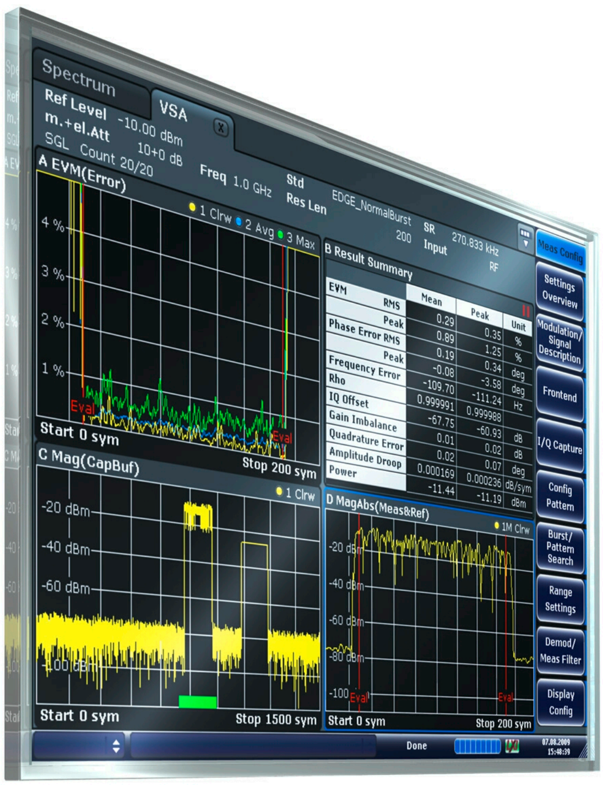
R&S® FSV-K70 Firmware Option Vector Signal Analysis

Operating Manual



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Test & Measurement

Operating Manual

ROHDE&SCHWARZ

This manual describes the following R&S®FSV options:

- analyzer-K70 (1310.8455.02)

This manual is applicable for the following analyzer models with firmware version 1.55:

- R&S®FSV 3 (1307.9002K03)
- R&S®FSV 7 (1307.9002K07)
- R&S®FSV 13 (1307.9002K13)
- R&S®FSV 30 (1307.9002K30)
- R&S®FSV 40 (1307.9002K39)
- R&S®FSV 40 (1307.9002K40)
- R&S®FSVR 7 (1311.0006K7)
- R&S®FSVR 13 (1311.0006K13)
- R&S®FSVR 30 (1311.0006K30)

The firmware of the instrument makes use of several valuable open source software packages. The most important of them are listed below together with their corresponding open source license. The verbatim license texts are provided on the user documentation CD-ROM (included in delivery).

Package	**Link**	**License**
OpenSSL	http://www.openssl.org	OpenSSL/SSLeavy
Xitami	http://www.xitami.com	2.5b6
PHP	http://www.php.net	PHP v.3
DOJO-AJAX	http://www.dojotoolkit.org	Academic Free License (BSD)
ResizableLib	http://www.geocities.com/ppescher	Artistic License
BOOST Library	http://www.boost.org	Boost Software v.1
ONC/RPC	http://www.plt.rwth-aachen.de/ index.php?id=258	SUN

The product Open SSL includes cryptographic software written by Eric Young (eay@cryptsoft.com) and software written by Tim Hudson (tjh@cryptsoft.com).

Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this manual: R&S®FSV is abbreviated as R&S FSV.

Contents

1 Documentation Overview

The user documentation for the analyzer is divided as follows:

- Quick Start Guide
- Operating Manuals for base unit and options
- Service Manual
- Online Help
- Release Notes

Quick Start Guide

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and basic measurements are described. Also a brief introduction to remote control is given. The manual includes general information (e.g. Safety Instructions) and the following chapters:

Chapters 1-3	Introduction, General information
Chapter 4	Front and Rear Panel
Chapter 5	Preparing for Use
Chapter 6	Firmware Update and Installation of Firmware Options
Chapter 7	Basic Operations
Chapter 8	Basic Measurement Examples
Chapter 9	Brief Introduction to Remote Control
Appendix 1	Printer Interface
Appendix 2	LAN Interface

Operating Manuals

The Operating Manuals are a supplement to the Quick Start Guide. Operating Manuals are provided for the base unit and each additional (software) option.

