual control: See "Full Scale Level" on page 137

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.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

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

Manual control: See "Adjust Reference Level to Full Scale Level" on page 138

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".

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:
<Level> <numeric value>
Range: 1 µV to 7.071 V
*RST: 1 V

Manual control: See "Full Scale Level" on page 137

INPut:DIQ:RANGe[:UPPer]:UNIT <Unit>

Defines the unit of the full scale level (see "Full Scale Level" on page 137). The availability of units depends on the measurement application you are using.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:

<Level> VOLT | DBM | DBPW | WATT | DBMV | DBUV | DBUA | AMPere

*RST: Volt

Manual control: See "Full Scale Level" on page 137

INPut:DIQ:SRATe <SampleRate>

This command specifies or queries the sample rate of the input signal from the Digital Baseband Interface (R&S FSW-B17, see "Input Sample Rate" on page 137).

Note: the final user sample rate of the R&S FSW may differ and is defined using `SENS:DEM:PRAT` (see `[SENSe:]DDEMod:PRATe` on page 296).

Parameters:

<SampleRate> Range: 1 Hz to 10 GHz

*RST: 32 MHz

Example: INP:DIQ:SRAT 200 MHz

Manual control: See "Input Sample Rate" on page 137

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Input Sample Rate" on page 137

10.4.2.3 Frequency

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*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.

Usage: SCPI confirmed

Manual control: See "Center" on page 139

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer` on page 285.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual control: See "Center Frequency Stepsize" on page 142

[SENSe:]FREQuency:CENTer:STEP:AUTO <LinkMode>

Defines the step width of the center frequency.

Setting parameters:

<LinkMode> ON | OFF

ON
Links the step width to the current standard (currently 1 MHz for all standards)

OFF
Sets the step width as defined using the `FREQ:CENT:STEP` command (see `[SENSe:]FREQuency:CENTer:STEP` on page 285).

*RST: ON

Manual control: See "Center Frequency Stepsize" on page 142

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

See also "Frequency Offset" on page 142.

Parameters:

<Offset> Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual control: See "Frequency Offset" on page 142

10.4.2.4 Amplitude Settings

Amplitude and scaling settings allow you to configure the vertical (y-)axis display and for some result displays also the horizontal (x-)axis.

Useful commands for amplitude settings described elsewhere:

- `INPut:COUPling` on page 279
- `[SENSe:]ADJust:LEVel` on page 326

Remote commands exclusive to amplitude settings:

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level.

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual control: See "Reference Level" on page 139

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

This command defines a reference level offset.

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual control: See "Reference Level" on page 139
See "Shifting the Display (Offset)" on page 140

[SENSe:]DDEMod:PRESet:RLEVel

This command initiates a measurement that evaluates and sets the ideal reference level for the current measurement. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Usage: Event

INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 288).

The command requires option R&S FSW-B24.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.
- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

Example: INP:GAIN:VAL 30
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual control: See "Preamplifier (option B24)" on page 136
See "Input Settings" on page 145

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

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

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

Example: INP:GAIN:STAT ON
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual control: See "Preamplifier (option B24)" on page 136
See "Input Settings" on page 145

10.4.2.5 Configuring the Attenuation

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If an electronic attenuator is available and active, the command defines a mechanical attenuation (see INPut:EATT:STATe on page 290).

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.

This function is not available if the Digital Baseband Interface (R&S FSW-B17) is active.

Parameters:
<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual control: See "RF Attenuation" on page 140
See "Attenuation Mode / Value" on page 140
See "RF Attenuation" on page 145

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

This function is not available if the Digital Baseband Interface (R&S FSW-B17) is active.

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

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual control: See "RF Attenuation" on page 140
See "Attenuation Mode / Value" on page 140
See "RF Attenuation" on page 145

INPut:EATT <Attenuation>

This command defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 290).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:
<Attenuation> attenuation in dB
Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)

Example:
```
INP:EATT:AUTO OFF
INP:EATT 10 dB
```

Manual control: See "Using Electronic Attenuation (Option B25)" on page 141

INPut:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP:EATT:AUTO OFF`

Manual control: See "Using Electronic Attenuation (Option B25)" on page 141

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is only available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual control: See "Using Electronic Attenuation (Option B25)" on page 141

10.4.2.6 Scaling and Units

Useful commands for scaling described elsewhere:

- `DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE` on page 324
- `DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:VOFFset` on page 312

Remote commands exclusive to scaling and units:

CALCulate<n>:STATistics:PRESet

This command sets the x- and y-axis of the statistics measurement to measurement dependent default values.

Usage: Event

Manual control: See "X-Axis Scaling" on page 149
See "Default Settings" on page 149

CALCulate<n>:STATistics:SCALe:AUTO ONCE

This command initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

Parameters:
ONCE

Example: `CALC:STAT:SCAL:AUTO ONCE;*WAI`
Adapts the level setting for statistical measurements.

Usage: Event

Manual control: See "X-Axis Scaling" on page 149
See "Adjust Settings" on page 149

CALCulate<n>:STATistics:SCALe:X:BCOunt <StatNofColumns>

This command defines the number of columns for the statistical distribution.

Setting parameters:
<StatNofColumns> numeric value
Range: 2 to 1024
*RST: 101
Default unit: NONE

Manual control: See "X-Axis Scaling" on page 149
See "Quantize" on page 149

CALCulate<n>:STATistics:SCALe:Y:LOWer <Magnitude>

This command defines the lower vertical limit of the diagram.

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.

Range: 1E-9 to 0.1
*RST: 1E-6

Example: `CALC:STAT:SCAL:Y:LOW 0.001`

Manual control: See "Defining Min and Max Values" on page 148

CALCulate<n>:STATistics:SCALe:Y:UPPer <Magnitude>

This command defines the upper vertical limit of the diagram.

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.

Range: 1E-5 to 1.0
*RST: 1.0

Example: `CALC:STAT:SCAL:Y:UPP 0.01`

Manual control: See "Defining Min and Max Values" on page 148

CALCulate<n>:STATistics:SCALe:Y:UNIT <Unit>

This command selects the unit of the y-axis.

Parameters:

<Unit> PCT | ABS

*RST: ABS

Example: `CALC:STAT:SCAL:Y:UNIT PCT`
Sets the percentage scale.

Manual control: See "Y-Axis Unit" on page 151

CALCulate<n>:UNIT:ANGLe <Unit>

This command selects the default unit for angles.

Setting parameters:

<Unit> DEG | RAD

*RST: RAD

Manual control: See "Y-Axis Unit" on page 151

CALCulate<n>:X:UNIT:TIME <Unit>

This command selects the unit (symbols or seconds) for the x axis.

Setting parameters:

<Unit> S | SYM

*RST: SYM

Manual control: See "X-Axis Unit" on page 150

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:PDIVision <PDiv>

This command defines the scaling of the x-axis for statistical result displays.

For all other result displays, this command is only available as a query.

Setting parameters:

<PDiv> numeric value

Defines the range per division (total range = 10*<PDiv>)

Manual control: See "X-Axis Scaling" on page 149
See "Range per Division" on page 149

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:RPOSition <RPos>

This command defines the position of the reference value for the X axis.

Setting the position of the reference value is possible only for statistical result displays. All other result displays support the query only.

Setting parameters:

<RPos> numeric value

<numeric_value>

Example: `DISP:TRAC:X:RPOS 30 PCT`
The reference value is shifted by 30% towards the left.

Manual control: See "X-Axis Scaling" on page 149
See "X-Axis Reference Position" on page 149

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:RVALue <RVal>

This command defines the reference value for the x-axis for statistical result displays.

For all other result displays, this command is only available as a query.

Setting parameters:

<RVal> numeric value

Reference value for the x-axis

Manual control: See "X-Axis Scaling" on page 149
See "X-Axis Reference Value" on page 149

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe] <Range>

This command defines the display range of the y-axis.

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Parameters:

<Value> numeric value; the unit depends on the result display

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display

Example: `DISP:TRAC:Y:PDIV 10`

Sets the grid spacing to 10 units (e.g. dB) per division

Manual control: See "Configuring a Reference Point and Divisions" on page 148
See "Range per Division" on page 148

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid.

The R&S FSW adjusts the scaling of the y-axis accordingly.

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual control: See "Configuring a Reference Point and Divisions" on page 148
See "Y-Axis Reference Position" on page 148

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RVALue <Value>

The command defines the power value assigned to the reference position in the grid.

Parameters:

<Value> *RST: 0 dBm, coupled to reference level

Example: `DISP:TRAC:Y:RVAL -20dBm`

Sets the power value assigned to the reference position to -20 dBm

Manual control: See "Configuring a Reference Point and Divisions" on page 148
See "Y-Axis Reference Value" on page 148

DISPlay[:WINDow<n>]:TRACe:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis.

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Usage: SCPI confirmed

Manual control: See "Y-Axis Unit" on page 151

10.4.3 Signal Capture

The signal capture commands define how much, how and when data is captured from the input signal.

MSRA operating mode
In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The data acquisition settings for the VSA application in MSRA mode define the **application data extract** and **analysis interval**.
For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

The tasks for manual operation are described in chapter 5.6, "Signal Capture", on page 151.

CALCulate:MSRA:WINDow<n>:IVAL?

This command queries the analysis interval for the current window. This command is only available in application measurement channels, not the MSRA View or MSRA Master.

Return values:

<IntStart> Start value of the analysis interval
Default unit: us

<IntStop> Stop value of the analysis interval
Default unit: us

Usage: Query only

[SENSe:]DDEMod:PRATe <CaptOverSmplg>

Defines the number of samples that are captured per symbol, i.e. the factor by which the symbol rate is multiplied to obtain the sample rate. This parameter also affects the demodulation bandwidth and thus the usable I/Q bandwidth.

The sample rate depends on the defined Symbol Rate (see chapter 4.2.1, "Sample Rate and Symbol Rate", on page 57).

Setting parameters:

<CaptOverSmplg> 4 | 8 | 16 | 32
The factor by which the symbol rate is multiplied to obtain the sample rate, e.g. 4 samples per symbol:
sample rate = 4*symbol rate
*RST: 4

Manual control: See "Sample Rate" on page 153

[SENSe:]DDEMod:RLENgth:AUTO <RecLengthAuto>

This command switches the automatic adaptation of the recording length on or off. The automatic adaptation is performed so that a sufficient recording length is set as a function of result length, burst and pattern search and network-specific characteristics (e.g. burst and frame structure).

Setting parameters:

<RecLengthAuto> ON | OFF
*RST: ON

Manual control: See "Capture Length Settings" on page 152

[SENSe:]DDEMod:RLENgth[:VALue] <RecordLength>

This command defines the capture length for further processing, e.g. for burst search. The record length is defined in time (S, default) or symbols (SYM).

Note that the maximum record length depends on the sample rate for signal capture (see `[SENSe:]DDEMod:PRATe` on page 296). For the default value =4, the maximum is 50.000 symbols. For larger sample rates, the maximum record length (in symbols) can be calculated as:

$Recordlength_{MAX}$ = 200.000/ <points per symbol>

Setting parameters:

<RecordLength> numeric value

Range: 369.231 us to 184.615 ms
*RST: 29.538 ms
Default unit: s (not symbols as in manual operation!)

Manual control: See "Capture Length Settings" on page 152

[SENSe:]DDEMod:SBANd <SidebandPos>

This command selects the sideband for the demodulation.

Setting parameters:

<SidebandPos> NORMal | INVerse

NORMal
Normal (non-inverted) position

INVerse
Inverted position

*RST: NORMal

Manual control: See "Swap I/Q" on page 153

TRACe:IQ:WBANd[:STATe] <State>

Activates the bandwidth extension option R&S FSW-B160 / U160, if installed. Only if the extension is activated a bandwidth up to 160 MHz is available, which corresponds to a sample rate of 200 MHz. The extension must be activated for sample rates > 100 MHz.

Note: As opposed to manual operation, the bandwidth extension can also be activated for sample rates ≤ 100 MHz using this remote command. However, it is only actually employed when the sample rate exceeds 100 MHz. This simplifies creating remote programs as the sequence of activating the extension and controlling the sample rate is irrelevant.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Maximum Bandwidth" on page 153

10.4.4 Triggering Measurements

The trigger commands define the beginning of a measurement.

MSRA operating mode

In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. Thus, no trigger settings are available in the VSA application in MSRA operating mode. However, a **capture offset** can be defined with a similar effect as a trigger offset. It defines an offset from the start of the captured data (from the MSRA Master) to the start of the application data for vector signal analysis. (See Capture Offset.)

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

Tasks for manual configuration are described in chapter 5.6.2, "Trigger Settings", on page 154.

TRIGger[:SEQuence]:BBPower:HOLDoff <Period>

This command defines the holding time before the baseband power trigger event.

The command requires option R&S FSW-B17.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 299 command for new remote control programs.

Parameters:

<Period>
Range: 150 ns to 1000 s
*RST: 150 ns

Example:

```
TRIG:SOUR BBP
```
Sets the baseband power trigger source.
```
TRIG:BBP:HOLD 200 ns
```
Sets the holding time to 200 ns.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:
<DropoutTime> Dropout time of the trigger.
Range: 0 s to 10.0 s
*RST: 0 s

Manual control: See "Drop-Out Time" on page 157

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

Defines the time offset between the trigger event and the start of the sweep (data capturing).

Parameters:
<Offset> The allowed range is 0 s to 30 s.
*RST: 0 s

Example: `TRIG:HOLD 500us`

Manual control: See "Trigger Offset" on page 157

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

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

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

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:
<Period> *RST: 150 ns

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual control: See "Trigger Holdoff" on page 158

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

This command defines the trigger hysteresis.

Parameters:
<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual control: See "Hysteresis" on page 157

TRIGger[:SEQuence]:LEVel:BBPower <Level>

This command sets the level of the baseband power trigger.

This command is available with the **Digital Baseband Interface (R&S FSW-B17)**.

Parameters:

<Level> Range: -50 dBm to +20 dBm
*RST: -20 DBM

Example: `TRIG:LEV:BB -30DBM`

Manual control: See "Trigger Level" on page 156

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:

<port> 1 | 2 | 3
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)
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

Example: `TRIG:LEV 2V`

Manual control: See "Trigger Level" on page 156

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command 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.

Parameters:

<TriggerLevel> Range: -50 dBm to 20 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IFP -30DBM`

Manual control: See "Trigger Level" on page 156

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual control: See "Trigger Level" on page 156

TRIGger[:SEQuence]:SLOPe <Type>

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.

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 control: See "Slope" on page 157

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Parameters:

<Source>

IMMediate
Free Run

EXTern
Trigger signal from the TRIGGER INPUT connector.

EXT2
Trigger signal from the TRIGGER INPUT/OUTPUT connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.
Note: Connector must be configured for "Input".

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications

BBPower
Baseband power (for digital input via the Digital Baseband Interface R&S FSW-B17)

*RST: IMMediate

Example:

```
TRIG:SOUR EXT
```

Selects the external trigger input as source of the trigger signal

Manual control:

See "Trigger Source" on page 155
See "Free Run" on page 155
See "External Trigger 1/2/3" on page 155
See "IF Power" on page 156
See "Baseband Power" on page 156
See "IQ Power" on page 156

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for applications in MSRA mode, not for the MSRA Master. It has a similar effect as the trigger offset in other measurements.

Parameters:

<Offset>

This parameter defines the time offset between the capture buffer start and the start of the extracted application data. The offset must be a positive value, as the application can only analyze data that is contained in the capture buffer.

Range: 0 to <Record length>
*RST: 0

Manual control:

See "Capture Offset" on page 158

10.4.5 Configuring Sweeps

The sweep commands define how often data from the input signal is acquired and then evaluated.

Manual configuration of the sweeps is described in chapter 5.6.3, "Sweep Settings", on page 158.

[SENSe:]DDEMod:SEARch:MBURst:CALC <SelResRangeNr>

Sets the result range to be displayed after a single sweep (e.g. a burst number).

Setting parameters:

<SelResRangeNr> numeric value

Range: 1 to 1000000
*RST: 1
Default unit: NONE

Manual control: See "Select Result Rng" on page 160

[SENSe:]SWEep:COUNt[:VALue] <SweepCount>

This command sets the statistics count.

For more information see "Statistic Count" on page 159.

Setting parameters:

<SweepCount> numeric value

0
activates "Auto" mode

numeric value > 0
Activates "Manual" mode and sets the statistics count to the corresponding number.

Range: 0 to 32767
*RST: 0
Default unit: NONE

Usage: SCPI confirmed

Manual control: See "Statistic Count" on page 159

[SENSe:]SWEep:COUNt:CURRent <Counter>

This command queries the current statistics counter value which indicates how many result ranges have been evaluated. For results that use the capture buffer as a source, the number of used capture buffers can be queried.

Setting parameters:

<Counter> CAPTure | STATistics

STATistics
Returns the number of result ranges that have been evaluated.

CAPTure
Returns the number of used capture buffers evaluated.

*RST: STATistics

10.4.6 Configuring Bursts and Patterns

The burst and pattern search settings can be configured, and new patterns can be defined.

Manual configuration of bursts and patterns is described in chapter 5.7, "Burst and Pattern Configuration", on page 160.

10.4.6.1 Burst Search

The burst search commands define when a burst is detected in the analyzed signal.

[SENSe:]DDEMod:SEARch:BURSt:AUTO <AutoBurstSearch>

This command links the burst search to the type of signal. When a signal is marked as bursted, burst search is switched on automatically.

Setting parameters:

<AutoBurstSearch> AUTO | MANual

*RST: AUTO

Manual control: See "Enabling Burst Searches" on page 162

[SENSe:]DDEMod:SEARch:BURSt:CONFigure:AUTO <AutoConfigure>

This command sets the search tolerance and the min gap length to their default values.

Setting parameters:

<AutoConfigure> ON | OFF

*RST: ON

Manual control: See "Burst Configuration" on page 162

[SENSe:]DDEMod:SEARch:BURSt:GLENgth[:MINimum] <MinGapLength>

This command defines the minimum time between two bursts. A minimum time with decreased level must occur between two bursts. The default unit is symbol. The value can also be given in seconds.

Setting parameters:

<MinGapLength> numeric value

Range: 1 to 15000
*RST: 1
Default unit: SYM

Manual control: See "Burst Configuration" on page 162
See "Min Gap Length" on page 162

[SENSe:]DDEMod:SEARch:BURSt:MODE <MeasOnlyOnBurst>

This command sets the vector analyzer so that a measurement is performed only if a burst is found. The command is available only if the burst search is activated (see `[SENSe:]DDEMod:SEARch:BURSt:STATe` on page 305).

Setting parameters:

<MeasOnlyOnBurst> MEAS | BURS

MEAS
Measurement is always performed

BURS
Measurement is performed only if a burst is found

*RST: MEAS

Manual control: See "Measuring only if burst was found" on page 162

[SENSe:]DDEMod:SEARch:BURSt:STATe <SearchState>

This command switches the search for a signal burst on or off.

Setting parameters:

<SearchState> ON | OFF

*RST: OFF

[SENSe:]DDEMod:SEARch:BURSt:TOLerance <SearchTolerance>

This command controls burst search tolerance.

Setting parameters:
<SearchTolerance> numeric value
Range: 0 to 100000
*RST: 4
Default unit: SYM

Manual control: See "Burst Configuration" on page 162
See "Search Tolerance" on page 162

10.4.6.2 Pattern Searches

The pattern search commands define when a pattern is detected in the analyzed signal.

[SENSe:]DDEMod:SEARch:PATTern:CONFigure:AUTO <AutoConfigure>

This command sets the IQ correlation threshold to its default value.

Setting parameters:
<AutoConfigure> ON | OFF
*RST: ON

Manual control: See "I/Q Correlation Threshold" on page 164

[SENSe:]DDEMod:SEARch:SYNC:AUTO <AutoPattSearch>

This command links the pattern search to the type of signal. When a signal is marked as patterned, pattern search is switched on automatically.

Setting parameters:
<AutoPattSearch> AUTO | MANual
*RST: AUTO

Manual control: See "Enabling Pattern Searches" on page 163

[SENSe:]DDEMod:SEARch:SYNC:IQCThreshold <CorrelationLev>

This command sets the IQ correlation threshold for pattern matching in percent. A high level means stricter matching.

Setting parameters:
<CorrelationLev> numeric value
Range: 10.0 to 100.0
*RST: 90.0
Default unit: PCT

Manual control: See "I/Q Correlation Threshold" on page 164

[SENSe:]DDEMod:SEARch:SYNC:MODE <MeasOnlyOnPatt>

This command sets the vector analyzer so that the measurement is performed only if the measurement was synchronous to the selected sync pattern.

The command is available only if the pattern search is activated (see `[SENSe:]DDEMod:SEARch:SYNC:STATe` on page 307).

Setting parameters:

<MeasOnlyOnPatt> MEAS | SYNC

MEAS
The measurement is performed independently of successful synchronization

SYNC
The measured values are displayed and considered in the error evaluation only if the set sync pattern was found. Bursts with a wrong sync pattern (sync not found) are ignored. If an invalid or no sync pattern is found, the measurement waits and resumes running only when a valid sync pattern is found.

*RST: OFF

Manual control: See "Meas only if Pattern Symbols Correct" on page 164

[SENSe:]DDEMod:SEARch:SYNC:SELect <Select>

This command selects a predefined sync pattern file.

Setting parameters:

<Select> string

Manual control: See "Selected Pattern for Search" on page 164

[SENSe:]DDEMod:SEARch:SYNC:STATe <PatternSearch>

This command switches the search for a sync sequence on or off.

Setting parameters:

<PatternSearch> ON | OFF

*RST: OFF

Manual control: See "Enabling Pattern Searches" on page 163
See "Pattern Search On" on page 167

10.4.6.3 Configuring Patterns

New patterns can be defined and assigned to a signal standard.

Useful commands for configuring patterns described elsewhere:

- [SENSe:]DDEMod:SEARch:SYNC:STATe on page 307
- [SENSe:]DDEMod:SEARch:SYNC:CATalog on page 277

Remote commands exclusive to configuring patterns:

[SENSe:]DDEMod:SEARch:SYNC:COMMent <Comment>

This command defines a comment to a sync pattern. The pattern must have been selected before using [SENSe:]DDEMod:SEARch:SYNC:NAME on page 309.

Setting parameters:
<Comment> string

Manual control: See "Edit" on page 166
See "New" on page 166
See "Comment" on page 169

[SENSe:]DDEMod:SEARch:SYNC:COPY <Pattern>

This command copies a pattern file. The pattern to be copied must have been selected before using [SENSe:]DDEMod:SEARch:SYNC:NAME on page 309.

Tip: In manual operation, a pattern can be copied in the editor by storing it under a new name.