The Operating Manual for the base unit provides basic information on operating the analyzer in general, and the "Spectrum" mode in particular. Furthermore, the software options that enhance the basic functionality for various measurement modes are described here. The set of measurement examples in the Quick Start Guide is expanded by more advanced measurement examples. In addition to the brief introduction to remote control in the Quick Start Guide, a description of the basic analyzer commands and programming examples is given. Information on maintenance, instrument interfaces and error messages is also provided.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the analyzer is not included in the option manuals.

The following Operating Manuals are available for the analyzer:

- R&S FSV base unit; in addition:
  - R&S FSV-K9 Power Sensor Support
  - R&S FSV-K14 Spectrogram Measurement
- R&S FSV-K7 Analog Demodulation and R&S FSV-K7S FM Stereo Measurements
- R&S FSV-K10 GSM/EDGE Measurement
- R&S FSV-K30 Noise Figure Measurement
- R&S FSV-K40 Phase Noise Measurement
- R&S FSV-K70 Vector Signal Analysis
- R&S FSV-K72 3GPP FDD BTS Analysis
- R&S FSV-K73 3GPP FDD UE Analysis
- R&S FSV-K76/77 3GPP TD-SCDMA BTS/UE Measurement
- R&S FSV-K82/83 CDMA2000 BTS/MS Analysis
- R&S FSV-K84/85 1xEV-DO BTS/MS Analysis
- R&S FSV-K91 WLAN IEEE 802.11a/b/g/j/n
- R&S FSV-K93 WiMAX IEEE 802.16 OFDM/OFDMA Analysis
- R&S FSV-K100/K104 EUTRA / LTE Downlink Measurement Application

These manuals are available in PDF format on the CD delivered with the instrument. The printed manual can be ordered from Rohde & Schwarz GmbH & Co. KG.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the analyzer by replacing modules. The manual includes the following chapters:

Chapter 1	Performance Test
Chapter 2	Adjustment
Chapter 3	Repair
Chapter 4	Software Update / Installing Options
Chapter 5	Documents

Online Help

The online help contains context-specific help on operating the analyzer and all available options. It describes both manual and remote operation. The online help is installed on the analyzer by default, and is also available as an executable .chm file on the CD delivered with the instrument.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The current release notes are provided in the Internet.

2 Conventions Used in the Documentation

2.1 Typographical Conventions

The following text markers are used throughout this documentation:

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

2.2 Conventions for Procedure Descriptions

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

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

3 How to Use the Help System

Calling context-sensitive and general help

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

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

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

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

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

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

Contents of the help dialog box

The help dialog box contains four tabs:

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

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

Navigating in the table of contents

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

Navigating in the help topics

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

Searching for a topic

1. Change to the "Index" tab.

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

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

Changing the zoom

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

Closing the help window

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

4 Firmware Option Vector Signal Analysis – R&S FSV-K70

When equipped with application firmware R&S FSV-K70, the analyzer performs vector measurements on digitally modulated signals in the time domain. Based on the vector measurements, further evaluations, e.g. statistical evaluations, can be performed.

This section contains all information required for operation of an analyzer equipped with Application Firmware R&S FSV-K70. This section describes the menus and remote-control commands for vector signal analysis, as well as some common measurements.

4.1 Brief Description of Vector Signal Analysis

The "Vector Signal Analysis" software option R&S FSV-K70 performs vector and scalar measurements on digitally modulated single-carrier signals. To perform the measurements it converts RF signals into the complex baseband. It can also use the optional Digital Baseband interface (R&S FSV-B17 option) to analyze I/Q signals already delivered to the complex baseband.

For details on the Digital Baseband interface (R&S FSV-B17 option), see the base unit description.

The following sections describe the digital signal processing hardware, the interplay of analog and digital filters for bandwidth limiting, modulation and demodulation filters, as well as the algorithms used by the measurement demodulator. The implemented modulation modes and the associated predefined symbol mappings are also listed.

The last part of this chapter deals with vector and scalar modulation errors.

4.1.1 Block Diagram of Digital Signal Processing Hardware for I/Q Data

The following sections describe the digital hardware used to capture I/Q data for vector signal analysis with the R&S FSV-K70.

4.1.1.1 Block Diagram for RF Input

The following block diagram provides an overview on how RF input is processed in the R&S FSV-K70 option.

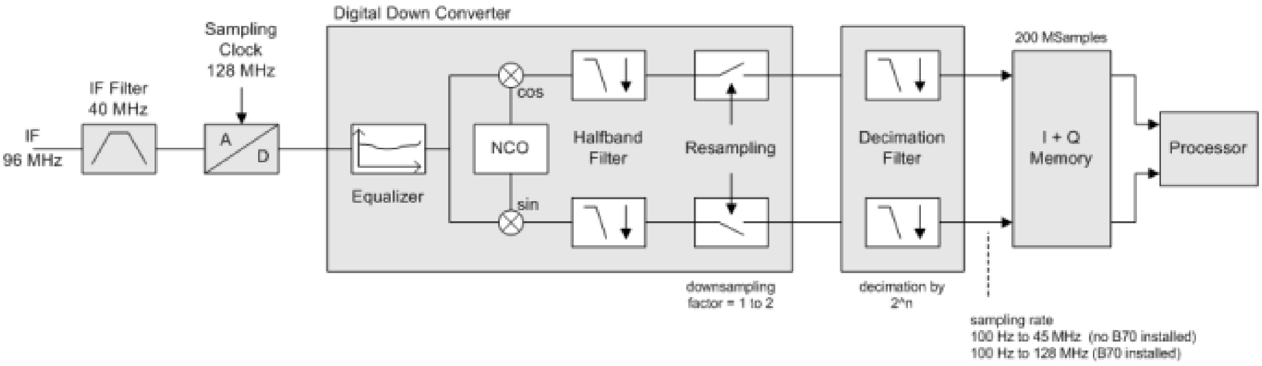


Fig. 4-1: Block diagram of digital hardware for RF input in vector signal analysis

After having passed several RF, IF and filter stages, the RF input signal is converted to an IF of 96 MHz and applied to an A/D converter with a sample frequency of exactly 128 MHz.

The digitized signal is then routed through two ICs for resampling (conversion of sample rate by a real factor) and for filtering and decimation (reduction of sample rate by an integral factor). An **equalizer filter** before the **resampler** compensates for the frequency response of the analyzer's analog filter stages which would otherwise add to the modulation errors.

During operation, the filters and decimation factors of the instrument are set so that a sample frequency is obtained at the output of the **decimation** stage, which exactly corresponds to the following equation:

Sample rate = Symbol rate * Capture Oversampling (see "Capture Oversampling" on page 166)

The complex output signal of the **decimation** stage is stored in the I/Q memory (**record buffer**) and forwarded to a signal processor (DSP) for further processing.

4.1.1.2 Block Diagram for Digital Baseband Input

The following block diagram provides an overview on how digital baseband input is processed in the R&S FSV-K70 option. The digital baseband input requires option R&S FSV-B17.

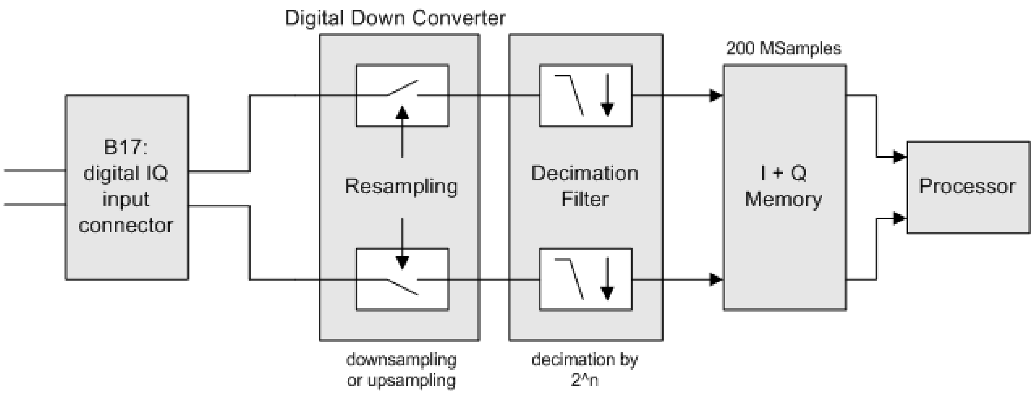


Fig. 4-2: Block diagram of digital hardware for digital baseband input (B17) in vector signal analysis

The digital I/Q data stream is fed into the analyzer via the connector of the digital baseband interface (R&S FSV-B17 option). There is no need to equalize any IF filter or mix the signal into the complex baseband. The digital hardware just has to ensure that the final I/Q data stored in the record buffer has the correct sample rate; therefore, the signal is resampled and filtered.