Setting parameters:
<Pattern> string

Example: :DDEM:SEAR:SYNC:NAME 'GSM_TSC0'
Selects the pattern.
:DDEM:SEAR:SYNC:COPY 'GSM_PATT'
Copies "GSM_TSC0" to GSM_PATT.

Usage: Setting only

Manual control: See "Save As" on page 166

[SENSe:]DDEMod:SEARch:SYNC:DELete

This command deletes a sync sequence. The sync sequence to be deleted must have been selected before using [SENSe:]DDEMod:SEARch:SYNC:NAME on page 309.

Usage: Event

Manual control: See "Delete" on page 167

[SENSe:]DDEMod:SEARch:SYNC:DATA <Data>

This command defines the sync sequence of a sync pattern. The pattern must have been selected before using `[SENSe:]DDEMod:SEARch:SYNC:NAME` on page 309.

Important: The value range of a symbol depends on the degree of modulation,e.g. for an 8PSK modulation the value range is from 0 to 7. The degree of modulation belongs to the pattern and is set using the `DDEM:SEAR:SYNC:NST` command (see `[SENSe:]DDEMod:SEARch:SYNC:NSTate` on page 309).

Setting parameters:

<Data> string

Four values represent a symbol (hexadecimal format). The value range of a symbol depends on the degree of modulation.
With a degree of modulation of 4, all symbols have a value range of: 0000, 0001, 0002, 0003
With a degree of modulation of 8:
0000, 0001, 0002, 0003, 0004, 0005, 0006, 0007

Example: `DDEM:SEAR:SYNC:DATA '00010000FFFF'`
Defines the pattern data.

Manual control: See "Edit" on page 166
See "New" on page 166
See "Symbols" on page 169

[SENSe:]DDEMod:SEARch:SYNC:NAME <Name>

This command selects a sync pattern for editing or for a new entry.

Setting parameters:

<Name> string

Manual control: See "Edit" on page 166
See "New" on page 166
See "Name" on page 168

[SENSe:]DDEMod:SEARch:SYNC:NSTate <NState>

This command selects the degree of modulation (number of permitted states). The pattern must have been selected before using using `[SENSe:]DDEMod:SEARch:SYNC:NAME` on page 309.

The number of permitted states depends on the modulation mode.

Setting parameters:

<NState> numeric value

Manual control: See "Mod. order" on page 169

[SENSe:]DDEMod:SEARch:SYNC:PATTern:ADD <AddPattern>

This command adds a pattern to the current standard. Using the `DDEM:SEAR:SYNC:SEL` command, only those patterns can be selected which belong to the current standard (see `[SENSe:]DDEMod:SEARch:SYNC:SELect` on page 307).

Setting parameters:
<AddPattern> string

Usage: Setting only

Manual control: See "Adding patterns to a standard" on page 166

[SENSe:]DDEMod:SEARch:SYNC:PATTern:REMove

This command deletes one or all patterns from the current standard.

Usage: Setting only

Manual control: See "Removing patterns from a standard" on page 165

[SENSe:]DDEMod:SEARch:SYNC:TEXT <Text>

This command defines a text to explain the pattern. The text is displayed only in the selection menu (manual control). This text should be short and concise. Detailed information about the pattern is given in the comment (see `[SENSe:]DDEMod:SEARch:SYNC:COMMent` on page 308).

Setting parameters:
<Text> string

Manual control: See "Edit" on page 166
See "New" on page 166
See "Description" on page 168

10.4.7 Defining the Result Range

The result range determines which part of the capture buffer, burst or pattern is displayed.

Manual configuration of the result range is described in chapter 5.8, "Result Range Configuration", on page 169.

CALCulate<n>:TRACe<t>:ADJust:ALIGnment[:DEFault] <Alignment>

This command defines where the reference point is to appear in the result range.

Suffix:
<t> 1..6

Setting parameters:
<Alignment> LEFT | CENTer | RIGHt

LEFT
The reference point is at the start of the result range.

CENTer
The reference point is in the middle of the result range.

RIGHt
The reference point is displayed at the end of the result range.

*RST: LEFT

Manual control: See "Alignment" on page 171

CALCulate<n>:TRACe<t>:ADJust:ALIGnment:OFFSet <FitOffset>

This command shifts the display range (relative to the reference time) by the number of given symbols. The resolution is 1 symbol. A value >0 results in a shift towards the right, and a value <0 results in a shift towards the left.

Suffix:
<t> 1..6

Setting parameters:
<FitOffset> numeric value

Range: -8000 to 8000
*RST: 0
Default unit: SYM

Manual control: See "Offset" on page 171

CALCulate<n>:TRACe<t>:ADJust[:VALue] <Reference>

This command defines the reference point for the display.

Suffix:
<t> 1..6

Setting parameters:
<Reference> TRIGger | BURSt | PATTern

TRIGger
The reference point is defined by the start of the capture buffer.

BURSt
The reference point is defined by the start/center/end of the burst.

PATTern
The instrument selects the reference point and the alignment.

*RST: TRIGger

Manual control: See "Reference" on page 170

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:VOFFset <VOffset>

This command defines an offset to numbering of the symbols (Except capture buffer).

Setting parameters:

<VOffset> numeric value

Range: -100000 to 100000
*RST: 0
Default unit: NONE

Manual control: See "Symbol Number at <Reference> Start" on page 171

[SENSe:]DDEMod:TIME <ResultLength>

The command determines the number of displayed symbols (result length).

Setting parameters:

<ResultLength> numeric value

Range: 10 to 20000
*RST: 800
Default unit: SYM

Manual control: See "Result Length" on page 170

10.4.8 Demodulation Settings

During demodulation of the vector signal some undesired effects that may occur during transmission can be compensated for. Furthermore, you can influence the synchronization process.

Manual configuration of the demodulation process is described in chapter 5.9, "Demodulation Settings", on page 171.

[SENSe:]DDEMod:ECALc[:MODE] <EvmCalc>

This command defines the calculation formula for EVM.

Setting parameters:

<EvmCalc> SIGNal | SYMBol | MECPower | MACPower

SIGNal
Calculation normalized to the average power within the measurement range (mean ref power)

SYMBol
Calculation normalized to the maximum power at symbol times (max ref power)

MECPower
Calculation normalized to mean constellation power

MACPower
Calculation normalized to maximum constellation power

*RST: SIGN

Manual control: See "Normalize EVM to" on page 176

[SENSe:]DDEMod:ECALc:OFFSet <EVMOffsetState>

ConfigureS the way the VSA application calculates the error vector results for offset QPSK.

Setting parameters:

<EVMOffsetState> ON | OFF

ON
VSA application compensates the delay of the Q component with respect to the I component in the measurement signal as well as the reference signal before calculating the error vector. That means that the error vector contains only one symbol instant per symbol period.

OFF
the VSA application substracts the measured signal from the reference signal to calculate the error vector. This method results in the fact that the error vector contains two symbol instants per symbol period: one that corresponds to the I component and one that corresponds to the Q component.

*RST: ON

Manual control: See "Offset EVM" on page 179

[SENSe:]DDEMod:EPRate:AUTO <LinkMode>

Defines how many sample points are used at each symbol to calculate modulation accuracy results automatically.

If enabled, the VSA application uses the following settings, depending on the modulation type:

Modulation	Est. Points
PSK, QAM	1
Offset QPSK	2
FSK, MSK	Sample rate (see `[SENSe:]DDEMod:PRATe` on page 296)

Setting parameters:

<LinkMode> ON | OFF

*RST: ON

Manual control: See "Estimation Points/Sym" on page 177

[SENSe:]DDEMod:EPRate[:VALue] <EstOverSmplg>

Defines how many sample points are used at each symbol to calculate modulation accuracy results.

For more information see "Estimation points per symbol" on page 115.

You can also let the VSA application decide how many estimation points to use, see `[SENSe:]DDEMod:EPRate:AUTO` on page 314.

Setting parameters:

<EstOverSmplg> **1**
the estimation algorithm takes only the symbol time instants into account

2
two points per symbol instant are used (required for Offset QPSK)

4 | 8 | 16 | 32
the number of samples per symbol defined in the signal capture settings is used (see `[SENSe:]DDEMod:PRATe` on page 296), i.e. all sample time instants are weighted equally

*RST: 1

Manual control: See "Estimation Points/Sym" on page 177

[SENSe:]DDEMod:EQUalizer:LENGth <FilterLength>

This command defines the length of the equalizer in terms of symbols.

Setting parameters:

<FilterLength> numeric value

Range: 1 to 256
*RST: 10
Default unit: SYM

Example: `DDEM:EQU:LENG 101`
Sets the equalizer length to 101 symbols.

Manual control: See "Equalizer Settings" on page 174
See "Filter Length" on page 175

[SENSe:]DDEMod:EQUalizer:LOAD <Name>

This command selects a user-defined equalizer. The equalizer mode is automatically switched to `USER` (see `[SENSe:]DDEMod:EQUalizer:MODE` on page 315).

Setting parameters:

<Name> string

Path and file name (without extension)

Example: `DDEM:EQU:LOAD 'D:\MyEqualizer'`
Selects equalizer named `MyEqualizer` in directory `D`.

Manual control: See "Equalizer Settings" on page 174
See "Store/Load Current Equalizer" on page 175

[SENSe:]DDEMod:EQUalizer:MODE <Mode>

Switches between the equalizer modes.

For details see chapter 4.4.5, "The Equalizer", on page 93.

Setting parameters:

<Mode>

NORMal
Switches the equalizer on for the next sweep.

TRACking
Switches the equalizer on; the results of the equalizer in the previous sweep are considered to calculate the new filter.

FREeze
The filter is no longer changed, the current equalizer values are used for subsequent sweeps.

USER
A user-defined equalizer loaded from a file is used.

AVERaging
Switches the equalizer on; the results of the equalizer in all previous sweeps (since the instrument was switched on or the equalizer was reset) are considered to calculate the new filter. To start a new averaging process, use the `[SENSe:]DDEMod:EQUalizer:RESet` on page 316 command.

*RST: TRACe

Example: `DDEM:EQU:MODE TRAC`
Activates the tracking mode of the equalizer.

Manual control: See "Equalizer Settings" on page 174
See "Mode" on page 174

[SENSe:]DDEMod:EQUalizer:RESet

This command deletes the data of the currently selected equalizer. After deletion, training can start again using the command `DDEM:EQU:MODE TRA` (see `[SENSe:]DDEMod:EQUalizer:MODE` on page 315).

Usage: Event

Manual control: See "Equalizer Settings" on page 174
See "Reset Equalizer" on page 175

[SENSe:]DDEMod:EQUalizer:SAVE <Name>

This command saves the current equalizer results to a file.

Setting parameters:

<Name> string

File name

Example: `DDEM:EQU:SAVE 'D:\MyEqualizer''`
Saves the current equalizer results to `D:\MyEqualizer.vae`.

Manual control: See "Equalizer Settings" on page 174
See "Store/Load Current Equalizer" on page 175

[SENSe:]DDEMod:EQUalizer[:STATe] <State>

This command activates or deactivates the equalizer.

For more information on the equalizer see chapter 4.4.5, "The Equalizer", on page 93.

Setting parameters:

<State> ON | OFF

*RST: OFF

Example: `DDEM:EQU OFF`

Manual control: See "Equalizer Settings" on page 174
See "State" on page 174

[SENSe:]DDEMod:FSYNc:AUTO <FineSyncAuto>

This command selects manual or automatic Fine Sync

Setting parameters:

<FineSyncAuto> ON | OFF

*RST: ON

Manual control: See "Fine Synchronization" on page 178

[SENSe:]DDEMod:FSYNc:LEVel <SERLevel>

This command sets the Fine Sync Level if fine sync works on Known Data

Setting parameters:

<SERLevel> numeric value

Range: 0.0 to 100.0
*RST: 10.0
Default unit: PCT

Manual control: See "If SER ≤" on page 179

[SENSe:]DDEMod:FSYNc:RESult?

The result of this query is 0 if the fine sync with known data failed, otherwise 1.

Usage: Query only

Manual control: See "Fine Synchronization" on page 178

[SENSe:]DDEMod:FSYNc[:MODE] <FineSync>

This command defines the fine synchronization mode used to calculate results, e.g. the bit error rate.

Note: You can define a maximum symbol error rate (SER) for the known data in reference to the analyzed data. If the SER of the known data exceeds this limit, the default synchronization using the detected data is performed. See `[SENSe:]DDEMod:FSYNc:LEVel` on page 317.

Setting parameters:

<FineSync> KDATa | PATTern | DDATa

KDATa
The reference signal is defined as the data sequence from the loaded Known Data file that most closely matches the measured data.

PATTern
The reference signal is estimated from the defined pattern.
This setting requires an activated pattern search, see `[SENSe:]DDEMod:SEARch:SYNC:STATe` on page 307.

DDATa
(Default) The reference signal is estimated from the detected data.

*RST: DDATa

Manual control: See "Fine Synchronization" on page 178

[SENSe:]DDEMod:KDATa:STATe <KnownDataState>

This command selects the Known Data state. The use of known data is a prerequisite for the BER measurement and can also be used for the fine sync.

Setting parameters:

<KnownDataState> ON | OFF

*RST: OFF

Manual control: See "Known Data" on page 133

[SENSe:]DDEMod:KDATa[:NAME] <FileName>

This command selects the Known Data file

Setting parameters:

<FileName> string

Manual control: See "Load Data File" on page 134

[SENSe:]DDEMod:NORMalize:ADRoop <CompAmptDroop>

This command switches the compensation of the amplitude droop on or off.

Setting parameters:

<CompAmptDroop> ON | OFF

*RST: ON

Manual control: See "Compensate for... (PSK, MSK, ASK, QAM)" on page 173

[SENSe:]DDEMod:NORMalize:CFDRift <CarrFreqDrift>

This command defines whether the carrier frequency drift is compensated for FSK modulation.

Setting parameters:

<CarrFreqDrift> ON | OFF

*RST: OFF

Manual control: See "Compensate for... (FSK)" on page 174

[SENSe:]DDEMod:NORMalize:CHANnel <TransmitChannel>

This command switches the channel compensation on or off. (With equalizer only)

Setting parameters:

<TransmitChannel> ON | OFF

*RST: ON

Manual control: See "Compensate for... (PSK, MSK, ASK, QAM)" on page 173

[SENSe:]DDEMod:NORMalize:FDERror <RefDevComp>

This command defines whether the deviation error is compensated for when calculating the frequency error for FSK modulation.

Setting parameters:

<RefDevComp> ON | OFF

ON
Scales the reference signal to the actual deviation of the measurement signal.

OFF
Uses the entered nominal deviation for the reference signal.

*RST: ON

Manual control: See "Compensate for... (FSK)" on page 174

[SENSe:]DDEMod:NORMalize:IQIMbalance <CompIQImbalance>

This command switches the compensation of the IQ imbalance on or off.

Setting parameters:

<CompIQImbalance> ON | OFF

*RST: OFF

Manual control: See "Compensate for... (PSK, MSK, ASK, QAM)" on page 173

[SENSe:]DDEMod:NORMalize:IQOFfset <CompIQOffset>

This command switches the compensation of the IQ offset on or off.

Setting parameters:
<CompIQOffset> ON | OFF
*RST: ON

Manual control: See "Compensate for... (PSK, MSK, ASK, QAM)" on page 173

[SENSe:]DDEMod:NORMalize:SRERror <SymbolClockError>

This command switches the compensation for symbol rate error on or off

Setting parameters:
<SymbolClockError> ON | OFF
*RST: OFF

Manual control: See "Compensate for... (PSK, MSK, ASK, QAM)" on page 173
See "Compensate for... (FSK)" on page 174

[SENSe:]DDEMod:SEARch:PATTern:SYNC:AUTO <UseWfmForSync>

This command selects manual or automatic synchronization with a pattern waveform to speed up measurements.

Setting parameters:
<UseWfmForSync> AUTO | MANual
*RST: AUTO

Manual control: See "Coarse Synchronization" on page 177

[SENSe:]DDEMod:SEARch:PATTern:SYNC[:STATe] <FastSync>

This command switches fast synchronization on and off, if you manually synchronize with a waveform pattern.

Setting parameters:
<FastSync> ON | OFF
*RST: OFF

Manual control: See "Coarse Synchronization" on page 177

10.4.9 Measurement Filter Settings

You can configure the measurement filter to be used.

Manual configuration of the measurement filter is described in chapter 5.10, "Measurement Filter Settings", on page 179.

For more information on measurement filters, refer to chapter 4.1.4, "Measurement Filters", on page 53.

Useful commands for defining measurement filters described elsewhere:

- `[SENSe:]DDEMod:FILTer:ALPHa` on page 269

- [SENSe:]DDEMod:FILTer[:STATe] on page 269

Remote commands exclusive to configuring measurement filters:

[SENSe:]DDEMod:MFILter:ALPHa <MeasFiltAlphaBT>

This command sets the alpha value of the measurement filter.

Setting parameters:

<MeasFiltAlphaBT> numeric value

Range: 0.1 to 1.0
*RST: 0.22
Default unit: NONE

Manual control: See "Type" on page 180
See "Alpha/BT" on page 181

[SENSe:]DDEMod:MFILter:AUTO <MeasFilterAuto>

If this command is set to "ON", the measurement filter is defined automatically depending on the transmit filter (see [SENSe:]DDEMod:TFILter:NAME on page 275).

Setting parameters:

<MeasFilterAuto> ON | OFF

*RST: ON

Manual control: See "Using the Transmit Filter as a Measurement Filter (Auto)" on page 180

[SENSe:]DDEMod:MFILter:NAME <Name>

This command selects a measurement filter and automatically sets its state to "ON".

Setting parameters:

<Name> Name of the measurement filter or 'User' for a user-defined filter.
An overview of available measurement filters is provided in chapter A.2.2, "Measurement Filters", on page 404.

Manual control: See "Type" on page 180

[SENSe:]DDEMod:MFILter[:STATe] <MeasFilterState>

Use this command to switch the measurement filter off. To switch a measurement filter on, use the [SENSe:]DDEMod:MFILter:NAME command.

Setting parameters:

<MeasFilterState> ON | OFF

OFF
Switches the measurement filter off.

ON
Switches the measurement filter specified by `[SENSe:]DDEMod:MFILter:NAME` on. However, this command is not necessary, as the `[SENSe:]DDEMod:MFILter:NAME` command automatically switches the selected filter on.

*RST: ON

Manual control: See "Type" on page 180

[SENSe:]DDEMod:MFILter:USER <FilterName>

This command selects the user-defined measurement filter.

For details on user-defined filters, see chapter 4.1.5, "Customized Filters", on page 55.

Setting parameters:

<FilterName> Name of the user-defined filter

Example: `SENS:DDEM:MFIL:NAME 'USER'`
Selects user filter mode for the meas filter
`ENS:DDEM:MFIL:USER 'D:\MyMeasFilter'`
Selects the user-defined meas filter

Manual control: See "Type" on page 180
See "Load User Filter" on page 181

10.4.10 Defining the Evaluation Range

The evaluation range defines which range of the result is to be evaluated.

Manual configuration of the evaluation range is described in chapter 5.11, "Evaluation Range Configuration", on page 181.

CALCulate<n>:ELIN<startstop>:STATe <Auto>

This command restricts the evaluation range. The evaluation range is considered for the following display types:

- eye diagrams
- constellation diagrams
- modulation accuracy
- statistic displays
- spectrum displays

Suffix:
<startstop> 1..2
irrelevant

Setting parameters:
<Auto> ON | OFF

ON
The evaluation range extends from the start value defined by `CALC:ELIN1:VAL` to the stop value defined by `CALC:ELIN2:VAL` (see `CALCulate<n>:ELIN<startstop>[:VALue]` on page 323).

OFF
The complete result area is evaluated.

*RST: OFF

Manual control: See "Evaluating the Entire Result Range" on page 182

CALCulate<n>:ELIN<startstop>[:VALue] <LeftDisp>

Defines the start and stop values for the evaluation range (see `CALCulate<n>:ELIN<startstop>:STATe` on page 322).

Suffix:
<startstop> 1..2
1: start value, 2: stop value

Setting parameters:
<LeftDisp> numeric value

Range: 0 to 1000000
*RST: 0
Default unit: SYM

Manual control: See "Start / Stop" on page 182

10.4.11 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

Manual execution of automatic adjustment functions is described in chapter 5.12, "Adjusting Settings Automatically", on page 183.

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again.

Usage: SCPI confirmed

Manual control: See "Auto Scale Once/Auto Scale Window" on page 148

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO:ALL

Automatic scaling of the y-axis is performed once in all windows, then switched off again.

Usage: Event

Manual control: See "Auto Scale All" on page 184

[SENSe:]ADJust:CONFigure:DURation <Duration>

In order to determine the ideal reference level, the R&S FSW performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual control: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 183

[SENSe:]ADJust:CONFigure:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S FSW performs a measurement on the current input data. This command selects the way the R&S FSW determines the length of the measurement .

Parameters:

<Mode>

AUTO
The R&S FSW determines the measurement length automatically according to the current input data.

MANual
The R&S FSW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 324.

*RST: AUTO

Manual control: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 183
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 183

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 326 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>
Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual control: See "Lower Level Hysteresis" on page 184

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 326 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>
Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual control: See "Upper Level Hysteresis" on page 184

[SENSe:]ADJust:LEVel
[SENSe:]DDEMod:PRESet:RLEVel

This command initiates a measurement that evaluates and sets the ideal reference level for the current measurement. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Usage: Event

10.5 Performing a Measurement

When the VSA application is activated, a continuous sweep is performed automatically. However, you can stop and start a new measurement any time.

Furthermore, you can perform a sequence of measurements using the Sequencer (see "Multiple Measurement Channels and Sequencer Function" on page 12).

ABORt

This command aborts a current measurement 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 see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` on page 329 command.

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: SCPI confirmed

INITiate:CONMeas

This command restarts a (single) measurement that has been stopped (using `INIT:CONT OFF`) or finished in single sweep mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate[:IMMediate]`, this command does not reset traces in max-hold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Example: (for Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Setting the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.
`INIT:CONM;*WAI`
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual control: See "Continue Single Sweep" on page 159

INITiate:CONTinuous <State>

This command controls the sweep mode.

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

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 330) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: ON

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

Manual control: See "Continuous Sweep/RUN CONT" on page 158

INITiate[:IMMediate]

This command starts a (single) new measurement.

For a statistics count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

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

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Example: (For Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

Manual control: See "Single Sweep/ RUN SINGLE" on page 159

INITiate:REFMeas

Repeats the evaluation of the data currently in the capture buffer without capturing new data. This is useful after changing settings, for example filters, patterns or evaluation ranges.