4.1.2 Filters and Bandwidths During Signal Processing

This section describes the used filters in vector signal analysis with an analyzer, as well as the bandwidth after each filter.

The relevant filters for vector signal analysis are shown in figure 4-3.

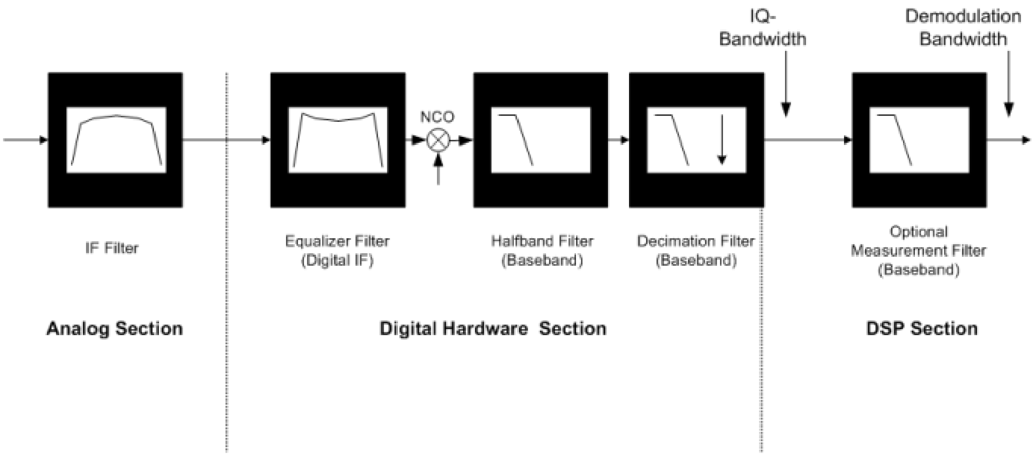


Fig. 4-3: Block diagram of bandwidth-relevant filters for vector signal analysis

- After the IF Filter (only for RF input operation): bandwidth = 40 MHz.
- After the digital hardware section:
  The phase and amplitude distortions of the IF filter have been compensated for.
  Usually, the I/Q data has a usable bandwidth of about:
  0.8 * sample rate = 0.8 * symbol rate * "Capture Oversampling"
  For details refer to chapter 4.1.2.1, "I/Q Bandwidth", on page 17.
  The I/Q data's sample rate and bandwidth automatically scale themselves with the set symbol rate. For most modulated signals even the smallest allowed value for "Capture Oversampling" leads to a sufficient I/Q data bandwidth. The whole spectrum of the input signal is captured, but most adjacent channels and interferers are effectively suppressed. Only for very wide signals (FSK, no TX-filter used) it can be necessary to try higher values for "Capture Oversampling" (see "Capture Oversampling" on page 166), increasing the I/Q bandwidth. The I/Q data delivered to the DSP section has no considerable amplitude or phase distortion and a suitable bandwidth.

The "I/Q Capture" dialog of the vector signal analysis shows the sample rate and the usable I/Q bandwidth achieved for the current settings (see "I/Q Capture", on page 140).

- After the optional measurement filter:

The measurement signal and the reference signal can be filtered by various measurement filters which have different bandwidths.

The filters described above are the ones that directly affect the bandwidth of the captured I/Q data and the final measurement signal and reference signal. Note, however, that several other filters are also involved in the DSP section but are not mentioned above:

- Receive filter to prevent ISI (intersymbol-interference)
- filters necessary for various estimators
- others

4.1.2.1 I/Q Bandwidth

The bandwidth of the I/Q data used as input for the vector signal analysis is filtered as described in chapter 4.1.2, "Filters and Bandwidths During Signal Processing", on page 16. Its flat, usable bandwidth (no considerable amplitude or phase distortion) depends on:

- the used sample rate, which depends on the
  – defined "Symbol Rate" (see "Symbol Rate" on page 134)
  – defined "Capture Oversampling" (see "Capture Oversampling" on page 166
- the type of input used (digital baseband input, RF input, etc)

The sample rate of the I/Q input data is:

Sample rate = Symbol rate * Capture Oversampling

Using this sample rate, the resulting I/Q data bandwidth can be determined from the figure "Relation between maximum usable bandwidth and sample rate (RF input)" in the base unit description (section "Working with I/Q data)" for RF input operation or the figure "Bandwidths depending on sample rate for active digital input" in the description of the Digital Baseband interface (R&S FSV option B17).