Usage: Event

Manual control: See "Refresh (non-MSRA mode)" on page 159

INITiate:REFResh

This function is only available if the Sequencer is deactivated (SYSTem:SEQuencer SYST:SEQ:OFF) and only for applications in MSRA mode, not the MSRA Master.

The data in the capture buffer is re-evaluated by the currently active application only. The results for any other applications remain unchanged.

Example:
```
SYST:SEQ:OFF
```
Deactivates the scheduler
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a new data measurement and waits for the end of the sweep.
```
INST:SEL 'IQ ANALYZER'
```
Selects the IQ Analyzer channel.
```
INIT:REFR
```
Refreshes the display for the I/Q Analyzer channel.

Usage: Event

Manual control: See "Refresh" on page 160

INITiate:SEQuencer:REFResh[:ALL]

This function is only available if the Sequencer is deactivated (SYSTem:SEQuencer SYST:SEQ:OFF) and only in MSRA mode.

The data in the capture buffer is re-evaluated by all active MSRA applications.

Example:
```
SYST:SEQ:OFF
```
Deactivates the scheduler
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a new data measurement and waits for the end of the sweep.
```
INIT:SEQ:REFR
```
Refreshes the display for all MSRA channels.

Usage: Event

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using INITiate:SEQuencer:IMMediate on page 330.

To deactivate the Sequencer use SYSTem:SEQuencer on page 331.

Usage: Event

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer. Its effect is similar to the `INITiate[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 331).

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

Usage: Event

INITiate:SEQuencer:MODE <Mode>

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

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 331).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

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

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Parameters:

<Mode>

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

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

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

*RST: CONTinuous

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

SYSTem:SEQuencer <State>

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

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF

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

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

*RST: OFF

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

10.6 Analysis

General result analysis settings concerning the trace, markers, windows etc. can be configured.

10.6.1 Configuring Traces

The trace settings determine how the measured data is analyzed and displayed on the screen. Depending on the result display, between 1 and 6 traces may be displayed.

Manual configuration of traces is described in chapter 6.1, "Trace Settings", on page 185.

Commands for storing trace data are described in chapter 10.8.1, "Retrieving Trace Data and Marker Values", on page 361.

Useful commands for trace configuration described elsewhere:

- `DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]` on page 293

Remote commands exclusive to trace configuration:

CALCulate<n>:TRACe<t>[:VALue] <TrRefType>

This commands selects the measurment or the reference signal as the data source for a trace.

Suffix:
<t> 1..6

Setting parameters:
<TrRefType> MEAS | REF

*RST: The default for trace 1 is always the measurement signal (MEAS). For all other traces, the default signal type depends on the current measurement.

Usage: SCPI confirmed

Manual control: See "Evaluation" on page 187

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode.

In case of max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt[:VALue]`. Note that synchronization to the end of the measurement is possible only in single sweep mode. Depending on the result display, not all trace modes may be available.

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:

```
INIT:CONT OFF
```
Switching to single sweep mode.
```
SWE:COUN 16
```
Sets the number of measurements to 16.
```
DISP:TRAC3:MODE WRIT
```
Selects clear/write mode for trace 3.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the measurement.

Manual control: See "Trace Mode" on page 186

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Example:
```
DISP:TRAC3 ON
```

Usage: SCPI confirmed

Manual control: See "Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6" on page 186
See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 187

10.6.2 Working with Markers

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

Manual configuration of markers is described in chapter 6.3, "Markers", on page 189.

10.6.2.1 Individual Marker Settings

In VSA evaluations, up to 5 markers can be activated in each diagram at any time.

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

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

Usage: Event

Manual control: See "All Markers Off" on page 191

CALCulate<n>:MARKer<m>:LINK <MarkerCoupling>

With this command markers between several screens can be coupled, i.e. use the same stimulus. All screens can be linked with the marker stimulus scaled in symbols or time, except those showing the capture buffer. If several capture buffer measurements are visible, their markers are coupled, too.

Setting parameters:

<MarkerCoupling> ON | OFF
*RST: OFF

Manual control: See "Couple Windows" on page 191

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

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual control: See "Marker State" on page 190
See "Marker Type" on page 191

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

This command 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.

Parameters:

<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual control: See "Assigning the Marker to a Trace" on page 191

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

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

If necessary, the command activates the marker.

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

Parameters:

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

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

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

Manual control: See "Stimulus" on page 190

CALCulate<n>:DELTamarker:AOFF

This command turns all delta markers off.

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

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

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

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

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual control: See "Marker State" on page 190
See "Marker Type" on page 191

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

This command selects the trace a delta 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.

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

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

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

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

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

Manual control: See "Stimulus" on page 190

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

This command moves a marker to a particular coordinate on the x-axis. If necessary, the command activates the marker.

Return values:
<Value>

Usage: Query only

10.6.2.2 Marker Search and Positioning Settings

Several functions are available to set the marker to a specific position very quickly and easily. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

Useful commands for positioning markers described elsewhere:

- `CALCulate<n>:MARKer<m>:TRACe` on page 335
- `CALCulate<n>:DELTamarker<m>:TRACe` on page 336

Remote commands exclusive to positioning markers:

CALCulate<n>:DELTamarker<m>:MAXimum:APEak

This command positions the active marker or deltamarker on the largest absolute peak value (maximum or minimum) of the selected trace.

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192
See "Search Next Peak" on page 193

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

This command moves a delta marker to the highest level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Peak Search" on page 193

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192
See "Search Next Minimum" on page 194

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

This command moves a delta marker to the minimum level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Search Minimum" on page 193

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:MARKer<m>:MAXimum:APEak

sets the marker to the largest absolute peak value (maximum or minimum) of the selected trace.

Usage: Event

Manual control: See "Max |Peak|" on page 193

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192
See "Search Next Peak" on page 193

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

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

This command moves a marker to the highest level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Peak Search" on page 193

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192
See "Search Next Minimum" on page 194

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 192

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

This command moves a marker to the minimum level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Search Minimum" on page 193

CALCulate<n>:MARKer:SEARch <MarkRealImag>

This command specifies whether the marker search works on the real or the imag trace (for all markers).

Setting parameters:
<MarkRealImag> REAL | IMAG
*RST: REAL

Manual control: See "Real / Imag Plot" on page 192

CALCulate:MARKer:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<SearchLimit> The value range depends on the span or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border

<Limit> Range: -1e9 to 1e9
*RST: 0.0

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual control: See "Search Limits (Left / Right)" on page 193

CALCulate:MARKer:X:SLIMits:RIGHT <SearchLimit>

This command defines the right limit of the marker search range.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<Limit> The value range depends on the span or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border

<Limit> Range: -1e9 to 1e9
*RST: 800.0

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual control: See "Search Limits (Left / Right)" on page 193

CALCulate:MARKer:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

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

Example: CALC:MARK:X:SLIM ON
Switches on search limitation.

Manual control: See "Search Limits (Left / Right)" on page 193

10.6.3 Configuring Modulation Accuracy Limit Lines

The results of a modulation accuracy measurement can be checked for violation of defined limits automatically.

Manual configuration of limit lines is described in chapter 6.4, "Modulation Accuracy Limit Lines", on page 194.

10.6.3.1 General Commands

The following commands determine the general behaviour of the limit line check.

CALCulate:LIMit:MACCuracy:DEFault

Restores the default limits and deactivates all checks in all windows.

Usage: Event

Manual control: See "Set to Default" on page 195

CALCulate:LIMit:MACCuracy:STATe <LimitState>

Limits checks for all evaluations based on modulation accuracy (e.g. Result Summary) are enabled or disabled.

Setting parameters:
<LimitState> ON | OFF
*RST: OFF

Manual control: See "Checking Modulation Accuracy Limits" on page 195

10.6.3.2 Defining Limits

The following commands are required to define limits for specific results.

CALCulate<n>:LIMit:MACCuracy:CFERror:CURRent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:CFERror:MEAN:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:CFERror:PEAK:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:PCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:PMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:PPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:RCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:RMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:EVM:RPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FDERror:CURRent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FDERror:MEAN:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FDERror:PEAK:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:PCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:PMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:PPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:RCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:RMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:FERRor:RPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:PCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:PMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:PPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:RCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:RMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:MERRor:RPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:OOFFset:CURRent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:OOFFset:MEAN:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:OOFFset:PEAK:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:PCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:PMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:PPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:RCURrent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:RMEan:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:PERRor:RPEak:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:RHO:CURRent:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:RHO:MEAN:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:RHO:PEAK:STATe <LimitState>
CALCulate<n>:LIMit:MACCuracy:<ResultType>:<LimitType>:STATe <LimitState>

This command switches the limit check for the selected result type and limit type on or off.

Suffix:

<ResultType>
CFERror = Carrier Frequency Error
EVM = Error Vector Magnitude
FERRor = Frequency error (FSK only)
FDERror = Frequency deviation error (FSK only)
MERRor = Magnitude Error
OOFFset = I/Q Offset
PERRor = Phase Error
RHO = Rho

<LimitType> **For CFERor, OOFFset, RHO:**
CURRent
MEAN
PEAK
For EVM, FERRor, MERRor, PERRor:
PCURRent = Peak current value
PMEan = Peak mean value
PPEak = Peak peak value
RCURRent = RMS current value
RMEan = RMS mean value
RPEak = RMS peak value

Setting parameters:

<LimitState> ON | OFF

Activates a limit check for the selected result and limit type.

*RST: OFF

Example:
```
CALC2:FEED 'XTIM:DDEM:MACC'
```
switch on result summary in screen 2
```
CALC2:LIM:MACC:CFER:CURR:VAL 100 Hz
```
define a limit of [-100;100]
```
CALC2:LIM:MACC:CFER:CURR:STAT ON
```
switch limit check ON

Manual control: See "Current/Mean/Peak" on page 195
See "Check" on page 196

CALCulate<n>:LIMit:MACCuracy:CFERror:CURRent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:CFERror:MEAN:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:CFERror:PEAK:VALue <LimitValue>

This command defines the limit for the current, peak or mean center frequency error limit. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

the value x (x>0) defines the interval [-x; x]

Range: 0.0 to 1000000
*RST: 1000.0 (mean: 750.0)
Default unit: Hz

CALCulate<n>:LIMit:MACCuracy:EVM:PCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:EVM:PMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:EVM:PPEak:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:EVM:RCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:EVM:RMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:EVM:RPEak:VALue <LimitValue>

This command defines the value for the current, peak or mean EVM (peak or RMS) limit. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

Range: 0.0 to 100
*RST: 1.5
Default unit: %

CALCulate<n>:LIMit:MACCuracy:FDERror:CURRent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FDERror:MEAN:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FDERror:PEAK:VALue <LimitValue>

This command defines the lower limit for the current, peak or mean center frequency deviation error. Note that the limits for the current and the peak value are always kept identical.

This command is available for FSK modulation only.

Setting parameters:

<LimitValue> numeric value

Range: 0.0 to 1000000
*RST: 1 kHz
Default unit: Hz

CALCulate<n>:LIMit:MACCuracy:FERRor:PCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FERRor:PMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FERRor:PPEak:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FERRor:RCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FERRor:RMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:FERRor:RPEak:VALue <LimitValue>

This command defines the value for the current, peak or mean frequency error (peak or RMS) limit. Note that the limits for the current and the peak value are always kept identical.

This command is available for FSK modulation only.

Setting parameters:

<LimitValue> numeric value

the value x (x>0) defines the interval [-x; x]

Range: 0.0 to 100
*RST: 1.5 (mean: 1.0)
Default unit: Hz

CALCulate<n>:LIMit:MACCuracy:MERRor:PCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:MERRor:PMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:MERRor:PPEak:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:MERRor:RCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:MERRor:RMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:MERRor:RPEak:VALue <LimitValue>

This command defines the value for the current, peak or mean magnitude error (peak or RMS) limit. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

the value x (x>0) defines the interval [-x; x]

Range: 0.0 to 100
*RST: 1.5
Default unit: %

CALCulate<n>:LIMit:MACCuracy:OOFFset:CURRent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:OOFFset:MEAN:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:OOFFset:PEAK:VALue <LimitValue>

This command defines the upper limit for the current, peak or mean I/Q offset. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

Range: -200.0 to 0.0
*RST: -40.0 (mean: -45.0)
Default unit: DB

CALCulate<n>:LIMit:MACCuracy:PERRor:PCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:PERRor:PMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:PERRor:PPEak:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:PERRor:RCURrent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:PERRor:RMEan:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:PERRor:RPEak:VALue <LimitValue>

This command defines the value for the current, peak or mean phase error (peak or RMS) limit. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

the value x (x>0) defines the interval [-x; x]

Range: 0.0 to 360
*RST: 3.5 (RMS: 1.5)
Default unit: deg

CALCulate<n>:LIMit:MACCuracy:RHO:CURRent:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:RHO:MEAN:VALue <LimitValue>
CALCulate<n>:LIMit:MACCuracy:RHO:PEAK:VALue <LimitValue>

This command defines the lower limit for the current, peak or mean Rho limit. Note that the limits for the current and the peak value are always kept identical.

Setting parameters:

<LimitValue> numeric value

Range: 0.0 to 1.0
*RST: 0.999 (mean: 0.9995)
Default unit: NONE

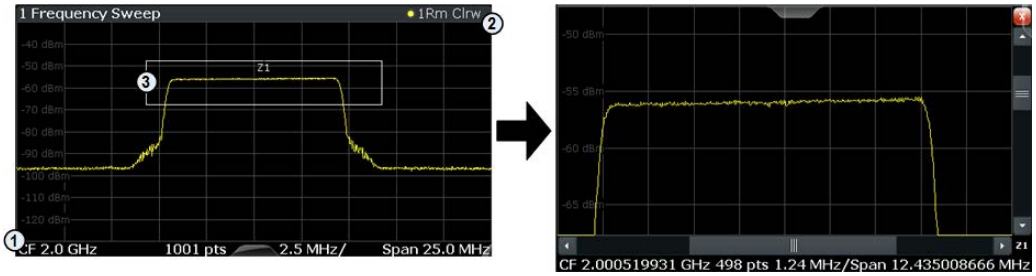
10.6.4 Zooming into the Display

10.6.4.1 Using the Single Zoom

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Parameters:

<x1>,<y1>, <x2>,<y2>
Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

Manual control: See "Single Zoom" on page 200

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Parameters:

<State>
ON | OFF
*RST: OFF

Example:
```
DISP:ZOOM ON
```
Activates the zoom mode.

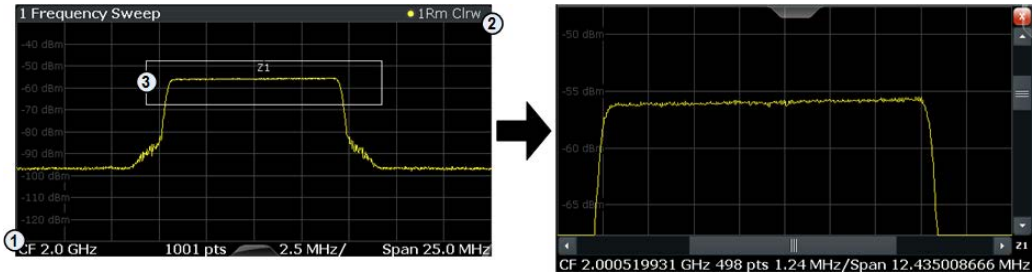
Manual control: See "Single Zoom" on page 200
See "Restore Original Display" on page 200
See "Deactivating Zoom (Selection mode)" on page 200

10.6.4.2 Using the Multiple Zoom

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<zoom> 1...4
Selects the zoom window.

Parameters:

<x1>,<y1>,
<x2>,<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

Manual control: See "Multiple Zoom" on page 200

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the mutliple zoom on and off.

Suffix:

<zoom> 1...4
Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Multiple Zoom" on page 200
See "Restore Original Display" on page 200
See "Deactivating Zoom (Selection mode)" on page 200

10.7 Configuring the Result Display

The following commands are required to configure the result display in a remote environment. The tasks for manual operation are described in chapter 6.5, "Display and Window Configuration", on page 196.

10.7.1 General Window Commands

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

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 264).

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SPL

Example:

```
DISP:FORM SING
```

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

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 353).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

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

*RST: SMALl

Example: `DISP:WIND2:LARG`

DISPlay[:WINDow<n>]:SELect

This command sets the focus on the selected result display window.

This window is then the active window.

Example: `DISP:WIND1:SEL`
Sets the window 1 active.

Usage: Setting only

DISPlay:WSELect?

This command queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

Return values:

<ActiveWindow> Index number of the currently active window.

Range: 1 to 16

Usage: Query only

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 measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 264).

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

This command adds a window to the display.

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

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

Parameters:

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

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

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

Return values:

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

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

Usage: Query only

Manual control:
See "Capture Buffer" on page 16
See "Measurement & Reference Signal" on page 16
See "Symbols" on page 17
See "Error Vector" on page 17
See "Modulation Errors" on page 17
See "Modulation Accuracy" on page 18
See "Equalizer" on page 18
See "Signal Source" on page 197

Table 10-2: <WindowType> parameter values for VSA application

Parameter value	Data source (+default result display)
CBUFfer	Capture buffer (Magnitude absolute)
MEAS	Meas & Ref (Magnitude relative)
REF	
EQUalizer	Equalizer
EVECtor	Error vector (EVM)
MACCuracy	Modulation Accuracy (Result Summary)
MERRor	Modulation Errors (Magnitude error)
SYMB	Symbols (Hexadecimal)

LAYout:CATalog[:WINDow]?

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

<WindowName_1>,<Index_1>..<WindowName_n>,<Index_n>

Return values:

<WindowName> string

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

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

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

Usage: Query only

LAYout:IDENtify[:WINDow] ? <WindowName>

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

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

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

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

Usage: Event

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

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

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

Parameters:

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

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 351 for a list of available window types.

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

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

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

As opposed to the `DISPlay[:WINDow<n>]:SIZE` on page 349 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

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

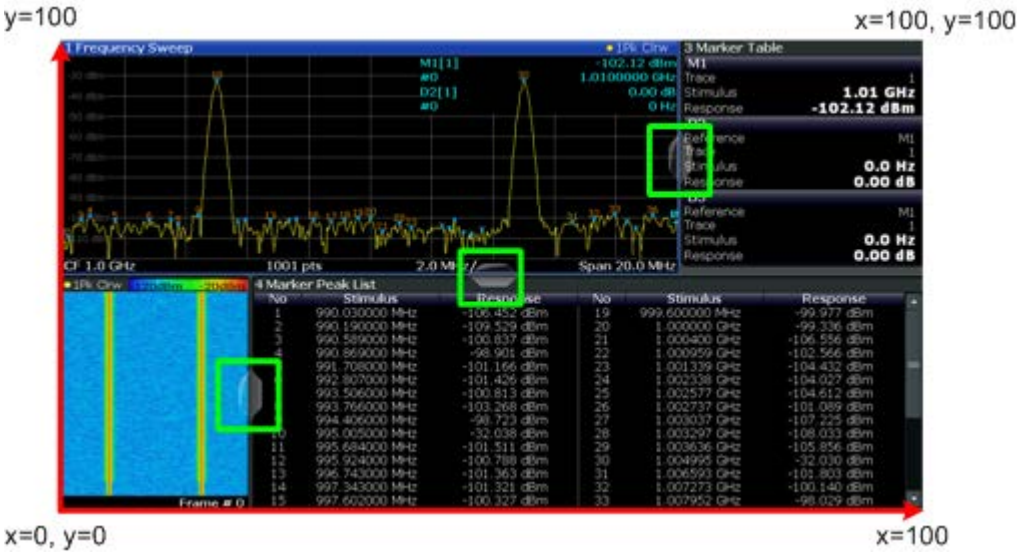


Fig. 10-1: SmartGrid coordinates for remote control of the splitters

Parameters:

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

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

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 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
```

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

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

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

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

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 351 for a list of available window types.

Return values:

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

Example:

```
LAY:WIND1:ADD? LEFT,MTAB
Result:
'2'
```

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

Usage: Query only

LAYout:WINDow<n>:IDENtify?

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

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

Return values:

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

Usage: Query only

LAYout:WINDow<n>:REMove

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

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

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

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

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

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 351 for a list of available window types.

LAYout:WINDow<n>:TYPe?

Queries the window type of the window specified by the index <n>. For a list of possible window types see `LAYout:ADD[:WINDow]?` on page 351.

Example: `LAY:WIND2:TYPE?`
Response:
`MACC`
Modulation accuracy

Usage: Query only

10.7.3 VSA Window Configuration

For each window you can select a different evaluation method (result type), based on the data source selected in the "Display Configuration". Further window settings are available for some result types.

Manual configuration of VSA windows is described in chapter 6.5.1, "Window Configuration", on page 197.

Useful commands for configuring the window described elsewhere:

- `LAYout:ADD[:WINDow]?` on page 351

Remote commands exclusive to configuring VSA windows:

CALCulate<n>:DDEM:SPECtrum[:STATe] <AddEvaluation>

This command switches the result type transformation to spectrum mode. Spectral evaluation is available for the following result parameters:

- MAGNitude
- PHASe/UPHase
- FREQuency
- Real/Imag (RIMAG)

The result parameters are defined using the CALC:FORM command (see `CALCulate<n>:FORMat` on page 357).

Setting parameters:

<AddEvaluation> ON | OFF

*RST: Off

Manual control: See "Result Type Transformation" on page 197

CALCulate<n>:FORMat <Format>

This command defines the result type of the traces. Which parameters are available depends on the setting for the data source (see `LAYout:ADD[:WINDow]?` on page 351 and table 3-1).

Whether the result type shows absolute or relative values is defined using the `DISP:WIND:TRAC:Y:MODE` command (see `DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MODE` on page 360).

Setting parameters:

<Format> MAGNitude | PHASe | UPHase | RIMag | FREQuency | COMP | CONS | IEYE | QEYE | FEYE | CONF | COVF | RCONstellation | RSUMmary | BERate | GDELay | NONE

MAGNitude
Magnitude Absolute

PHASe
Phase Wrap

UPHase
Phase Unwrap

RIMag
Real/Imag (I/Q)

FREQuency
Frequency Absolute

COMP
Vector I/Q

CONS
Constellation I/Q

IEYE
Eye Diagram Real (I)

QEYE
Eye Diagram Imag (Q)

FEYE
Eye Diagram Frequency

CONF
Constellation Frequency

COVF
Vector Frequency

RCONstellation
Constellation I/Q (Rotated)

RSUMmary
Result summary

BERate
Bit error rate

GDELay
Group delay

Manual control: See "Result Type" on page 197

CALCulate<n>:STATistics:CCDF[:STATe] <AddEvaluation>

This command switches the measurement of the statistical distribution of magnitude, phase or frequency values on or off.

Setting parameters:
<AddEvaluation> ON | OFF
*RST: OFF

Manual control: See "Result Type Transformation" on page 197

CALCulate<n>:STATistics:MODE <StatisticMode>

This command defines whether only the symbol points or all points are considered for the statistical calculations.

Setting parameters:
<StatisticMode> SONLy | INFinite
SONLy
Symbol points only are used
INFinite
All points are used
*RST: SONLy

Manual control: See "Oversampling" on page 198

DISPlay[:WINDow<n>]:PRATe:AUTO <DisplayPPSMode>

Defines the number of display points that are displayed per symbol automatically, i.e. according to `[SENSe:]DDEMod:PRATe` on page 296. To define a different number of points per symbol for display, use the `MANual` parameter and the `DISPlay[:WINDow<n>]:PRATe[:VALue]` command.

Setting parameters:
<DisplayPPSMode> AUTO | MANual
*RST: AUTO

Manual control: See "Display Points/Sym" on page 198

DISPlay[:WINDow<n>]:PRATe[:VALue] <DisplayPPS>

This command determines the number of points to be displayed per symbol if manual mode is selected (see `DISPlay[:WINDow<n>]:PRATe:AUTO` on page 359).

This command is not available for result displays based on the capture buffer; in this case, the displayed points per symbol are defined by the sample rate (`[SENSe:]DDEMod:PRATe` command).

Setting parameters:

<DisplayPPS> 1, 2, 4, 8,16 or 32

1
only the symbol time instants are displayed

2, 4, 8, 16, 32
more points are displayed than symbols

*RST: 4

Manual control: See "Display Points/Sym" on page 198

DISPlay[:WINDow<n>]:TRACe:SYMBol

This command enables the display of the decision instants (time when the signals occurred) as dots on the trace.

Manual control: See "Highlight Symbols" on page 198

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis.

When the display update during remote control is off, this command has no immediate effect.

Parameters:

<Mode> **ABSolute**
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

Example: `DISP:TRAC:Y:MODE REL`

10.8 Retrieving Results

The following commands are required to retrieve the calculated VSA parameters.

All results that are not based on the capture buffer data are calculated for a single result range only (see chapter 4.6.1, "Result Range", on page 112). To retrieve the results for several result ranges, use the `[SENSe:]DDEMod:SEARch:MBURst:CALC` on page 303 command to move from one result range to the next.

10.8.1 Retrieving Trace Data and Marker Values

In order to retrieve the trace and marker results in a remote environment, use the following commands:

CALCulate<n>:DELTamarker<m>:X:ABSolute?

This command queries the absolute x-value of the selected delta marker in the specified window. The command activates the corresponding delta marker, if necessary.

Usage: Query only

CALCulate<n>:DELTamarker<m>:X:RELative?

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

If necessary, the command activates the delta marker first.

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

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

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

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 327.

Return values:

<Result> Result at the marker position.

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

Usage: Query only

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:STARt?

This command queries the first value of the x-axis in symbols or time, depending on the unit setting for the x-axis.

Note: using the `CALCulate<n>:TRACe<t>:ADJust:ALIGnment:OFFSet` command, the burst is shifted in the diagram; the x-axis thus no longer begins on the left at 0 symbols but at a selectable value.

Usage: Query only

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

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 control: See "Decimal Separator" on page 189

FORMat:DEXPort:HEADer <Header>

This command defines if a file header (including start frequency, sweep time, detector, etc.) is created or not. A small header with the instrument model, the version and the date is always transferred.

Setting parameters:

<Header> ON | OFF

*RST: OFF

Manual control: See "Header" on page 188

FORMat:DEXPort:MODE <Mode>

This command defines which data are transferred, raw I/Q data or trace data.

Setting parameters:

<Mode> RAW | TRACe

*RST: TRACe

Manual control: See "Data Export Mode" on page 188

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual control: See "Trace ASCII Export" on page 189

TRACe<n>[:DATA] <Trace>

This command queries the trace data.

Which data is returned depends on the result display in the window specified by the suffix <n>.

- Capture Buffer
  For the Capture Buffer result display, the command returns the y-axis values of the data that is stored in the capture buffer. The number of returned values depends on the size of the capture buffer and the sample rate. For example, a capture buffer of 500 in combination with an sample rate of 4 would return 2000 level values. The unit is dBm.
- Cartesian diagrams
  For cartesian diagrams, the command returns the y-values of the trace only (magnitude, phase, frequency, real/imag, eye diagrams). The number of returned values is the product of the "Result Length" and the display points per symbol. The unit depends on the unit you have set previously. You can query the x-value that relates to the first value of the y-axis using `DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:STARt?` on page 362.
  When querying the results for eye diagrams, the results are merely superimposed in the display. This means that the eye diagram result displays are the same as the real/imag result display.
- Polar diagrams
  For polar diagrams, the command returns a pair of values for each trace point. The first value is the real part, the second value the imaginary part. The number of returned value pairs depends on the result type:
  - Vector I/Q:
    evaluation range length * display points per symbol
  - Constellation I/Q:
    evaluation range length
  - Constellation Frequency and Vector Frequency: one value for each trace point on the y-axis
- Symbols

For the symbol table result diagrams, the command returns one value for each number in the table. The command always returns the values in the decimal format. The number of returned values depends on the modulation scheme you have selected.

- Eye diagram
  For eye diagrams, the command returns one value for each sample. The number of returned values is the product of evaluation range length and display points per symbol.
- Result Summary
  For the Result Summary, the command returns all values listed in the result table from top to bottom, i.e.:
  <EVM_RMS>,<EVM_Peak>,<MER_RMS>,<MER_Peak>,<Phase Error RMS>,<Phase Error Peak>,<MagError_RMS>,<MagError_Peak>,<Carrier Frequency Error>,<Rho>,<I/Q Offset>,<I/Q Imbalance>,<Gain Imbalance>,<Quadratue Error>,Amplitude Droop>,<Power>,**<Symbol Rate Error>**
  (Note that the "Symbol Rate Error" was appended at the end to provide compatibility to previous versions and instruments.)
  For each result type, both the current and statistical values are provided. The order of the results is as follows:
  <result1_current>, <result1_mean>, <result1_peak>, <result1_stddev>, <result1_95%ile>,
  <result2_current>, <result2_mean>, (...)
  Empty cells in the table return nothing. The number of returned values depends on the modulation scheme you have selected. PSK, MSK and QAM modulation returns 85 values, FSK modulation returns 55 values. The unit of each value depends on the particular result.
- Equalizer
  For Equalizer diagrams, the command returns the y-axis values of the equalizer trace. The number of returned values depends on the result type:
  – For impulse response diagrams:
    (filter length * sample rate) +1
  – For frequency response, channel and group delay diagrams: 4096 values

  You can query the x-value that relates to the first value of the y-axis using
  `DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:STARt?` on page 362.

Setting parameters:

<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6 | TRACe1R | TRACe1I | TRACe2R | TRACe2I | TRACe3R | TRACe3I

TRACe1/2/3/4/5/6
The complete data from the corresponding trace.

TRACe1R/TRACe2R/TRACe3R
The real data from the corresponding trace. The parameters are available for the Real/Imaginary result types.

TRACe1I/TRACe2I/TRACe3I
The imaginary data from the corresponding trace. The parameters are available for the Real/Imaginary result types.

10.8.2 Retrieving Parameter Values

For each parameter, the VSA application calculates and shows various statistical values:

- Current value
- Mean value
  Calculated as the average of the number of results defined by the Statistic Count.
- Peak value
- Standard deviation
- 95 percentile
  Unlike the mean value, the 95%ile is a result of all measurement results since the last start of a single or continous sweep, or of all measurements since the last change of a measurement parameter.

For details on the individual parameters see chapter 3.3, "Common Parameters in VSA", on page 48 and chapter A.5, "Formulae", on page 410.

CALCulate<n>:BERate <Format>

Queries the Bit Error Rate results. The available results are described in chapter 3.2.23, "Bit Error Rate (BER)", on page 42.

Query parameters:

<Format> Specifies a particular BER result to be queried. If no parameter is specified, the current bit error rate is returned.
The parameters for these results are listed in table 10-3.

Table 10-3: Parameters for BER result values

Result	Current	Min	Max	Acc
Bit Error Rate	CURRent	MIN	MAX	TOTal
Total # of Errors	TECurrent	TEMIN	TEMAX	TETotal
Total # of Bits	TCURrent	TMIN	TMAX	TTOTal

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:ADRoop? <type>

This command queries the results of the amplitude droop error measurement performed for digital demodulation. The output values are the same as those provided in the Modulation Accuracy table (see chapter 3.2.22, "Result Summary", on page 39).

Query parameters:

<type>

<none>
Amplitude droop in dB/symbol (for current sweep)

AVG
Amplitude droop in dB/symbol, evaluating the linear average value over several sweeps

RPE
Peak value for amplitude droop over several sweeps

SDEV
Standard deviation of amplitude droop

PCTL
95 percentile value of amplitude droop

*RST: RPE

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:ALL?

The command queries all results of the result summary as shown on the screen.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:CFERror? <type>

This command queries the results of the carrier frequency error measurement performed for digital demodulation.

The output values are the same as those provided in the Modulation Accuracy table.

Query parameters:

<type>

<none>
Carrier frequency error for current sweep

AVG
Average carrier frequency error (over several sweeps)

RPE
Peak carrier frequency error (over several sweeps)

SDEV
Standard deviation of frequency error

PCTL
95 percentile value of frequency error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:EVM? <type>

This command queries the results of the error vector magnitude measurement of digital demodulation. The output values are the same as those provided in the Modulation Accuracy table .

Query parameters:

<type>

<none>
Average EVM value of current sweep

AVG
RMS average EVM value (over several sweeps)

RPE
Peak value of EVM (over several sweeps)

SDEV
Standard deviation of EVM values over several sweeps

PCTL
95% percentile of RMS value (over several sweeps)

PEAK
Maximum EVM over all symbols of current sweep

PAVG
Average of maximum EVM values over several sweeps

TPEA
Maximum EVM over all symbols over several sweeps

PSD
Standard deviation of maximum EVM values over several sweeps

PPCT
95% percentile of maximum RMS values over several sweeps

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:FDERror? <type>

This command queries the results of the FSK deviation error of FSK modulated signals.

Query parameters:

<type>

<none>
Deviation error for current sweep.

AVG
Average FSK deviation error.

RPE
Peak FSK deviation error.

SDEV
Standard deviation of FSK deviation error.

PCTL
95 percentile value of FSK deviation error.

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:FSK:CFDRift? <type>

This command queries the results of the carrier frequency drift for FSK modulated signals.

Query parameters:

<type>

<none>
Carrier frequency drift for current sweep.

AVG
Average FSK carrier frequency drift.

RPE
Peak FSK carrier frequency drift.

SDEV
Standard deviation of FSK carrier frequency drift.

PCTL
95 percentile value of FSK carrier frequency drift.

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:FSK:DERRor? <type>

This command queries the results of the frequency error of FSK modulated signals.

Query parameters:

<type>

<none>
Frequency error for current sweep.

AVG
Average frequency error (over several sweeps).

RPE
Frequency error (over several sweeps).

SDEV
Standard deviation of frequency error.

PCTL
95 percentile value of frequency error.

PEAK
Maximum frequency error over all symbols of current sweep.

PAVG
Average of maximum frequency error values over several sweeps.

TPE
Maximum frequency error over all symbols over several sweeps.

PSD
Standard deviation of maximum frequency error values over several sweeps.

PPCT
95% percentile of maximum RMS values over several sweeps.

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:FSK:MDEViation?
<type>

This command queries the results of the measurement deviation of FSK modulated signals.

Query parameters:

<type>

<none>
Measurement deviation for current sweep.

AVG
Average FSK measurement deviation.

RPE
Peak FSK measurement deviation.

SDEV
Standard deviation of FSK measurement deviation.

PCTL
95 percentile value of FSK measurement deviation.

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:FSK:RDEViation?
<type>

This command queries the results of the reference deviation of FSK modulated signals.

Query parameters:

<type>

<none>
Measurement deviation for current sweep.

AVG
Average FSK measurement deviation.

RPE
Peak FSK measurement deviation.

SDEV
Standard deviation of FSK measurement deviation.

PCTL
95 percentile value of FSK measurement deviation.

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:GIMBalance? <type>

This command queries the results of the Gain Imbalance error measurement of digital demodulation. The output values are the same as those provided in the Modulation Accuracy table .

Query parameters:

<type>

<none>
Gain imbalance error for current sweep

AVG
Average gain imbalance error (over several sweeps)

RPE
Peak gain imbalance error (over several sweeps)

SDEV
Standard deviation of gain imbalance error

PCTL
95 percentile value of gain imbalance error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:IQIMbalance? <type>

This command queries the results of the I/Q imbalance error measurement of digital demodulation.

Query parameters:

<type> **<none>**
I/Q imbalance error (for current sweep)

AVG
Average I/Q imbalance error (over several sweeps)

RPE
Peak I/Q imbalance error (over several sweeps)

SDEV
Standard deviation of I/Q imbalance error

PCTL
95 percentile value of I/Q imbalance error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:MERRor? <type>

This command queries the results of the magnitude error measurement of digital demodulation.

Query parameters:

<type> **<none>**
magnitude error for current sweep

AVG
Average magnitude error (over several sweeps)

RPE
Peak magnitude error (over several sweeps)

SDEV
Standard deviation of magnitude error

PCTL
95 percentile value of magnitude error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:MPOWer? <type>

This command queries the results of the power measurement of digital demodulation.

Query parameters:

<type>

<none>
power measurement (for current sweep)

AVG
Average of power measurement (over several sweeps)

RPE
Peak of power measurement (over several sweeps)

SDEV
Standard deviation of power measurement

PCTL
95 percentile value of power measurement

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:OOFFset? <type>

This command queries the results of the I/Q offset measurement performed for digital demodulation.

Query parameters:

<type>

<none>
Origin offset error (for current sweep)

AVG
Average origin offset error (over several sweeps)

RPE
Peak origin offset error (over several sweeps)

SDEV
Standard deviation of origin offset error

PCTL
95 percentile value of origin offset error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:PERRor? <type>

This command queries the results of the phase error measurement performed for digital demodulation.

Query parameters:

<type>

<none>
Phase error in degree

AVG
RMS phase error value (over several sweeps)

RPE
Peak value of phase error (over several sweeps)

SDEV
Standard deviation of phase error values over several sweeps

PCTL
95% percentile of RMS value (over several sweeps)

PEAK
Maximum phase error of current sweep

PAVG
Average of maximum phase error values over several sweeps

TPE
Maximum phase error over several sweeps

PSD
Standard deviation of maximum phase error values over several sweeps

PPCT
95% percentile of maximum RMS values over several sweeps

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:QERRor? <type>

This command queries the results of the Quadratur error measurement performed for digital demodulation.

Query parameters:

<type>

<none>
quadrature error (for current sweep)

AVG
Average quadrature error (over several sweeps)

RPE
Peak quadrature error (over several sweeps)

SDEV
Standard deviation of quadrature error

PCTL
95 percentile value of quadrature error

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:RHO? <type>

This command queries the results of the Rho factor measurement performed for digital demodulation.

Query parameters:

<type>

<none>
Rho factor (for current sweep)

AVG
Average rho factor (over several sweeps)

RPE
Peak rho factor (over several sweeps)

SDEV
Standard deviation of rho factor

PCTL
95 percentile value of rho factor

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:SNR? <type>

This command queries the results of the SNR error measurement performed for digital demodulation.

Query parameters:

<type>

<none>
Average SNR value of current sweep

AVG
RMS Average SNR value (over several sweeps)

RPE
Peak value of SNR (over several sweeps)

SDEV
Standard deviation of SNR values over several sweeps

PCTL
95% percentile of RMS value (over several sweeps)

PEAK
Maximum SNR over all symbols of current sweep

PAVG
Average of maximum SNR values over several sweeps

TPE
Maximum SNR over all symbols over several sweeps

PSD
Standard deviation of maximum SNR values over several sweeps

PPCT
95% percentile of maximum RMS values over several sweeps

*RST: PEAK

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:DDEMod:STATistic:SRERror?
<ResultType>

This command queries the symbol rate error

Query parameters:

<ResultType> PEAK | AVG | SDEV | PCTL | TPEak | RPEak | PAVG | PSDev | PPCTI

<none>
symbol rate error (for current sweep)

AVG
average symbol rate error (over several sweeps

RPE
Peak symbol rate error (over several sweeps)

SDEV
Standard deviation of symbol rate error

PCTL
95 percentile value of symbol rate error

*RST: PEAK

Usage: Query only

10.8.3 Retrieving Limit Check Results

The modulation accuracy parameters can be checked against defined limits. The following commands are required to query the results of these limit checks.

CALCulate<n>:LIMit:MACCuracy:CFERror:CURRent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:CFERror:MEAN[:RESult]?
CALCulate<n>:LIMit:MACCuracy:CFERror:PEAK[:RESult]?
CALCulate<n>:LIMit:MACCuracy:EVM:PCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:EVM:PMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:EVM:PPEak[:RESUlt]?
CALCulate<n>:LIMit:MACCuracy:EVM:RCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:EVM:RMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:EVM:RPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FDERror:CURRent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FDERror:MEAN[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FDERror:PEAK[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FERRor:PCURrent[:RESUlt]?
CALCulate<n>:LIMit:MACCuracy:FERRor:PMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FERRor:PPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FERRor:RCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FERRor:RMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:FERRor:RPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:MERRor:PCURrent[:RESult]?

CALCulate<n>:LIMit:MACCuracy:MERRor:PMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:MERRor:PPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:MERRor:RCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:MERRor:RMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:MERRor:RPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:OOFFset:CURRent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:OOFFset:MEAN[:RESult]?
CALCulate<n>:LIMit:MACCuracy:OOFFset:PEAK[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:PCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:PMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:PPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:RCURrent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:RMEan[:RESult]?
CALCulate<n>:LIMit:MACCuracy:PERRor:RPEak[:RESult]?
CALCulate<n>:LIMit:MACCuracy:RHO:CURRent[:RESult]?
CALCulate<n>:LIMit:MACCuracy:RHO:MEAN[:RESult]?
CALCulate<n>:LIMit:MACCuracy:RHO:PEAK[:RESult]?
CALCulate<n>:LIMit:MACCuracy:<ResultType>:<LimitType>[:RESUlt]

This command queries whether the limit for the specified result type and limit type was violated.

For details on result types and limit types see chapter 3.2.22, "Result Summary", on page 39.

Suffix:

<ResultType> CFERror | EVM | FDERror | FERRor | MERRor | OOFFset | PERRor | RHO
CFERror = Carrier Frequency Error
EVM = Error Vector Magnitude
FDERror = Frequency deviation error (FSK only)
FERRor = Frequency error (FSK only)
MERRor = Magnitude Error
OOFFset = I/Q Offset
PERRor = Phase Error
RHO = Rho

<LimitType> CURRent | MEAN | PEAK | PCURRent | PMEan | PPEak | RCURRent | RMEan | RPEak
For CFERor, OOFFset, RHO:
CURRent
MEAN
PEAK
For EVM, FDERror, FERRor, MERRor, PERRor:
PCURRent = Peak current value
PMEan = Peak mean value
PPEak = Peak peak value
RCURRent = RMS current value
RMEan = RMS mean value
RPEak = RMS peak value

Return values:

<LimitResult> NONE | PASS | FAIL | MARGIN

NONE
No limit check result available yet.

PASS
All values have passed the limit check.

FAIL
At least one value has exceeded the limit.

MARGIN
currently not used

*RST: NONE

10.8.4 Importing and Exporting I/Q Data and Results

The I/Q data to be evaluated in VSA can not only be measured by the VSA application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the VSA application can be exported for further analysis in external applications.

For details on importing and exporting I/Q data see the R&S FSW User Manual.

MMEMory:LOAD:IQ:STATe 1,<FileName>

This command restores I/Q data from a file.

The file extension is *.iq.tar.

Parameters:

1

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

Example: `MMEM:LOAD:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Loads IQ data from the specified file.

Usage: Setting only

MMEMory:STORe:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Parameters:

<Comment> String containing the comment.

Example: `MMEM:STOR:IQ:COMM 'Device test 1b'`
Creates a description for the export file.
`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores I/Q data and the comment to the specified file.

MMEMory:STORe:IQ:FORMat? <Format>,<DataFormat>

This command queries the format of the I/Q data to be stored.

Parameters:

<Format> **FLOat32**
32-bit floating point format.
*RST: FLOat32

<DataFormat> **COMPlex**
Exports complex data.
*RST: COMPlex

Usage: Query only

MMEMory:STORe:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Parameters:
1

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores the captured I/Q data to the specified file.

10.9 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, e.g. information on errors or limit violations which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

In this section, only the status registers/bits specific to the VSA application are described.

For details on the common R&S FSW status registers refer to the description of remote control basics in the R&S FSW User Manual.

*RST does not influence the status registers.

Description of the Status Registers

In addition to the registers provided by the base system, the following registers are used in the VSA application:

- `STATus:QUEStionable:SYNC<n>` - contains application-specific information about synchronization errors or errors during burst detection.
- `STATus:QUESTionable:MODulation<n>` – provides information on any limit violations that occur after demodulation in one of the 4 windows
- `STATus:QUESTionable:MODulation<n>:EVM` - limit violations in EVM evaluation
- `STATus:QUESTionable:MODulation<n>:PHASe` - limit violations in Phase Error evaluation
- `STATus:QUESTionable:MODulation<n>:MAGnitude` - limit violations in Magnitude Error evaluation
- `STATus:QUESTionable:MODulation<n>:CFRequency` - limit violations in Carrier Frequency evaluation
- `STATus:QUESTionable:MODulation<n>:IQRHO` - limit violations in I/Q-Offset and RHO evaluation
- `STATus:QUESTionable:MODulation<n>:FSK` - limit violations in FSK evaluation

The `STATus:QUEStionable` register "sums up" the information from all subregisters (e.g. bit 11 sums up the information for all `STATus:QUEStionable:SYNC` registers). For some subregisters, there may be separate registers for each active channel. Thus, if a status bit in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific subregisters. In this case, you must check the subregister of each channel to determine which channel caused the error. By default, querying the status of a subregister always returns the result for the currently selected channel.

The commands to query the contents of the following status registers are described in chapter 10.9.9, "Querying the Status Registers", on page 384.

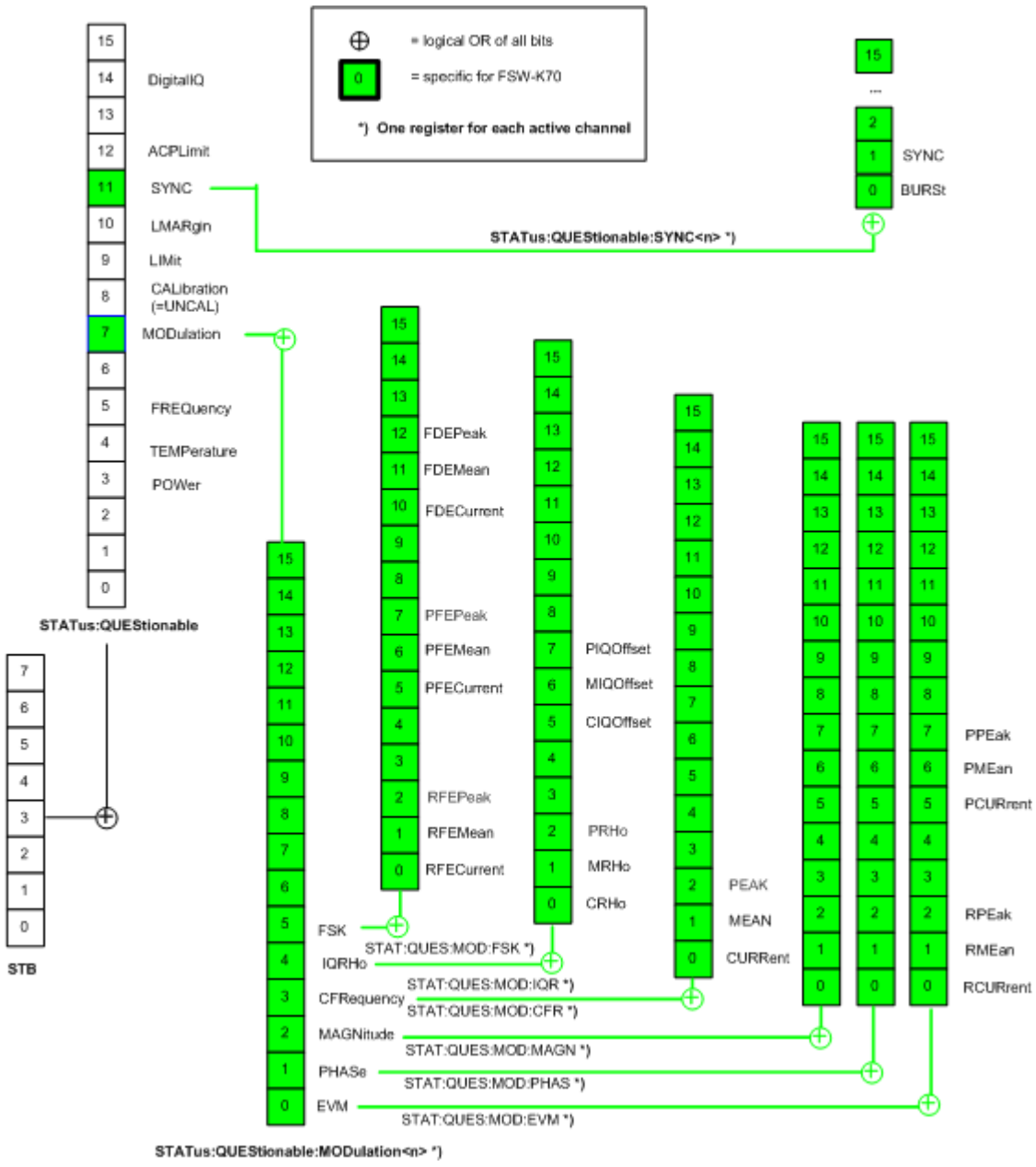


Fig. 10-2: Overview of VSA-specific status registers

10.9.1 STATus:QUEStionable:SYNC<n> Register

This register contains application-specific information about synchronization errors or errors during burst detection for each window in each VSA channel. It can be queried with commands `STATus:QUEStionable:SYNC:CONDition?` on page 386 and `STATus:QUEStionable:SYNC[:EVENt]?` on page 386.

Table 10-4: Status error bits in STATus:QUEStionable:SYNC register for R&S FSW-K70

Bit	Definition
0	Burst not found. This bit is set if a burst could not be detected.
1	Sync not found This bit is set if the sync sequence (pattern) of the midamble could not be detected.
2 to 14	Not used.
15	This bit is always 0.

10.9.2 STATus:QUEStionable:MODulation<n> Register

This register comprises information about any limit violations that may occur after demodulation in any of the VSA windows. It can be queried with commands `STATus:QUEStionable:MODulation<n>:CONDition?` on page 386 and `STATus:QUEStionable:MODulation<n>[:EVENt]?` on page 386.

The status of the `STATus:QUESTionable:MODulation` register is indicated in bit 7 of the "STATus:QUESTionable" register. It can be queried using the `STATus:QUESTionable:EVENt` command.

Bit No	Meaning
0	Error in EVM evaluation
1	Error in Phase Error evaluation
2	Error in Magnitude Error evaluation
3	Error in Carrier Frequency evaluation
4	Error in I/Q offset or RHO evaluation
5	Error in FSK evaluation
6-15	These bits are not used

10.9.3 STATus:QUESTionable:MODulation<n>:EVM Register

This register comprises information about limit violations in EVM evaluation. It can be queried with commands

STATus:QUEStionable:MODulation<n>:EVM:CONDition and
STATus:QUEStionable:MODulation<n>:EVM[:EVENt].

Bit No	Meaning
0	Error in current RMS value
1	Error in mean RMS value
2	Error in peak RMS value
3-4	These bits are not used
5	Error in current peak value
6	Error in mean peak value
7	Error in peak peak value
8-15	These bits are not used

10.9.4 STATus:QUESTionable:MODulation<n>:PHASe Register

This register comprises information about limit violations in Phase Error evaluation. It can be queried with commands
STATus:QUEStionable:MODulation<n>:PHASe:CONDition and
STATus:QUEStionable:MODulation<n>:PHASe[:EVENt].

Bit No	Meaning
0	Error in current RMS value
1	Error in mean RMS value
2	Error in peak RMS value
3-4	These bits are not used
5	Error in current peak value
6	Error in mean peak value
7	Error in peak peak value
8-15	These bits are not used

10.9.5 STATus:QUESTionable:MODulation<n>:MAGnitude Register

This register comprises information about limit violations in Magnitude Error evaluation. It can be queried with commands
STATus:QUEStionable:MODulation<n>:MAGNitude:CONDition and
STATus:QUEStionable:MODulation<n>:MAGNitude[:EVENt].

Bit No	Meaning
0	Error in current RMS value
1	Error in mean RMS value
2	Error in peak RMS value
3-4	These bits are not used
5	Error in current peak value
6	Error in mean peak value
7	Error in peak peak value
8-15	These bits are not used

10.9.6 STATus:QUESTionable:MODulation<n>:CFRequency Register

This register comprises information about limit violations in Carrier Frequency evaluation. It can be queried with commands
`STATus:QUEStionable:MODulation<n>:CFREQuency:CONDition` and
`STATus:QUEStionable:MODulation<n>:CFREQuency[:EVENt]`.

Bit No	Meaning
0	Error in current value
1	Error in mean value
2	Error in peak value
3-15	These bits are not used

10.9.7 STATus:QUESTionable:MODulation<n>:IQRHO Register

This register comprises information about limit violations in I/Q offset or RHO evaluation. It can be queried with commands
`STATus:QUEStionable:MODulation<n>:IQRHO:CONDition` and
`STATus:QUEStionable:MODulation<n>:IQRHO[:EVENt]`.

Bit No	Meaning
0	Error in current RHO value
1	Error in mean RHO value
2	Error in peak RHO value
3-4	These bits are not used
5	Error in current I/Q offset value
6	Error in mean I/Q offset value

Bit No	Meaning
7	Error in peak I/Q offset value
8-15	These bits are not used

10.9.8 STATus:QUESTionable:MODulation<n>:FSK Register

This register comprises information about limit violations in FSK evaluation. It can be queried with commands
`STATus:QUEStionable:MODulation<n>:FSK:CONDition` and
`STATus:QUEStionable:MODulation<n>:FSK[:EVENt]`.

Bit No	Meaning
0	Error in current Frequency Error RMS value
1	Error in mean Frequency Error RMS value
2	Error in peak Frequency Error RMS value
3-4	These bits are not used
5	Error in current Frequency Error peak value
6	Error in mean Frequency Error peak value
7	Error in peak Frequency Error peak value
8-9	These bits are not used
10	Error in current Frequency Deviation value
11	Error in mean Frequency Deviation value
12	Error in peak Frequency Deviation value
13-15	These bits are not used

10.9.9 Querying the Status Registers

The following commands query the contents of the individual status registers.

STATus:QUEStionable:ACPLimit:CONDition?
STATus:QUEStionable:DIQ:CONDition? <Condition>
STATus:QUEStionable:FREQuency:CONDition?
STATus:QUEStionable:LIMit<n>:CONDition?
STATus:QUEStionable:LMARgin<n>:CONDition?
STATus:QUEStionable:MODulation<n>:CONDition?
STATus:QUEStionable:MODulation<n>:CFRequency:CONDition?
STATus:QUEStionable:MODulation<n>:EVM:CONDition?
STATus:QUEStionable:MODulation<n>:FSK:CONDition?
STATus:QUEStionable:MODulation<n>:IQRHo:CONDition?
STATus:QUEStionable:MODulation<n>:MAGNitude:CONDition?
STATus:QUEStionable:MODulation<n>:PHASe:CONDition?
STATus:QUEStionable:POWer:CONDition?
STATus:QUEStionable:SYNC:CONDition? <ChannelName>

This command 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

STATus:QUEStionable:ACPLimit[:EVENt]?
STATus:QUEStionable:DIQ[:EVENt]? <Event>
STATus:QUEStionable:FREQuency[:EVENt]?
STATus:QUEStionable:LIMit<n>[:EVENt]?
STATus:QUEStionable:LMARgin<n>[:EVENt]?
STATus:QUEStionable:MODulation<n>:CFRequency[:EVENt]?
STATus:QUEStionable:MODulation<n>:EVM[:EVENt]?
STATus:QUEStionable:MODulation<n>:FSK[:EVENt]?
STATus:QUEStionable:MODulation<n>:IQRHo[:EVENt]?
STATus:QUEStionable:MODulation<n>:MAGNitude[:EVENt]?
STATus:QUEStionable:MODulation<n>:PHASe[:EVENt]?
STATus:QUEStionable:MODulation<n>[:EVENt]?
STATus:QUEStionable:POWer[:EVENt]?
STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

This command 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

STATus:QUEStionable:ACPLimit:ENABle <Enable>
STATus:QUEStionable:DIQ:ENABle <Enable>
STATus:QUEStionable:FREQuency:ENABle <Enable>
STATus:QUEStionable:LIMit<n>:ENABle <Enable>
STATus:QUEStionable:LMARgin<n>:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:CFRequency:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:EVM:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:FSK:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:IQRHo:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:MAGNitude:ENABle <Enable>
STATus:QUEStionable:MODulation<n>:PHASe:ENABle <Enable>
STATus:QUEStionable:POWer:ENABle <Enable>
STATus:QUEStionable:SYNC:ENABle <SumBit>,<ChannelName>

This command 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:

<SumBit> 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.

STATus:QUEStionable:ACPLimit:NTRansition <NTransition>
STATus:QUEStionable:DIQ:NTRansition <NTransition>
STATus:QUEStionable:FREQuency:NTRansition <NTransition>
STATus:QUEStionable:LIMit<n>:NTRansition <NTransition>
STATus:QUEStionable:LMARgin<n>:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:CFRequency:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:EVM:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:FSK:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:IQRHo:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:MAGNitude:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:NTRansition <NTransition>
STATus:QUEStionable:MODulation<n>:PHASe:NTRansition <NTransition>

STATus:QUEStionable:POWer:NTRansition <NTransition>
STATus:QUEStionable:SYNC:NTRansition <SumBit>,<ChannelName>

This command 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:

<SumBit> 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.

STATus:QUEStionable:ACPLimit:PTRansition <PTransition>
STATus:QUEStionable:DIQ:PTRanstion <PTranstion>
STATus:QUEStionable:FREQuency:PTRansition <PTransition>
STATus:QUEStionable:LIMit<n>:PTRansition <PTransition>
STATus:QUEStionable:LMARgin<n>:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:CFRequency:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:EVM:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:FSK:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:IQRHo:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:MAGNitude:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:PHASe:PTRansition <PTransition>
STATus:QUEStionable:MODulation<n>:PTRansition <PTransition>
STATus:QUEStionable:POWer:PTRansition <PTransition>
STATus:QUEStionable:SYNC:PTRansition <SumBit>,<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:

<SumBit> 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.

10.10 Obsolete Commands

The following commands are maintained for compatibility reasons with previous R&S analyzers only. Use the specified alternative commands for new remote control programs.

CALCulate<n>:FEED <Feed>

Selects the signal source for evaluation.

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 350).

Setting parameters:

<Feed> string

'XTIM:DDEM:MEAS'
Measured signal

'XTIM:DDEM:REF'
Reference signal

'XTIM:DDEM:ERR:VECT'
Error vector

'XTIM:DDEM:ERR:MPH'
Modulation errors

'XTIM:DDEM:MACC'
Modulation accuracy

'XTIM:DDEM:SYMB'
Symbol table

'TCAP'
Capture Buffer

'XTIM:DDEM:IMP'
Equalizer Impulse Response

'XFR:DDEM:RAT'
Equalizer Frequency Response

'XFR:DDEM:IRAT'
Equalizer Group Delay

CALCulate<n>:FSK:DEViation:COMPensation <RefDevComp>

This command defines whether the deviation error is compensated for when calculating the frequency error for FSK modulation.

Note that this command is maintained for compatibility reasons only. For newer remote programs, use `[SENSe:]DDEMod:NORMalize:FDERror` on page 319.

Setting parameters:

<RefDevComp> ON | OFF

ON
Scales the reference signal to the actual deviation of the measurement signal.

OFF
Uses the entered nominal deviation for the reference signal.

*RST: ON

[SENSe:]DDEMod:EQUalizer:ADAPt <Mode>

This command switches the learning phase of the equalizer on or off.

Note that this command is retained for compatibility reasons only. In newer remote programs, use the `[SENS:]DDEM:EQU:MODE TRAIN` command instead (see `[SENSe:]DDEMod:EQUalizer:MODE` on page 315).

Setting parameters:

<Mode> ON | OFF

*RST: OFF

[SENSe:]DDEMod:NORMalize[:VALue] <Normalize>

This command switches the compensation of the IQ offset and the compensation of amplitude droop on or off.

Note that this command is maintained for compatibility reasons only. Use the more specific `[SENSe:]DDEMod:NORMalize` commands for new remote control programs (see chapter 10.4.8, "Demodulation Settings", on page 312).

Parameters:

<Normalize> ON | OFF

OFF
No compensation for amplitude droop nor I/Q offset

ON
Compensation for amplitude droop and I/Q offset enabled

*RST: ON

10.11 Programming Examples

The following examples demonstrate how to perform vector signal analysis in a remote environment.

These examples are meant to demonstrate the use of the most common remote commands for vector signal analysis. Note that not all commands executed here are actually necessary, as they may reflect default settings.

10.11.1 Measurement Example 1: User-defined Measurement of Continuous QPSK Signal

The following example describes a scenario similar to the one for manual operation described in chapter 8.2, "Measurement Example 1: Continuous QPSK Signal", on page 220.