The sample rate and the usable I/Q bandwidth achieved for the current settings is displayed in the "I/Q Capture Settings" dialog, see "I/Q Capture", on page 140.

Usable I/Q bandwidth for analyzer 40 model 1307.9002K39

The maximum usable I/Q bandwidth for the analyzer 40 model 1307.9002K39 is 10 MHz. Thus, the maximum symbol rate is:

- For capture oversampling =4: symbol rate ≤ 3.125 MHz

4.1.2.2 Demodulation Bandwidth (Measurement Bandwidth)

Some modulation systems do not use a receive filter. In these cases special care should be taken that no interference or adjacent channels occur within the demodulation bandwidth. The "Capture Oversampling" parameter should be set to a low value (see "Capture Oversampling" on page 166).

Typical communication systems demand special receive or measurement filters (e.g. root-raised cosine receive filter or EDGE measurement filter).

If no such filtering is performed, care should be taken that neither interfering signals nor adjacent channels fall within the demodulation bandwidth.

4.1.2.3 Modulation and Demodulation Filters

Sample points are required for demodulation in the analyzer, where only information of the current symbol and none of neighbouring symbols is present (symbol points). These points are also called ISI-free points (ISI = intersymbol interference). If the transmitter does not provide an ISI-free signal after the transmit filter, this condition can be fulfilled by signal-specific filtering of the analyzer input signal (**receive filter** or **Rx filter**). If an RRC (root-raised cosine) filter is used in the transmitter, an RRC filter is also required in the analyzer to obtain ISI-free points.

In many PSK systems, RRC filters are used as transmit, ISI and measurement filters. To determine the I/Q modulation error, the measurement signal must be compared with the corresponding ideal signal. For this purpose a **reference filter** is required which is calculated by the analyzer by convolving the coefficient of the transmit filter (**Tx filter**) and the **meas filter** (see figure 4-4).

If unfiltered signals have to be measured as well (e.g. to determine nonlinear signal distortions), no measurement filter is switched into the signal path and the **reference filter** is identical to the **Tx filter** (see figure 4-4).

In the baseband block diagrams below, the system-theoretical transmitter and analyzer filters are shown for PSK and QAM demodulation. For the sake of clearness, RF stages, IF filters and the filter stages of the **digital hardware section** are not shown.

For a correct demodulation, the following filters have to be accurately specified for the analyzer:

- Tx filter: filter characteristic of transmitter
- Meas filter: The I and the Q part of the measurement and the reference signal are filtered with this filter. In many applications, this filter is identical with the ISI filter.

The receive filter (ISI filter) is configured internally depending on the Tx filter. The goal is to produce intersymbol-interference-free points for the demodulation.

The reference filter synthesizes the ideal transmitted signal (after meas filtering). It is calculated by the analyzer from the above filters (convolution operation **Tx Filter * Meas Filter**).

Table 4-1: 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

Transmit filter	Measurement filter (analyzer)	Remarks
GMSK linearized	EDGE_MEAS	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	CDMA2000 1X FOR-WARD	standard specific filter; filter combination without ISI
CDMA2000 1X REVERSE	CDMA2000 1X REVERSE	standard specific filter; filter combination without ISI
APCO25 C4FM	APCO25 C4FM	standard specific filter; filter combination without ISI
APCO25 H-CPM	APCO25 H-CPM	standard specific filter; filter combination without ISI
APCO25 H-DQPSK	APCO25 H-DQPSK	standard specific filter; filter combination without ISI
APCO25 H-D8PSK Narrow	APCO25 H-D8PSK Narrow	standard specific filter; filter combination without ISI
APCO25 H-D8PSK Wide	APCO25 H-D8PSK Wide	standard specific filter; filter combination without ISI

Typical combinations of Tx and Meas filters are shown in the table above; they can be set in the analyzer using "Meas filter = AUTO" (see "Auto" on page 161). If RC (raised cosine), RRC (root-raised cosine) and Gaussian filters are used, the Alpha (RC, RRC filters) or BT (Gaussian filters) parameters must be set in addition to the filter characteristic (roll-off factor). Typically the Alpha/BT value of the measurement filter should be the same as that of the transmission filter.