```
//-----------Configuring the measurement ------------

*RST
//Reset the instrument
FREQ:CENT 1GHz
//Set the center frequency.
DISP:TRAC:Y:RLEV 4dBm
//Set the reference level
INST:CRE:NEW DDEM,'MyVSA'
//Create new measurement channel for vector signal analysis named "MyVSA"

//--------- Configuring the expected input signal ---------------

DDEM:FORM QPSK
//Set the modulation type
DDEM:QPSK:FORM NORM
//Set the modulation order
DDEM:MAPP:CAT?
//Query the available symbol mappings for QPSK modulation
DDEM:MAPP 'WCDMA'
//Set the symbol mapping to WCDMA
DDEM:SRAT 1 MHz
//Set the symbol rate
DDEM:TFIL:NAME 'RRC'
DDEM:TFIL:ALPH 0.35
//Select the RRC transmit filter

//--------- Configuring an averaged EVM vs Time result display ---------

LAY:ADD? '1',RIGH,EVEC
//Create new window to the right of I/Q constellation (window 1) with
//error vector as data type
//Result: '5'
CALC5:FORM MAGN
//Set result type for window 5 to magnitude = EVM
DISPlay:WINDow5:TRACe2:MODE AVER
//Add a second trace in average mode
DISPlay:WINDow5:TRACe3:MODE MAXH
//Add a third trace in max hold mode
SWE:COUN 10
//Calculate an average over 10 sweeps

//--------------Performing the measurement-----
```

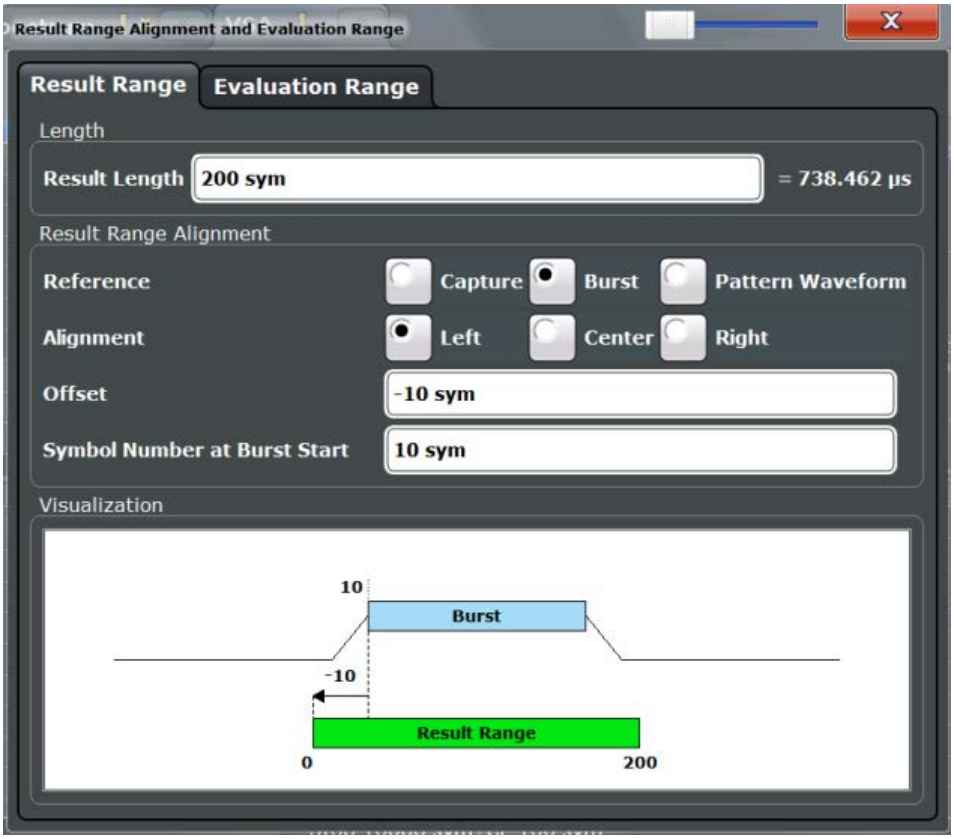
```
INIT:CONT OFF
//Select single sweep mode.
INIT;*WAI
//Initiate a new measurement and wait until the 10 sweeps have finished.

//-----Storing the Constellation I/Q diagram to a file ------

DISP:WIND1:SIZE LARG
//Display the I/Q Constellation result display (window 1) in full screen.
HCOP:DEST 'MMEM'
//Define the destination of the screenshot as a file.
HCOP:DEV:LANG BMP
//Select bmp as the file format.
MMEM:NAME 'C:\R_S\INST\USER\IQConstellation.bmp'
//Select the file name for the printout.
HCOP:ITEM:ALL
//Print all screen elements
HCOP
//Store the printout in a file called 'IQConstellation.bmp'.
DISP:WIND5:SIZE SMAL
//Restore the I/Q Constellation result display to one subwindow.


//------------Storing the EVM trace data to a file---------------

FORM:DEXP:HEAD ON
//Include a header in the trace export file
FORM:DEXP:MODE TRAC
//Export the trace data, not raw I/Q data
MMEM:STOR4:TRAC 1,'AverageEVM'
//Save the detected symbol values (x-values are not exported with trace data)
//Results:
MMEM:STOR5:TRAC 1,'AverageEVM'
//Save the  EVM values (window 5) to an ascii file.
//Results:
//
```

10.11.2 Measurement Example 2: GSM EDGE Burst Measurement Based on a Digital Standard

The following example describes a scenario similar to the one for manual operation described in chapter 8.3, "Measurement Example 2: Burst GSM EDGE Signals", on page 228chapter 8.2, "Measurement Example 1: Continuous QPSK Signal", on page 220.

Note that although this example uses the settings from a predefined digital standard, the configuration is changed to demonstrate the possibilities of the VSA application. A measurement that is performed strictly according to the standard requires much less programming efforts.

The rising and falling edges of a GSM burst are analyzed using the following result range settings:




```
//-----------Configuring the measurement ------------

*RST
//Reset the instrument
FREQ:CENT 1GHz
//Set the center frequency.
DISP:TRAC:Y:RLEV 4dBm
//Set the reference level
INST:CRE:NEW DDEM,'VSA'
//Create new measurement channel for vector signal analysis named "VSA"

//-------Loading the required digital standard -----------------

DDEM:PRES 'EDGE_NB'
//Loads the GSM EDGE_8PSK standard file and the settings defined there
```

```
//------Changing data acquisition settings --------------------

DDEM:RLEN 10000 sym

//-------- Defining the result range ---------------
DDEMod:TIME 200
//Defines the result length as 200 symbols.
CALC:TRAC:ADJ BURS
//Defines the burst as the reference for the result range
CALC:TRAC:ADJ:ALIG LEFT
//Aligns the result range to the left edge of the burst
CALC:TRAC:ADJ:ALIG:OFFS -10
//Defines an offset of 10 symbols from the burst start
DISP:TRAC:X:VOFF 10
//Defines the symbol number 10 as the result range start

//----------Defining the evaluation range ---------

CALC:ELIN:STAT ON
CALC:ELIN1 10
CALC:ELIN2 190
//Evaluation range starts at symbol 10 and ends at symbol 190

//--------- Changing the result display ---------

LAY:WIND4:REM
//Close symbol table display (window 4)
DISPlay:WINDow1:TRACe2:MODE MAXH
//Add a second trace in max hold mode to EVM vs Time display (window 1)
LAY:ADD? '3',RIGH,MEAS
//Create new window to the right of capture buffer (window 3) with
//measurement signal as data type
//Result: '4'
CALC4:FORM MAGN
//Set result type for window 4 to magnitude
DISPlay:WINDow4:TRACe2:MODE WRIT
CALC4:TRAC2 REF
//Add a second trace in clear/write mode for the reference signal

//-------- Activating limit checks for modulation accuracy ---------

CALC:LIM:MACC:STAT ON
//Activates limit checks for all values in the Result Summary

//--------------Performing the measurement -----

INIT:CONT OFF
//Select single sweep mode.
INIT;*WAI
//Initiate a new measurement and wait until the 10 sweeps have finished.
```

```
//----- Retrieving Results ------

CALC2:MARK:FUNC:DDEM:STAT:EVM? AVG
CALC:LIM:MACC:EVM:RCUR?
//Query the value and check the limit for the EVM RMS value in the
//result summary for the current evaluation range
//Result:
CALC2:MARK:FUNC:DDEM:STAT:EVM? PAVG
CALC:LIM:MACC:EVM:PPE?
//Query the value and check the limit for the largest error vector magnitude
//in the measurement.
//Result:
CALC2:MARK:FUNC:DDEM:STAT:CFER? AVG
CALC:LIM:MACC:CFER:MEAN?
//Query the value and check the limit for the mean carrier frequency offset
//in the result summary for the current evaluation range
//Result:

//------- Storing trace data to a file ---------------

FORM:DEXP:HEAD ON
//Include a header in the trace export file
FORM:DEXP:MODE TRAC
//Export the trace data, not raw I/Q data
DISP:WIND1:TRAC2:X:STAR?
//Query the first value of the x-axis for the current result range
//(x-values are not exported with trace data)
//Result:
MMEM:STOR4:TRAC 1,'Measurement signal'
//Save the measurement signal values (trace 1 in window 4) to an ascii file.
//Results:
//
MMEM:STOR4:TRAC 2,'Reference signal'
//Save the reference signal values (trace 2 in window 4) to an ascii file.
//Results:
//
MMEM:STOR2:TRAC 1,'Result Summary'
//Save the result summary values (window 2)  for the current result range
//to an ascii file.
//Results:
//

//-------- Retrieving results for further result ranges -------->

DDEM:SEAR:MBUR:CALC?
//Query the number of result ranges (current is last)
//Use variable <x> to determine number of previous result range
//DDEM:SEAR:MBUR:CALC <x>
```

```
//Move to next result range and repeat section "retrieving results" for
//range-specific results
```

10.11.3 Measurement Example 3: User-Defined Pattern Search and Limit Check

In this example a user-defined pattern is used to detect bursts and the calculated measurement results are checked against defined limits. The configuration settings are stored as a user-defined standard.

```
//-----------Configuring the measurement ------------

*RST
//Reset the instrument
FREQ:CENT 1GHz
//Set the center frequency.
DISP:TRAC:Y:RLEV 4dBm
//Set the reference level
INST:CRE:NEW DDEM,'VSA'
//Create new measurement channel for vector signal analysis named "VSA"

//----------------- Creating a pattern ------------------

DDEM:SEAR:SYNC:NAME 'EDGE_TSC_CUST'
//Create new pattern
DDEM:SEAR:SYNC:NST 4
DDEM:SEAR:SYNC:DATA '0003000100000000000300020002000100030001000 1'
DDEM:SEAR:SYNC:COMM 'Customized pattern'
DDEM:SEAR:SYNC:TEXT 'Special edge normal Burst'
DDEM:SEAR:SYNC:NAME 'EDGE_TSC_CUST'
//Store customized pattern
DDEM:SEAR:SYNC:PATT:ADD 'EDGE_TSC_CUST'
//Add new pattern to current standard

//--------- Configuring the expected input signal ---------------
DDEM:FORM QPSK
//Set the modulation type
DDEM:QPSK:FORM NORM
//Set the modulation order
DDEM:MAPP:CAT?
//Query the available symbol mappings for QPSK modulation
DDEM:MAPP 'WCDMA'
//Set the symbol mapping to WCDMA
DDEM:SRAT 1 MHz
//Set the symbol rate

DDEM:SIGN BURS
//Define input signal as burst signal
DDEM:SIGN:PATT ON
```

```
//Enable pattern search
DDEM:SEAR:SYNC:CAT? CURR
//Query the names of all defined patterns assigned to the current standard
DDEM:SEAR:SYNC:SEL 'EDGE_TSC_CUST'
//Select a pattern
DDEM:STAN:SYNC:OFFS 10
//Ignore the first 10 symbols of the signal before comparing pattern
DDEM:STAN:SYNC:OFFS:STAT ON
DDEM:SEAR:SYNC:STAT ON


//------ Storing the new settings as a user-defined standard -------------

DDEM:STAN:SAVE 'C:\TEMP\CustomizedBurstMeas'

//--------------Performing the measurement -----

INIT:CONT OFF
//Select single sweep mode.
INIT;*WAI
//Initiate a new measurement and wait until it has finished.

//----- Retrieving Results ------
TRAC3:DATA? TRACE1
//Query the trace results of the capture buffer display.
//Results:
//
TRAC2:DATA? TRACE1
//Query the results of the result summary.
//Results:
//
```

A Annex

The following sections are provided for reference purposes and include detailed information such as formulae and abbreviations.

A.1 Predefined Standards and Settings

In the "Digital Standards" menu, predefined basic settings for standards can be selected and user-defined standards stored (see chapter 5.2, "Configuration According to Digital Standards", on page 121).

The most common measurements are predefined as standard settings for a large number of mobile radio networks. The instrument comes prepared with the following settings for those standards:

- Capture length and result length
- Signal description
- Modulation
- Transmit filter and measurement filter
- Burst/Pattern search configuration
- Result range alignment
- Evaluation range settings
- Display configuration

The standard settings are grouped in folders to facilitate selecting a standard.

Table 1-1: List of predefined standards and settings

Folder	Standard (SCPI *)	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
GSM	GSM_NormalBurst (GSM)	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_TSC0 (...) GSM_TSC7	148	Pattern to Center	0.5 - 147.25
	GSM_SynchronizationBurst (GSM_SB)	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_SB0 (...) GSM_SB2	148	Pattern to Center	3 - 144
	GSM_FrequencyBurst (GSM_FB)	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_FB0 GSM_FB01	148	Pattern to Center	3 - 144
	GSM_AccessBurst (GSM_AB)	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_AB0 (...) GSM_AB2	88	Pattern to Center	8 - 85
	EDGE_8PSK (EDGE_NB, EDGE_Normalburst)	3π/8-8PSK EDGE	270.833 kHz	Linearized GMSK EDGE_NSR	-	✓	✓	EDGE_TSC0 (...) EDGE_TS7	148	Pattern to Center	3-144.75
	EDGE_16QAM	π/4-16QAM EDGE	270.833 kHz	Linearized GMSK EDGE_NSR	-	✓	✓	16QAM_EDGE_TSC0 (...) 16QAM_EDGE_TS7	148	Pattern to Center	3-144.75
***)** The SCPI parameter for remote commands is provided where it differs from the standard name or a short form is available.											

Folder	Standard (SCPI *)	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
	EDGE_32QAM	π/4-32QAM EDGE	270.833 kHz	Linearized GMSK EDGE_NSR	-	✓	✓	32QAM_EDGE_TSC0 (...) 32QAM_EDGE_TS7	148	Pattern to Center	3-144.75
	EDGE_QPSK_HSR_NarrowPulse	3π/4-QPSK EDGE	325 kHz	EDGE Narrow Pulse Shape EDGE HSR (Narrow Pulse)	-	✓	✓	EDGE_HSR_QPSK_TSC0 (...) EDGE_HSR_QPSK_TSC1..7	177	Pattern to Center	4- 172.75
	EDGE_QPSK_HSR_WidePulse	3π/4-QPSK EDGE	325 kHz	EDGE Wide Pulse Shape EDGE HSR (Wide Pulse)	-	✓	✓	EDGE_HSR_QPSK_TSC0 (...) EDGE_HSR_QPSK_TSC1..7	177	Pattern to Center	4- 172.75
	EDGE_16QAM_HSR_Narrow-Pulse	π/4-16QAM EDGE	325 kHz	EDGE Narrow Pulse Shape EDGE HSR (Narrow Pulse)	-	✓	✓	EDGE_HSR_16QAM_TSC0 (...) EDGE_HSR_16QAM_TSC1..7	177	Pattern to Center	4- 172.75
	EDGE_16QAM_HSR_WidePulse	π/4-16QAM EDGE	325 kHz	EDGE Wide Pulse Shape EDGE HSR (Wide Pulse)	-	✓	✓	EDGE_HSR_16QAM_TSC0 (...) EDGE_HSR_16QAM_TSC1..7	177	Pattern to Center	4- 172.75

*) The SCPI parameter for remote commands is provided where it differs from the standard name or a short form is available.

Folder	Standard (SCPI *)	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
	EDGE_32QAM_HSR_Narrow-Pulse	-π/4-32QAM EDGE	325 kHz	EDGE Narrow Pulse Shape EDGE HSR (Narrow Pulse)	-	✓	✓	EDGE_HSR_32QAM_TSC0 (...) EDGE_HSR_32QAM_TSC1..7	177	Pattern to Center	4- 172.75
	EDGE_32QAM_HSR_WidePulse	-π/4-32QAM EDGE	325 kHz	EDGE Wide Pulse Shape EDGE HSR (Wide Pulse)	-	✓	✓	EDGE_HSR_32QAM_TSC0 (...) EDGE_HSR_32QAM_TSC1..7	177	Pattern to Center	4- 172.75
TETRA	TETRA_Discontinuous-Downlink (TETRA_NDDOWN)	π/4-DQPSK TETRA	18 kHz	RRC RRC	0.35	✓	-	TETRA_S1 ... TETRA_S3	246	Burst to Center	0 - 244
	TETRA_Continuous-Downlink (TETRA_NCDOWN)	π/4-DQPSK TETRA	18 kHz	RRC RRC	0.35	✓	-	TETRA_E TETRA_S	255	Burst to Center	0 - 244
3GPP	3G_WCDMA (3G_WCDMA_FWD, 3G_WCDMA_REV)	QPSK WCDMA	3.84 MHz	RRC RRC	0.22	-	-	-	800	Capture/ Left	-

***)** The SCPI parameter for remote commands is provided where it differs from the standard name or a short form is available.

Folder	Standard (SCPI *)	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
CDMA	CDMA2000_1X_FWD (F1CD, CDMA2K_1X_FWD)	QPSK CDMA2K_FWD	1.2288 MHz	CDMA 2000 1X FWD Low ISI Meas Filter	-	-	-	-	800	Capture/ Left	-
	CDMA2000_1X_REV (R1CD)	Offset QPSK Gray	1.2288 MHz	CDMA 2000 1X Reverse Low ISI Meas Filter	-	-	-	-	800	Capture / Left	-
APCO25	APCO25_CQPSK	π/4 DQPSK APCO25	4.8 kHz	RC NONE	0.2 -	-	-	-	200	Capture/ Left	-
	APCO25_C4FM	4FSK APCO25	4.8 kHz	APCO25 C4FM Rectangular	-	-	-	-	200	Capture Left	-
Bluetooth	Blue-tooth_DH1	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	366	Burst to Center	2 - 363.75
	Blue-tooth_DH3	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	1622	Burst to Center	2 - 1619.75
	Blue-tooth_DH5	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	2870	Burst to Center	2 - 2867.75
DECT	DECT_P32_FixedPart (DECT_FP)	2FSK Natural	1.152 MHz	GMSK None	0.5	✓	✓	DECT_PP DECT_PP_Prolonged	424	Capture Left	0 - 799.75
	DECT_P32_Portable-Part	2FSK Natural	1.152 MHz	GMSK None	0.5	✓	✓	DECT_FP DECT_FP_Prolonged	424	Capture Left	-

*) The SCPI parameter for remote commands is provided where it differs from the standard name or a short form is available.

Folder	Standard (SCPI *)	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
DVB-S2	DVB_S2_8PSK	8PSK DVB_S2_8PSK	20 MHz	RRC RRC	0.35	-	-	-	90	Capture Left	-
	DVB_S2_16APSK	UserQAM 16ary DVB_S2_16APSK_34	20 MHz	RRC RRC	0.35	-	-	-	180	Capture Left	-
	DVB_S2_32APSK	UserQAM 32ary DVB_S2_32APSK_34	20 MHz	RRC RRC	0.35	-	-	-	270	Capture Left	-
	DVB_S2_QPSK	QPSK DVB_S2_QPSK	20 MHz	RRC RRC	0.35	-	-	-	90	Capture Left	-
ZIGBEE	ZIGBEE_BPSK_868M_300K	BPSK Natural	300 kHz	RC None	1.0	✓	-	-	1000	Busrt to Center	-
	ZIGBEE_BPSK_915M_600K	BPSK Natural	600 kHz	RC None	1.0	✓	-	-	1000	Burst to Center	-
	ZIGBEE_OQPSK_2450M_1M	Offset-QPSK Gray	1 MHz	Half Sine -	-	✓	-	-	1000	Burst to Center	-

*) The SCPI parameter for remote commands is provided where it differs from the standard name or a short form is available.

A.2 Predefined Measurement and Tx Filters

The most frequently required measurement and TX filters required for vector signal analysis according to digital standards are provided by the R&S FSW VSA application.

For general information on the use of these filters see chapter 4.1, "Filters and Bandwidths During Signal Processing", on page 50.

A.2.1 Transmit Filters

The transmit filters required for common standards are predefined in the VSA application.

Table 1-2: Overview of predefined Transmit filters

RC	Raised cosine
RRC	Root raised cosine
Gauss	Gauss filter
GMSK	Gauss filter convolved with a rectangular filter; typically used for MSK
Linearized GMSK	Standard-specific filter for GSM EDGE (3GPP TS 45.004), normal symbol rate
EDGE Narrow Pulse Shape	Standard-specific filter for GSM EDGE (higher symbol rate)
EDGE Wide Pulse Shape	Standard-specific filter for GSM EDGE (higher symbol rate)
Half Sine	Half Sine filter
APCO25 C4FM	Filter for the APCO25 C4FM standard.
APCO25 H-CPM	Filter for the APCO25 Phase 2 standard.
APCO25 DQPSK	Filter for the APCO25 Phase 2 standard.
APCO25 DQPSK Narrow	Filter for the APCO25 Phase 2 standard.
APCO25 DQPSK Wide	Filter for the APCO25 Phase 2 standard.
CDMA2000 1X Forward	Filter for CDMA ONE forward link (TIA/EIA/IS-95-A May 1995) and CDMA2000 1X forward link (http://www.3gpp2.org/Public_html/specs/C.S0002-C_v1.0.pdf 28/05/2002)
CDMA2000 1X Reverse	Filter for CDMA ONE forward link (TIA/EIA/IS-95-A May 1995) and CDMA2000 1X reverse link (http://www.3gpp2.org/Public_html/specs/C.S0002-C_v1.0.pdf 28/05/2002)
Rectangular	Rectangular filter in the time domain with a length of 1 symbol period
None	No filter is used.
USER	User-defined filter. Define the filter using the `[SENSe:]DDEMod:TFILter:USER` command.

A.2.2 Measurement Filters

The most frequently required measurement filters are predefined in the VSA application.

Table 1-3: Overview of predefined measurement filters

EDGE NSR	Measurement filter required for the "EDGE, Normal Symbol Rate" standard. (see 3GPP TS 45.005, chapter 4.6 Modulation Accuracy). The resulting system is NOT inter-symbol interference free.
EDGE HSR (Narrow Pulse)	Measurement filter required for the "EDGE, High Symbol Rate, Narrow Pulse" standard.
EDGE HSR (Wide Pulse)	Measurement filter required for the "EDGE, High Symbol Rate, Wide Pulse" standard.
Gauss	Classic Gauss filter with an adjustable BT
Low ISI Meas Filter	Measurement filter implemented to retain a low intersymbol interference. Best suited for eye diagrams or I/Q vector diagrams. Not necessarily suited for EVM evaluation due to amplification in the pass band.
Low Pass (Narrow)	Pass band up to $F_{symbol}/2$ Stop band starts at F_{symbol} (-40dB)
Low Pass (Wide)	Pass band up to F_{symbol} Stop band starts at $1.5*F_{symbol}$ (-40dB)
Rectangular	Rectangular filter in the time domain with a length of 1 symbol period; integrate and dump effect
RRC	Root Raised Cosine Filter. The roll-off parameter "Alpha" is set according to the Transmit filter if the "Auto (according to Transmit filter)" option is enabled (see "Using the Transmit Filter as a Measurement Filter (Auto)" on page 180). Otherwise it must be set manually. If the Transmit filter is also a Root Raised Cosine filter with the same roll-off parameter, the resulting system is inter-symbol interference free.
USER	User-defined filter. Define the filter using the Load User Filter function or the `[SENSe:]DDEMod:MFILter:USER` command. For details see chapter 7.2.1, "How to Select User-Defined Filters", on page 204.
NONE	No measurement filter is used.

The frequency response of the available standard-specific measurement filters is shown in chapter A.5.6.2, "Measurement Filter", on page 418.

A.2.3 Typical Combinations of Tx and Measurement Filters

Typical combinations of Tx and Meas filters are shown in table 1-4; they can be set in the VSA application using "Meas filter = AUTO" (see "Using the Transmit Filter as a Measurement Filter (Auto)" on page 180).

Table 1-4: Typical combinations of Tx and Meas filters

Transmit filter	Measurement filter (analyzer)	Remarks
RC (raised cosine)	-	filter combination without intersymbol interference (ISI)
RRC (root raised cosine)	RRC	filter combination without ISI
GMSK	-	filter combination with low ISI
Linearized GMSK	EDGE NSR	standard specific filter; filter combination with ISI
Gauss	-	filter combination with low ISI
Rectangular	-	filter combination without ISI
Half Sine	-	filter combination without ISI
CDMA2000 1X FORWARD	Low ISI Meas Filter	filter combination without ISI
CDMA2000 1X REVERSE	Low ISI Meas Filter	filter combination without ISI
APCO25 C4FM	Rectangular	filter combination without ISI
APCO25 H-CPM	Rectangular	filter combination without ISI
APCO25 H-DQPSK	Low ISI Meas Filter	filter combination without ISI
APCO25 H-D8PSK Narrow	Low ISI Meas Filter	filter combination without ISI
APCO25 H-D8PSK Wide	Low ISI Meas Filter	filter combination without ISI
EDGE Narrow Pulse Shape	EDGE HSR (Narrow Pulse)	standard specific filter; filter combination with ISI
EDGE Wide Pulse Shape	EDGE HSR (Wide Pulse)	standard specific filter; filter combination with ISI
User	Low ISI Meas Filter	filter combination with low ISI

A.3 ASCII File Export Format for VSA Data

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace), followed by the measured data in one or several columns (depending on the result type) which are also separated by a semicolon.

If several traces in several windows are exported to one file, the data for each window is listed subsequently. Within the data for a single window, the data for the individual traces is listed subsequently.

For details on which data is stored for which result display, see `TRACe<n>[:DATA]` on page 363.

Table 1-5: ASCII file format for VSA trace data export

File contents	Description
Header	
Type;FSW;	Instrument model

File contents	Description
Version;1.40;	Firmware version
Date;01.Apr 2012;	Date of data set storage
Header section for individual window	
Screen;1;	Window name
Points per Symbol;4;	Points per symbol
x Axis Start;-13;sym;	Start value of the x axis
x Axis Stop;135;sym;	Stop value of the x axis
y per div;0.22000000000000003;	Y axis range per division
Ref value y axis;-10.00;dBm;	Y axis reference value
Ref value position;100;%;	Y axis reference position
Header section for individual trace	
Trace; 1;	First trace
Meas Result;IQ;	Result type
Meas Signal;Meas;	Data source (measurement or reference data)
Demodulator;Offset QPSK;	Demodulation type
ResultMode;Trace;	Result mode
x unit;sym;	Unit of the x axis
y unit;dBm;	Unit of the y axis
Trace Mode;Clear Write;	Trace mode
Values;800;	Number of measurement points
Data section for individual trace	
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> is only available with detector AUTOPEAK and contains the smallest of the two measured values for a measurement point
Header section for individual trace	
Trace; 2;	Next trace in same window
Meas Result;IQ;	Result type
Meas Signal;Meas;	Data source (measurement or reference data)
Demodulator;Offset QPSK;	Demodulation type
ResultMode;Trace;	Result mode
x unit;sym;	Unit of the x axis
y unit;dBm;	Unit of the y axis
Trace Mode;Clear Write;	Trace mode

File contents	Description
Values;800;	Number of measurement points
Data section for individual trace	
...	
Header section for individual window	
Screen;2;	Name of next window
...	
Header section for individual trace	
Trace; 1;	First trace in second window
Data section for individual trace	
...	

A.4 Known Data File Syntax Description

When you load a Known Data file, the R&S FSW-K70 application checks whether the file complies with the following syntax:

Table 1-6: Known Data File Syntax

Syntax	Possible Values	Description
<RS_VSA_KNOWN_DATA_FILE Version="01.00">	as specified	File Header
<Comment></Comment>	arbitrary	Optional file description
<Base></Base>	2 | 16	The base used to specify the <Data> values (binary or hexadecimal) For <ModulationOrder> values ≥32, use binary (2).
<ModulationOrder></ModulationOrder>	2 | 4 | 8 | 16 | 32 | 64 | 128 | 256	Number of values each symbol can represent (order of modulation), e.g. 8 for 8-PSK For <ModulationOrder> values ≥32, use <Base> = 2.
<ResultLength></ResultLength>	1 ... up to 2000*)	Number of symbols in each <Data> element The number must be identical to the "Result Length" setting in the "Result Range" dialog box, i.e. the number of symbols to be demodulated.
*) the exact number also depends on available memory space		

Syntax	Possible Values	Description
<Data></Data>	One character per symbol in the sequence Possible characters are: 0 to n-1, where n is the <ModulationOrder> Spaces, tabs and line breaks are ignored	One possible sequence of symbols that can be demodulated from the input signal Up to 6000*) different sequences, i.e. <Data>-elements, can be defined in total
</RS_VSA_KNOWN_DATA_FILE>	as specified	File End
*) the exact number also depends on available memory space		

Sample xml file for known data

```
<RS_VSA_KNOWN_DATA_FILE Version="01.00">

<Comment>  Standard EDGE_8PSK  </Comment>
<Base>             16          </Base>
<ModulationOrder>   8          </ModulationOrder>
<ResultLength>    148          </ResultLength>

<Data>    777 511 727 242 206 341 366 632 073 607
          770 173 705 631 011 235 507 476 330 522
          177 177 171 117 777 177 717 717 111 615
          527 046 104 004 106 047 125 415 723 344
          241 264 773 111 337 446 514 600 677 7       </Data>