A measurement filter can be switched on or off even when demodulating MSK signals. MSK is an orthogonal modulation if the frequency deviation is 0.5*SR.

If this is not the case perform the measurement as if the signal were FSK modulated. For FSK, the measurement filter filters the instantaneous frequency of the signal, not the I/Q signal.

As for PSK, QAM and UserQAM, the measurement filter filters the I and Q parts of the measurement signal and the reference signal (i.e. not the instantaneous phase or magnitude of the MSK signal).

4.1.2.4 Measurement Filters

The measurement filter can be used to filter the following two signals in the same way:

- the measurement signal (after coarse frequency, phase and timing synchronization have been achieved)
- the reference signal, i.e the I/Q symbols that have been determined in the demodulator and have already been filtered with the TX filter;

For MSK, PSK, QAM and User QAM the measurement filter filters the real part and imaginary part of these signals. For FSK, the measurement filter filters the instantaneous frequency of these signals.

The R&S FSV-K70 defines the error signal as the difference between the reference signal and the measurement signal. Thus, the measurement filter also shapes the spectrum of the error signal, which is used to calculate the EVM, for example.

In many applications the measurement filter is the same as the RX filter. However, unlike the measurement filter, the RX filter is not relevant for the measurement, but is only required to create the reference signal optimally.

The RX filter and the TX filter are usually chosen such that their combination results in an **I**nter-**S**ymbol **I**nterference (ISI) free system. In figure 4-4 and figure 4-5 it becomes obvious that the REF signal and the MEAS signal are inter-symbol interference free.

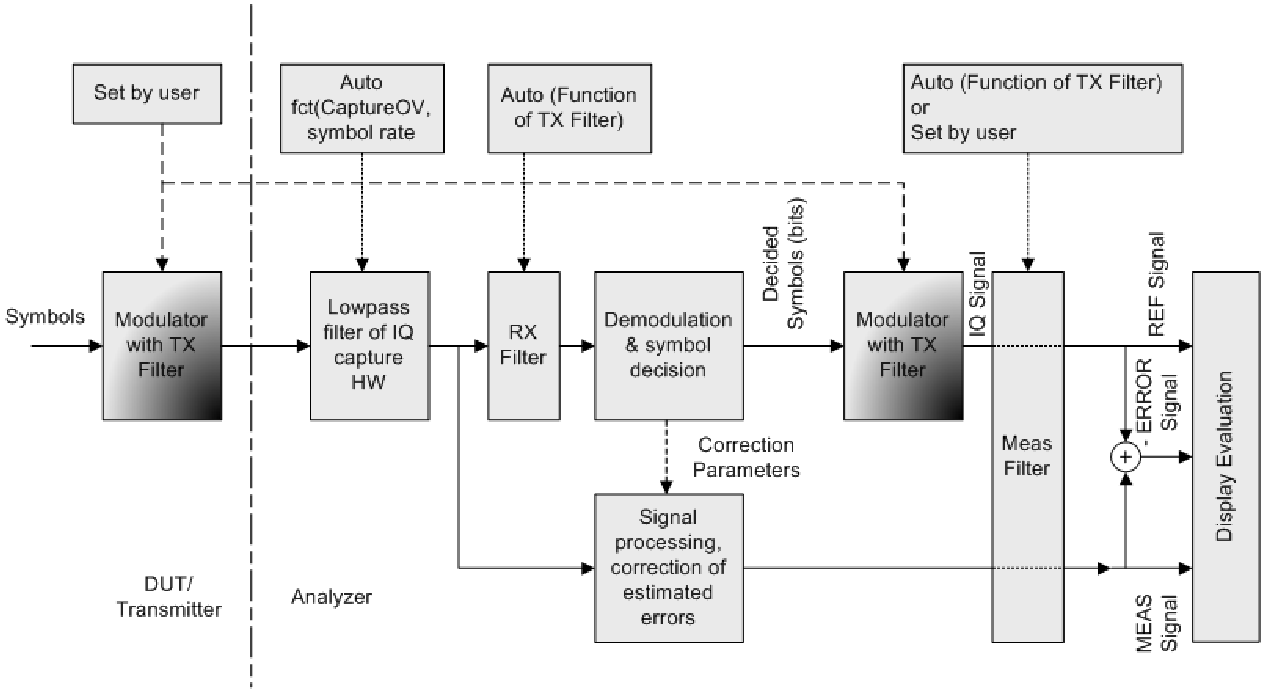


Fig. 4-4: Measurement filter in the block diagram (MSK, PSK, QAM and UserQAM)