<Data>     77 511 727 242 206 341 366 632 073 607
          770 173 705 631 011 235 507 476 330 522
          177 177 171 117 777 177 717 717 111 615
          527 046 104 004 106 047 125 415 723 344
          241 264 773 111 337 446 514 600 677 7    7  </Data>

<Data>      7 511 727 242 206 341 366 632 073 607
          770 173 705 631 011 235 507 476 330 522
          177 177 171 117 777 177 717 717 111 615
          527 046 104 004 106 047 125 415 723 344
          241 264 773 111 337 446 514 600 677 7    77 </Data>

<Data>  7 777 511 727 242 206 341 366 632 073 607
            770 173 705 631 011 235 507 476 330 522
            177 177 171 117 777 177 717 717 111 615
            527 046 104 004 106 047 125 415 723 344
            241 264 773 111 337 446 514 600 677        </Data>

<Data> 77 777 511 727 242 206 341 366 632 073 607
          770 173 705 631 011 235 507 476 330 522
          177 177 171 117 777 177 717 717 111 615
          527 046 104 004 106 047 125 415 723 344
```

```
          241 264 773 111 337 446 514 600 67        </Data>
</RS_VSA_KNOWN_DATA_FILE>
```

A.5 Formulae

A.5.1 Trace-based Evaluations

The trace-based evaluations all take place at the sample rate defined by the "Display Points Per Symbol" parameter (see "Display Points/Sym" on page 198). The sampling instants at this rate are referred to as "t" here, i.e.

$t=n*T_D$

where T_D equals the duration of one sampling period at the sample rate defined by the "Display Points Per Symbol" parameter.

Test parameter	Formula
Error vector	$EV(t) = MEAS(t) - REF(t)$
Error Vector Magnitude (EVM)	$EVM(t) = \frac{\lvert EV(t) \rvert}{C}$ with the normalization contant C depends on your setting. By default C² is the mean power of the reference signal. $C = \sqrt{\frac{1}{K}\sum_k \lvert REF(k \cdot T) \rvert^2}$ $T = \text{duration of symbol periods}$
Magnitude	$Mag_{MEAS}(t) = \lvert MEAS(t) \rvert$ $Mag_{REF}(t) = \lvert REF(t) \rvert$
Phase	$Phase_{MEAS}(t) = \angle(MEAS(t))$ $Phase_{REF}(t) = \angle(REF(t))$

Test parameter	Formula
Frequency	$FREQ_{MEAS}(t) = \frac{1}{2 \cdot \pi} \frac{d}{dt} \angle MEAS(t)$ $FREQ_{REF}(t) = \frac{1}{2 \cdot \pi} \frac{d}{dt} \angle REF(t)$
Magnitude error	$MAG\_ERR(t) = MAG_{MEAS}(t) - MAG_{REF}(t)$
Phase error	$PHASE\_ERR(t) = PHASE_{MEAS}(t) - PHASE_{REF}(t)$
Frequency error	$FREQ\_ERR(t) = FREQ_{MEAS}(t) - FREQ_{REF}(t)$

FSK Modulation

The trace based results for FSK signals are the same as those available for linear modulation types. However, as the signal processing for FSK signals is performed on the magnitude and instantaneous frequency, the I/Q based results first require a reconstruction of the reference and measured I/Q waveforms, as illustrated in Reconstruction of the reference and measured I/Q waveforms for FSK modulation.

The dashed outline of the "compensate" blocks indicate that these operations are optionally (de-)activated depending on the corresponding user settings. With respect to FSK measurements, the optional compensation parameters are:

- FSK Reference deviation
- Carrier frequency drift

Figure 3

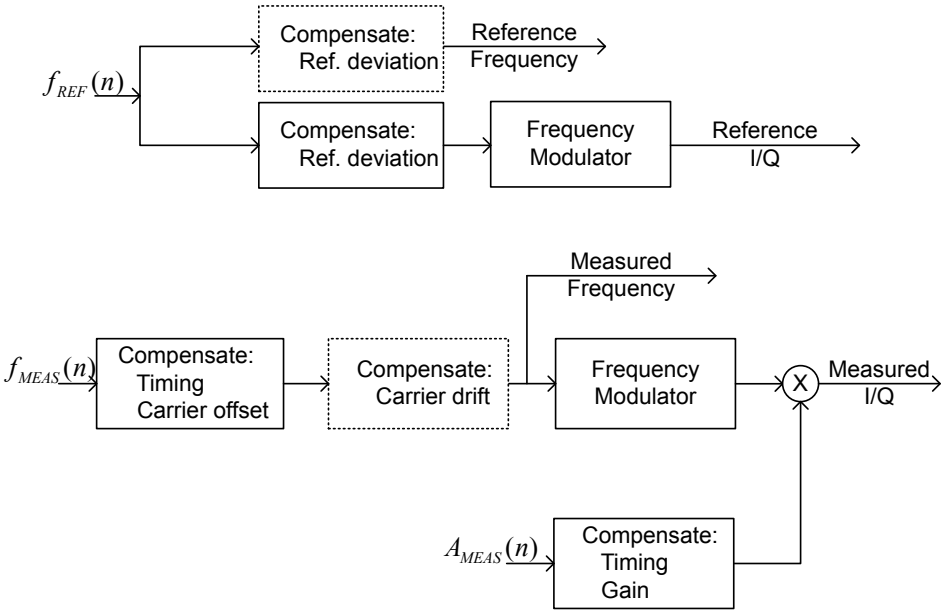


Fig. 1-1: Reconstruction of the reference and measured I/Q waveforms for FSK modulation

Note that a reference deviation error is corrected in the reference frequency trace. This ensures that the frequency deviation in the measured frequency trace corresponds to that of the originally measured signal. With respect to the I/Q reconstruction, the measured magnitude is timing compensated using the timing offset estimated from the measured instantaneous frequency. This ensures that the measured magnitude and frequency remain synchronized in the reconstructed I/Q waveform.

A.5.2 Result Summary Evaluations

The evaluations for the result summary take place at the sample rate defined by the "Display Points Per Symbol" parameter (see "Display Points/Sym" on page 198). This value can be one of the following:

- "1": only the symbol instant contributes to the result
- "2": two samples per symbol instant contribute to the result (required for offset QPSK)
- the "Sample rate" defined for data acquisition (see "Sample Rate" on page 153): all samples contribute to the result equally

The results are determined by the evaluation range.

The sampling instants at this rate are referred to as "t" here, i.e.

$t=n*T_D$

where T_D equals the duration of one sampling period at the sample rate defined by the "Display Points Per Symbol" parameter

A.5.2.1 PSK, QAM and MSK Modulation

For PSK, QAM and MSK modulation the estimation model is described in detail in chapter chapter 4.5.1, "PSK, QAM and MSK Modulation", on page 96. The parameters of the PSK, QAM and MSK-specific result summary table can be related to the distortion model parameters as follows:

Table 1-7: Evaluation of results in the PSK, QAM and MSK result summary

EVM	RMS	$\sqrt{\frac{1}{N}\sum_{n} EVM(n \cdot T_D)^2}$
	Peak	$\max(EVM(n \cdot T_D))$
Modulation error	RMS	$-20 \cdot \log_{10}\left(\frac{\sqrt{\frac{1}{N}\sum_{n} \lvert EV(n \cdot T_D)\rvert^2}}{\sqrt{\frac{1}{K}\sum_{k} \lvert REF(k \cdot T)\rvert^2}}\right)$
	Peak	$\min(MER(n \cdot T_D))$ $with\ MER(n \cdot T_D) = -20 \cdot \log_{10}\left(\frac{\sqrt{\frac{1}{N}\sum_{n} \lvert EV(n \cdot T_D)\rvert^2}}{\sqrt{\frac{1}{K}\sum_{k} \lvert REF(k \cdot T)\rvert^2}}\right)$
Magnitude error	RMS	$\sqrt{\frac{1}{N}\sum_{n} \lvert MAG\_ERR(n \cdot T_D)\rvert^2}$
	Peak	$\max(\lvert MAG\_ERR(n \cdot T_D)\rvert)$
Phase error	RMS	$\sqrt{\frac{1}{N}\sum_{n} \lvert PHASE\_ERR(n \cdot T_D)\rvert^2}$
	Peak	$\max(\lvert PHASE\_ERR(n \cdot T_D)\rvert)$
RHO (correlation coefficient)		$\rho = \frac{\left\lvert\sum_{n} REF^*(n) \cdot MEAS(n)\right\rvert^2}{\sum_{n} \lvert REF(n)\rvert^2 \cdot \sum_{n} \lvert MEAS(n)\rvert^2} = \frac{\lvert KKF(MEAS, REF)\rvert^2}{AKF(REF) \cdot AKF(MEAS)}$

IQ Offset C		$C_{[lin]} = \frac{\left(\frac{c_I}{g_I}\right)^2 + \left(\frac{c_Q}{g_Q}\right)^2}{\frac{1}{K}\sum_k \left|REF(k \cdot T)\right|^2}$ $C = 10 \cdot \log_{10}\left(C_{[lin]}\right)[\mathrm{dB}]$
IQ Imbalance B		$B_{[lin]} = \frac{\left|g_I - g_Q \cdot e^{j\theta}\right|}{\left|g_I + g_Q \cdot e^{j\theta}\right|}$ $B = 20 \cdot \log_{10}\left(B_{[lin]}\right)[\mathrm{dB}]$
Gain Imbalance G		$G_{[lin]} = \frac{g_Q}{g_i}$ $G = 20 \cdot \log_{10}\left(G_{[lin]}\right)[\mathrm{dB}]$
Quadrature Error Θ		$\theta_{[lin]} = \vartheta / \pi \cdot 180°$ $\theta = \theta_{[lin]}[\mathrm{deg}]$
Amplitude Droop A		$A_{[lin]} = e^{-\alpha \cdot T}$ $A = 20 \cdot \log_{10}\left(A_{[lin]}\right)[dB/Sym]$

A.5.2.2 FSK Modulation

For FSK modulation the estimation model is described in detail in section chapter 4.5.2, "FSK Modulation", on page 106. The parameters of the FSK-specific result summary table can be related to the distortion model parameters as follows:

Table 1-8: Evaluation of results in the FSK result summary

Frequency Error	RMS	$\sqrt{\frac{1}{N}\sum_n \left|FREQ\_ERR(n \cdot T_D)\right|^2}$
	Peak	$\max\left(\left|FREQ\_ERR(n \cdot T_D)\right|\right)$
Magnitude Error	RMS	$\sqrt{\frac{1}{N}\sum_n \left|MAG\_ERR(n \cdot T_D)\right|^2}$
	Peak	$\max\left(\left|MAG\_ERR(n \cdot T_D)\right|\right)$

FSK Deviation Error Λ_{ERR}		$\Lambda_{ERR} = \Lambda_{MEAS} - \Lambda_{REF} = (B-1) \cdot \Lambda_{REF}$ Estimated FSK deviation error [Hz].
FSK Measurement Deviation Λ_{MEAS}		$\Lambda_{MEAS} = B \cdot \Lambda_{REF}$ Estimated FSK deviation of the meas signal [Hz].
FSK Reference Deviation Λ_{REF}		FSK reference deviation as entered by the user [Hz].
Carrier Frequency Error f_0		$f_0 = \frac{C}{2 \cdot \pi}$ The carrier frequency error of the measured signal [Hz].
Carrier Frequency Drift f_d		$f_d = \frac{D}{2 \cdot \pi \cdot T}$ The drift in the carrier frequency of the measured signal [Hz/Sym].

A.5.3 Statistical Evaluations for the Result Summary

The statistical evaluations in the result summary are based on the measurement results that are displayed in the "Current" column. Hence, the index "m" here represents the current evaluation, "M" is the total number of evaluations. In single sweep mode, M corresponds to the statistics count.

If the measurement values are represented in the logarithmic domain, the linear values are averaged. The result is then subsequently converted back into logarithmic domain. The linear values are indicated by the subscript [lin] in chapter A.5.2.1, "PSK, QAM and MSK Modulation", on page 413.

	Mathematical expression	**Calculation in R&S FSW**
Mean $\hat{x}_M$	$\bar{x}_M = \frac{1}{M} \sum_m x_m$	$\bar{x}_M = \frac{(M-1) \cdot \bar{x}_{M-1} + x_M}{M}$ with $\bar{x}_0 = 0$
Peak $\hat{x}_M$	$\hat{x}_M = x_{idx}$ with $idx = \arg\max_m \lvert x_m \rvert$	$\hat{x}_M = x_M \text{ if } \lvert x_M \rvert > \lvert \hat{x}_{M-1} \rvert$ $\hat{x}_M = x_{M-1} \text{ if } \lvert x_M \rvert \leq \lvert \hat{x}_{M-1} \rvert$ with $\bar{x}_0 = 0$

	Mathematical expression	Calculation in R&S FSW
StdDev σ_M	$\sigma_M = \sqrt{\frac{1}{M}\sum_m (x_m - \bar{x}_m)^2}$ with $\bar{x}_M = \frac{1}{M}\sum_m x_m$	$\sigma_M = \sqrt{\frac{(M-1)\cdot\sigma_{M-1}^2 + (x_M - \bar{x}_M)^2}{M}}$ with $\sigma_0 = 0$
95%ile $x_{95,M}$	$x_{95,M} = \{x \mid \Pr(x_m \le x) = 0.95\}$ Pr() denotes the probability	Sorting the values and giving the 95%ile.

A.5.4 Trace Averaging

The index "m" represents the current evaluation, "M" is the total number of evaluations. In single sweep mode, M coresponds to the statistics count. The index "s" represents the s^{th} sample within the trace.

If the measurement results are represented in logarithmic domain, the average operation is performed on the linear values. The result is then subsequently converted back into logarithmic domain.

	Measurements	Calculation in R&S FSW
RMS Average $\bar{x}_{s,M}$	• Error Vector Magnitude (EVM) • Meas/Ref magnitude • Capture Buffer magnitude	$\bar{x}_{s,M} = \sqrt{\frac{(M-1)\cdot\bar{x}_{s,M-1}^2 + x_{s,M}^2}{M}}$
Linear Average $\bar{x}_{s,M}$	All measurements where trace averaging is possible **except for** the measurements listed for RMS averaging	$\bar{x}_{s,M} = \frac{(M-1)\cdot\bar{x}_{s,M-1} + x_{s,M}}{M}$

A.5.5 Analytically Calculated Filters

The following filters are calculated during runtime of the unit and as a function of the operating parameter Alpha or BT.

Filter Type	Setting Parameter	Impulse Response
Raised cosine (RC)	Alpha (α)	$h(t)=\frac{\sin\left(\frac{\pi t}{T}\right)}{\left(\frac{\pi t}{T}\right)}\cdot\frac{\cos\left(\frac{\pi\alpha t}{T}\right)}{1-4\left(\frac{\alpha t}{T}\right)^2}$
Root raised cosine (RRC)	Alpha (α)	$h(t)=4\alpha\frac{\cos((1+\alpha)\pi t/T)+\frac{\sin((1-\alpha)\pi t/T)}{4\alpha t/T}}{\pi\sqrt{T}\left(1-(4\alpha t/T)^2\right)}$
Gaussian filter (Gauss) ETSI TS 100 959 (V8.3.0)	BT	$h(t)=\frac{\exp\left(\frac{-t^2}{2\rho^2T^2}\right)}{\sqrt{(2\pi)\cdot\rho T}}$ with $\rho=\frac{\sqrt{\ln 2}}{2\pi BT}$

A.5.6 Standard-Specific Filters

A.5.6.1 Transmit filter

EDGE Tx filter ETSI TS 300 959 (V8.1.2) (Linearized GMSK)

$$c_0(t)=\begin{cases}\prod_{i=0}^{3}S(t+iT) & \text{for} \quad 0\le t\le 5T\\ 0 & \text{else}\end{cases}$$

$$S(t)=\begin{cases}\sin\left(\pi\int_0^t g(t')dt'\right) & \text{for} \quad 0\le t\le 4T\\ \sin\left(\frac{\pi}{2}-\pi\int_0^{t-4T}g(t')dt'\right) & \text{for} \quad 4T<t\le 8T\\ 0 & \text{else}\end{cases}$$

$$g(t)=\frac{1}{2T}\left(Q\left(2\pi\cdot 0.3\frac{t-5T/2}{T\sqrt{\ln(2)}}\right)-Q\left(2\pi\cdot 0.3\frac{t-3T/2}{T\sqrt{\ln(2)}}\right)\right)$$

$$Q(t) = \frac{1}{\sqrt{2\pi}} \int_{t}^{\infty} e^{\frac{\tau^2}{2}} d\tau$$

$c_0(t)$ is the impulse response of the EDGE transmit filter

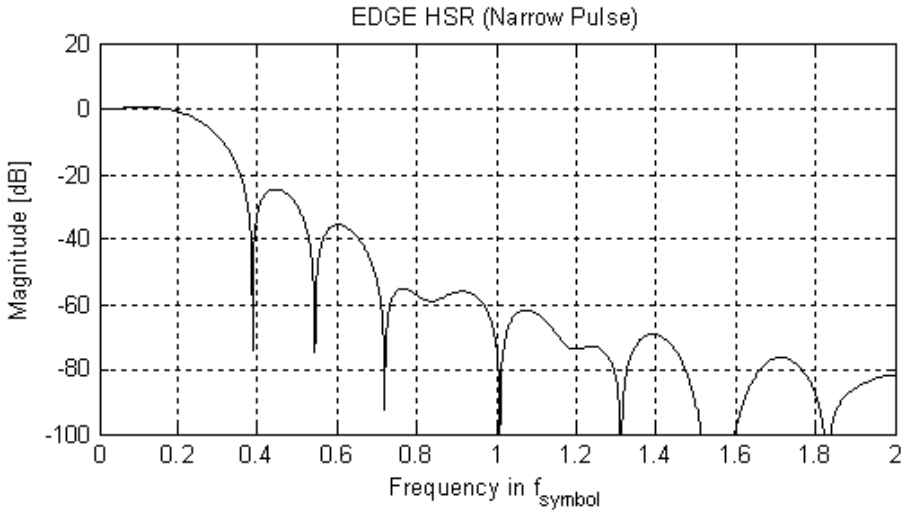
A.5.6.2 Measurement Filter

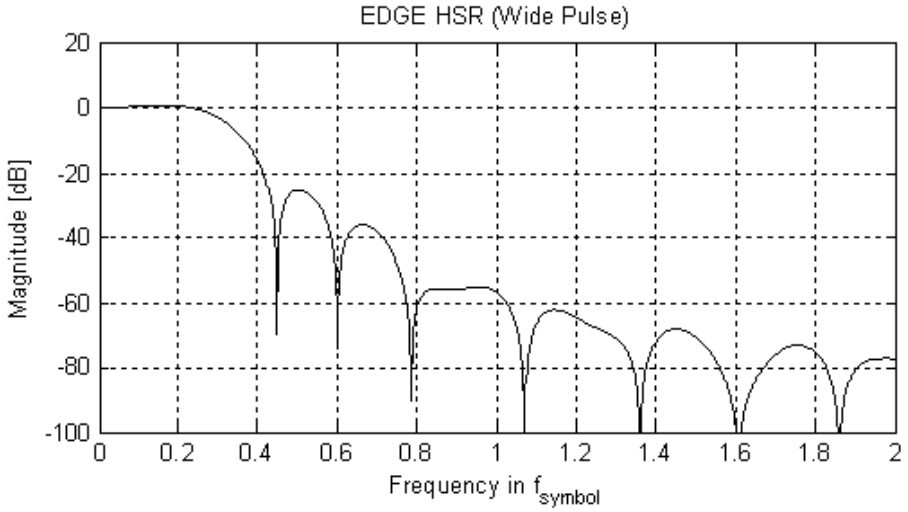
EDGE Measurement filters

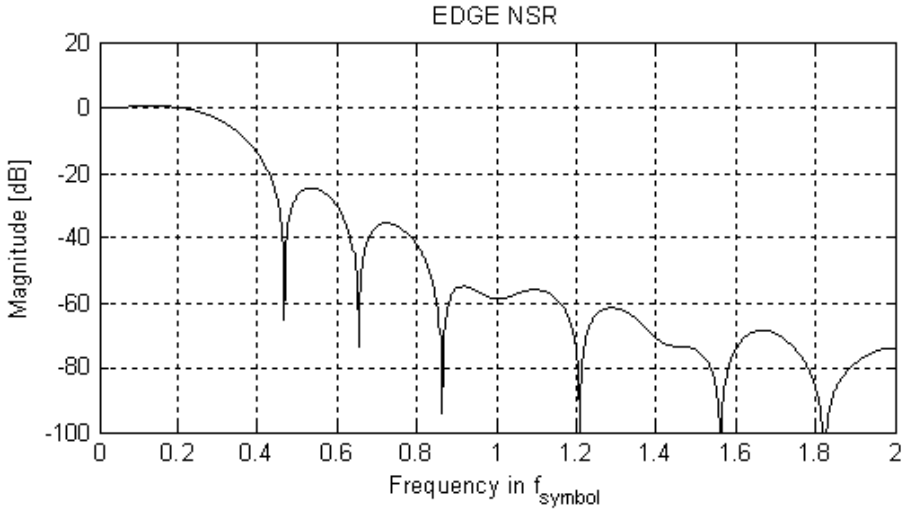
RC filter, Alpha = 0.25, single-side-band 6 dB bandwith = 90 kHz Windowing by multiplying the impulse response according to the following equation:

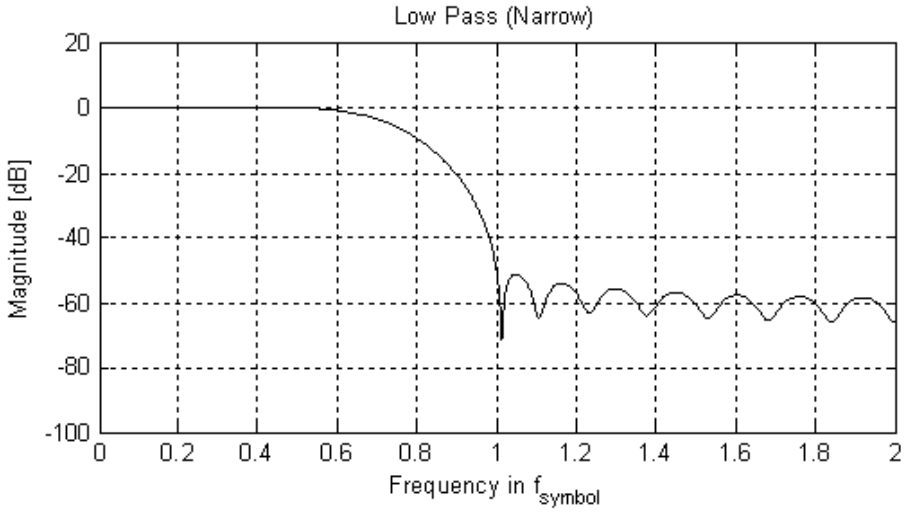
$$w(t) = \begin{cases} 1, & 0 \le |t| \le 1.5T \\ 0.5\left(1 + \cos\left[\pi\left(|t| - 1.5T\right)/2.25T\right]\right) & 1.5T < |t| < 3.75T \\ 0, & |t| \ge 3.75T \end{cases}$$

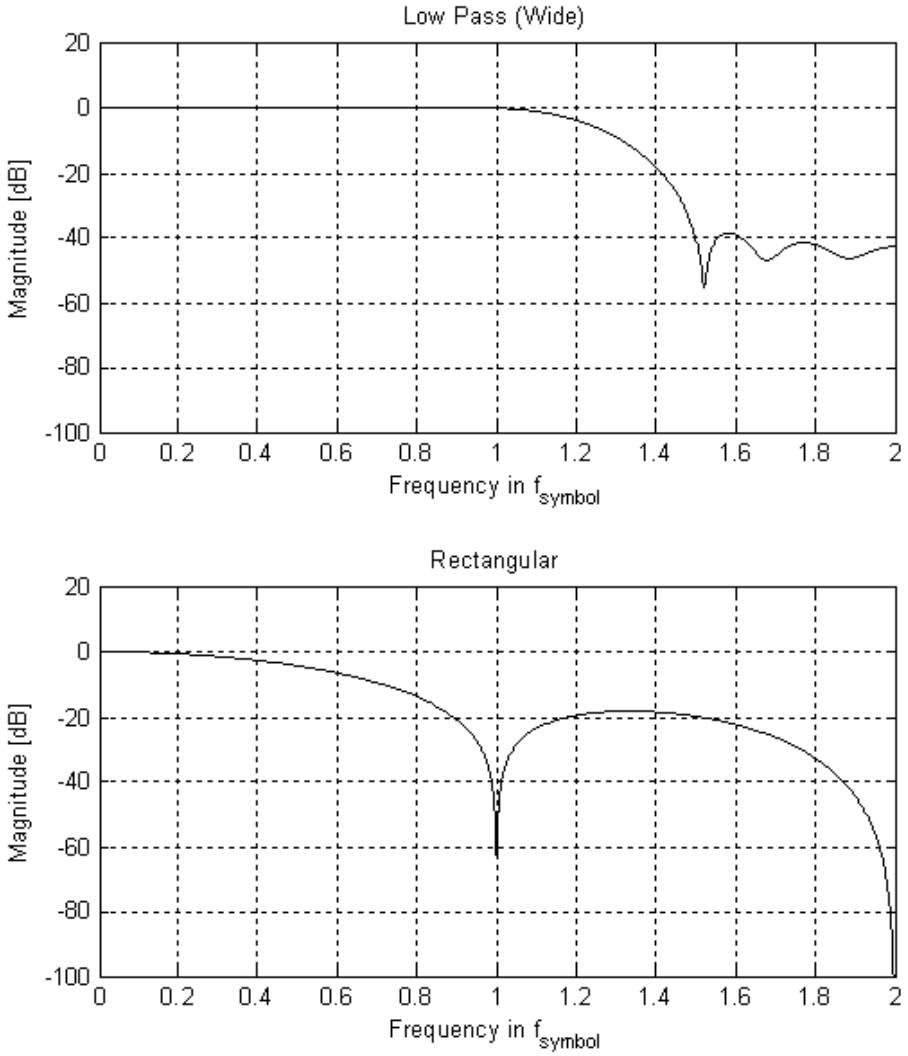
The following figure shows the frequency response of the standard-specific measurement filters.




EDGE HSR (Wide Pulse)
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

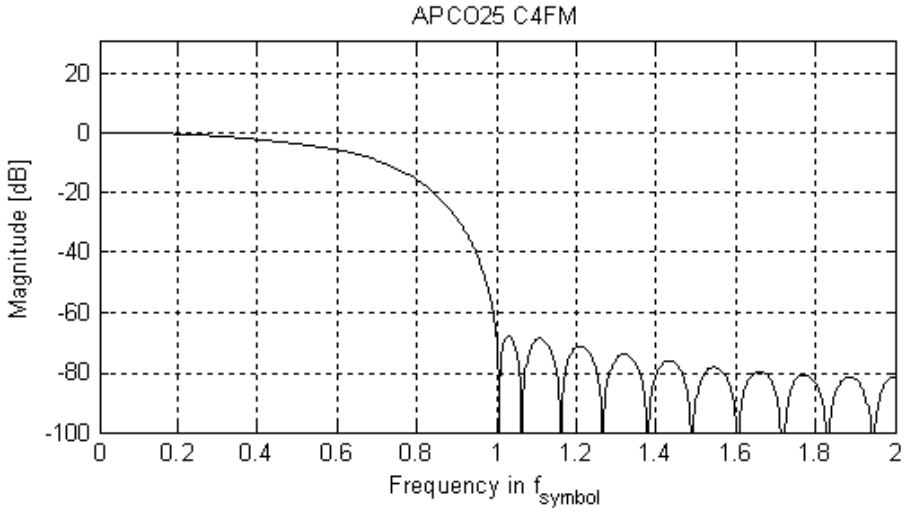

EDGE NSR
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

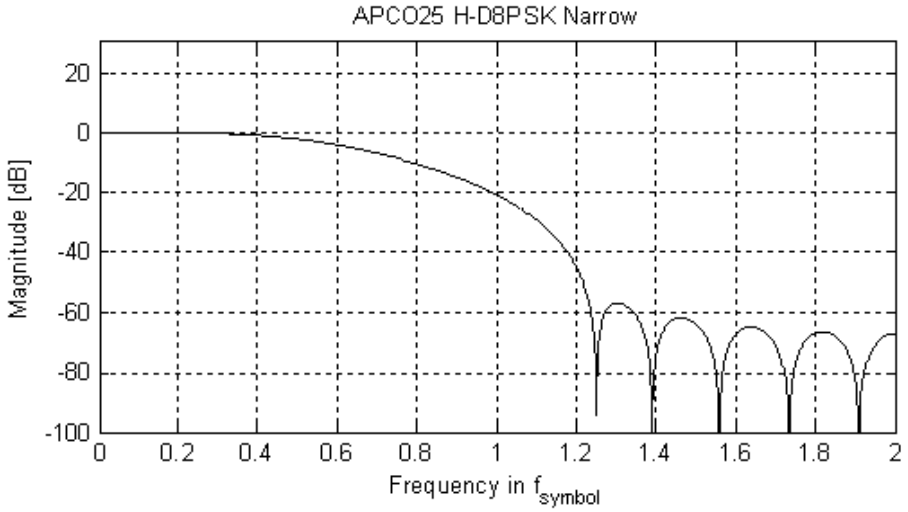

Low Pass (Narrow)
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

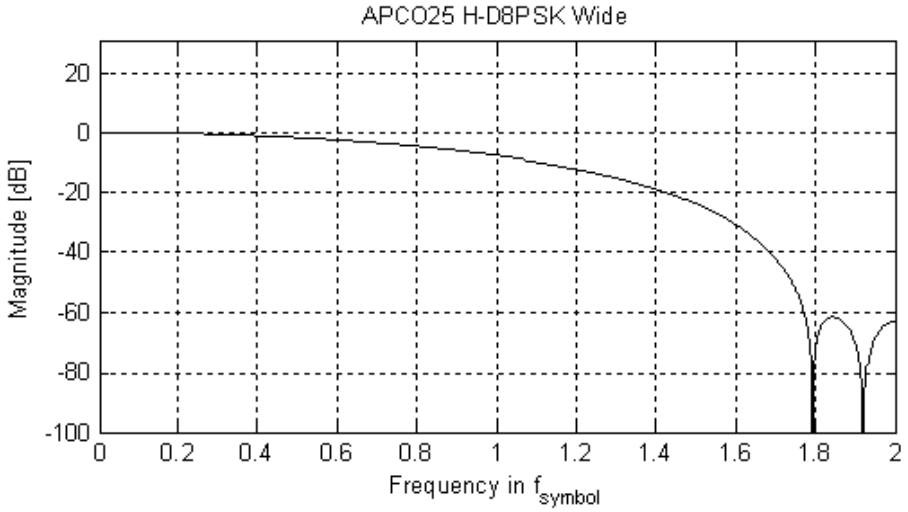


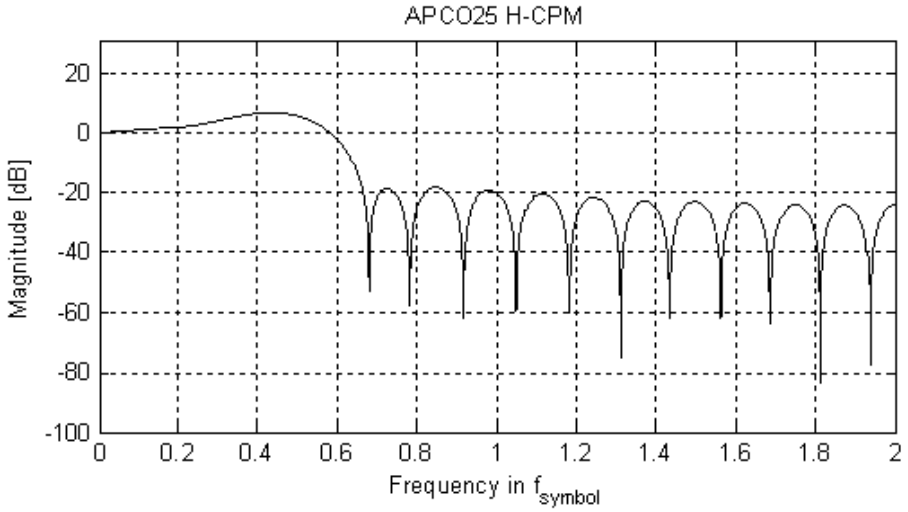
Low-ISI Filters

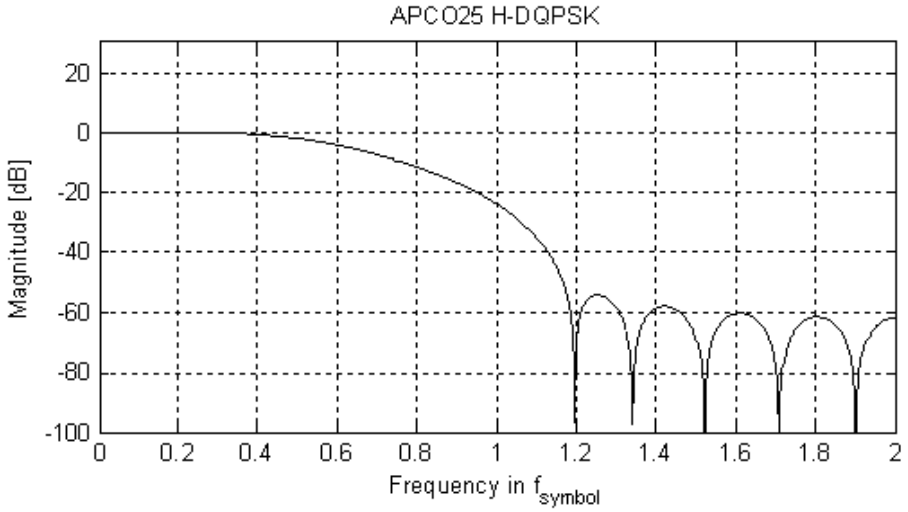
The following frequency responses are obtained when using a low-ISI measurment filter and the Transmit filter indicated in the title of each diagram.

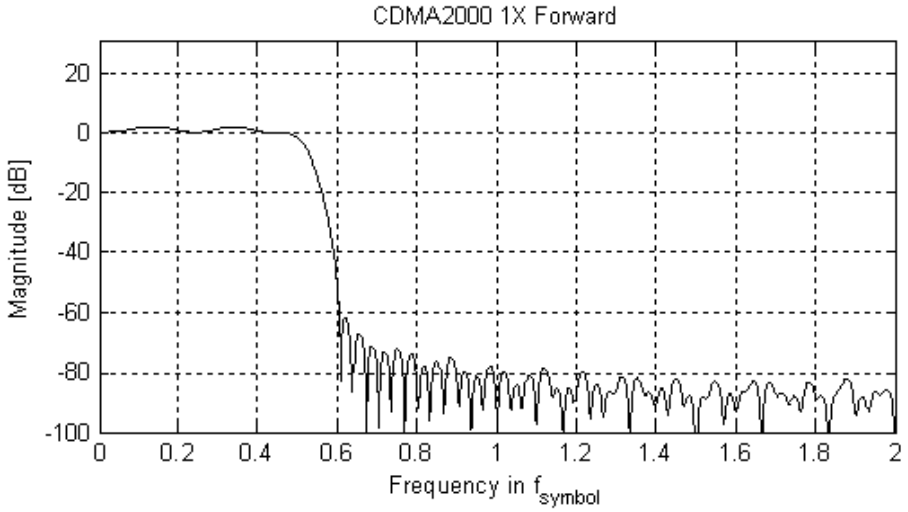

APCO25 C4FM
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

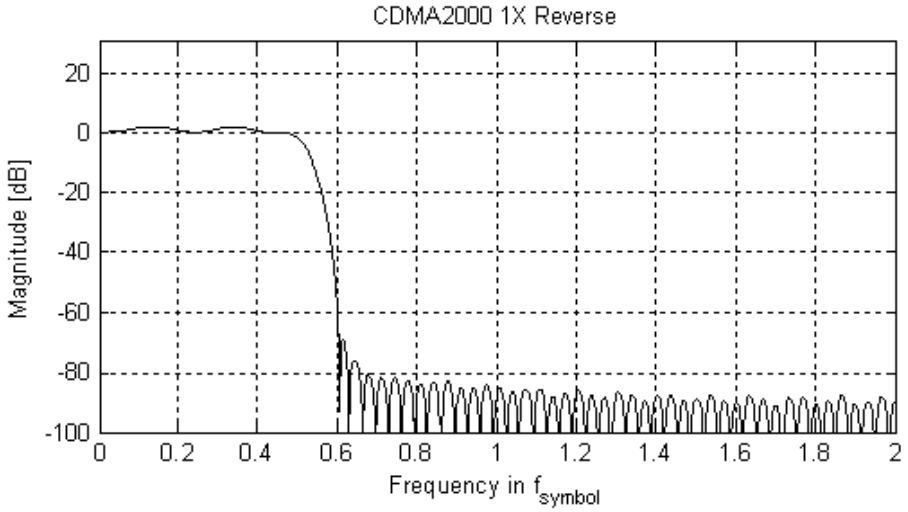

APCO25 H-D8PSK Narrow
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

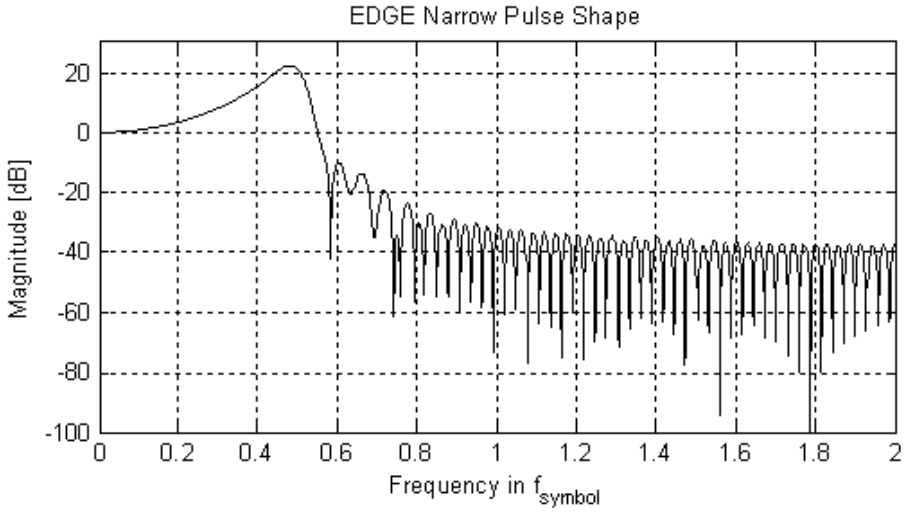

APCO25 H-D8PSK Wide
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

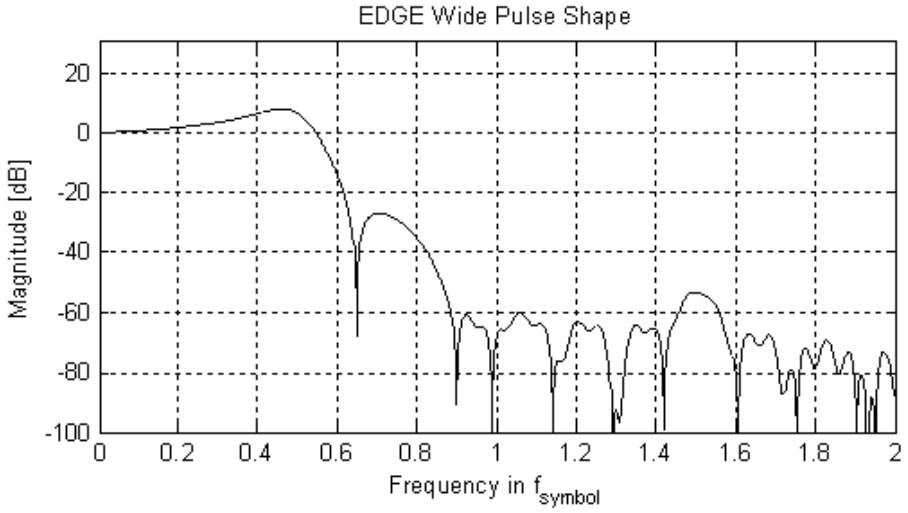

APCO25 H-CPM
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol

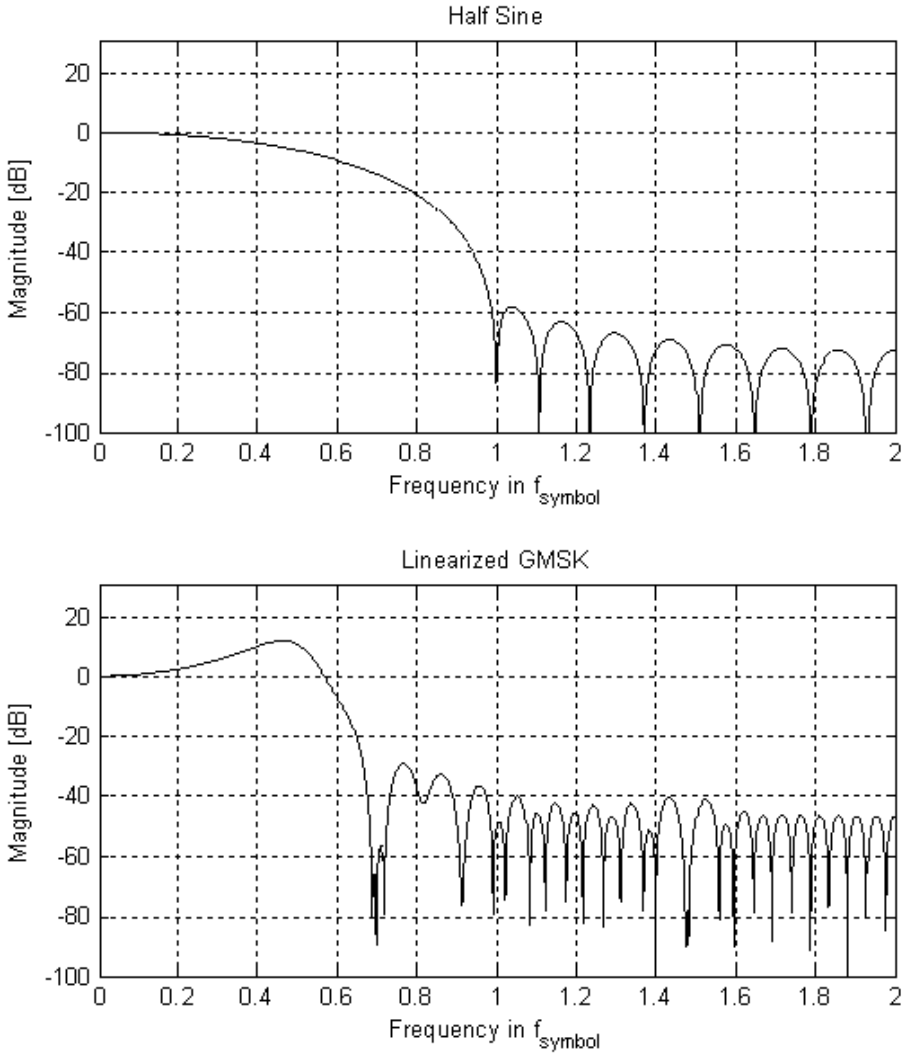

APCO25 H-DQPSK
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol


CDMA2000 1X Forward
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol


CDMA2000 1X Reverse
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol


EDGE Narrow Pulse Shape
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol


EDGE Wide Pulse Shape
Magnitude [dB]
20
0
-20
-40
-60
-80
-100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Frequency in f symbol



A.6 Abbreviations

The following abbreviations are commonly used in the description of the R&S FSW-K70 option.

Abbreviation	Meaning	See section
FSK	Frequency Shift Keying Modulation mode for which the information is encrypted in the frequency.	Frequency Shift Keying (FSK)
ISI	Inter-symbol Interference	

Abbreviation	Meaning	See section
ISI-free demodulation	Demodulation structure in which the signal is no longer influenced by adjacent symbols at the decision instants after signal-adapted filtering.	System-Theoretical Modulation and Demodulation Filters
MEAS filter	Measurement Filter Weighting filter for the measurement.	System-Theoretical Modulation and Demodulation Filters
MSK	Minimum Shift Keying Modulation mode.	Minimum Shift Keying (MSK)
NDA Demodulator	Non Data Aided Demodulator Demodulation without any knowledge of the sent data contents.	Demodulation and Algorithms
PSK	Phase Shift Keying Modulation mode for which the information lies within the phase or within the phase transitions.	Phase Shift Keying (PSK)
QAM	Quadrature Amplitude Modulation Modulation mode for which the information is encrypted both in the amplitude and phase.	Quadrature Amplitude Modulation (QAM)
RMS	Root Mean Square	Averaging RMS Quantities
RX filter	Receive Filter Baseband filter in analyzer used for signal-adapted filtering.	System-Theoretical Modulation and Demodulation Filters
Transmit filter	Transmitter Filter Digital impulse shaping filter in signal processing unit of transmitter.	System-Theoretical Modulation and Demodulation Filters
VSA	Vector Signal Analysis Measurement at complex modulated RF carriers.	

List of Remote Commands (VSA)

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