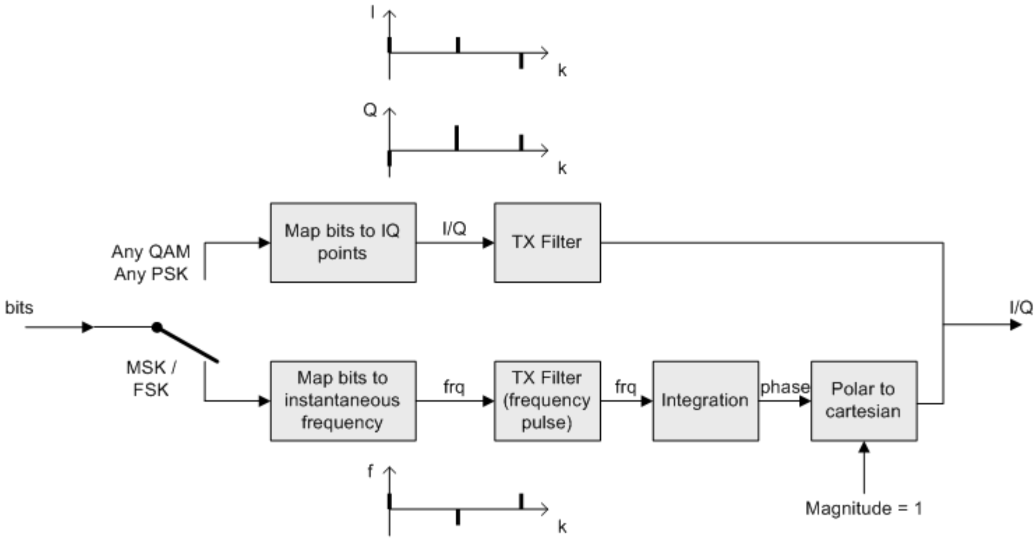


Fig. 4-5: Modulator with TX filter in detail

As the measurement filters of the R&S FSV-K70 have low-pass characteristics, they suppress high frequency distortion components in the Meas/Ref/Error signal. The errors are weighted spectrally. Thus, turning off the measurement filter can have an influence on the numeric and graphical error values. However, the measurement filter should be switched off if non-linear distortions have to be measured (they usually produce high frequency components).

The frequency response of the available standard specific measurement filters is shown in figure 4-101.

4.1.3 Symbol Mapping

Mapping or symbol mapping means that symbol numbers are assigned to points or transitions in the I/Q plane (e.g. PSK and QAM).

In the analyzer, the mapping is required to decode the transmitted symbols from the sampled I/Q or frequency/time data records.

The mappings for all standards used in the analyzer and for all employed modulation modes are described in the following. Unless characterized otherwise, symbol numbers are specified in hexadecimal form (MSB at the left).

4.1.3.1 Phase Shift Keying (PSK)

With this type of modulation, the information is represented by the absolute phase position of the received signal at the decision points. All transitions in the I/Q diagram are possible. The complex constellation diagram is shown. The symbol numbers are entered in the diagram according to the mapping rule.

BPSK (NATURAL)

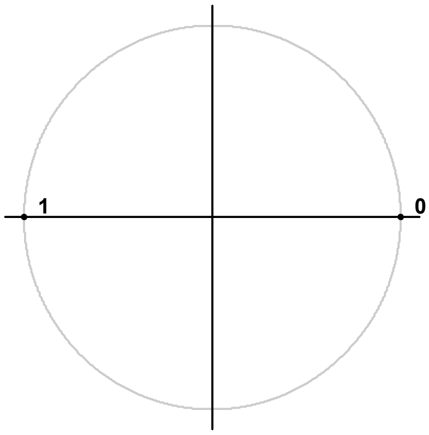


Fig. 4-6: Constellation diagram for BPSK including the symbol mapping

QPSK

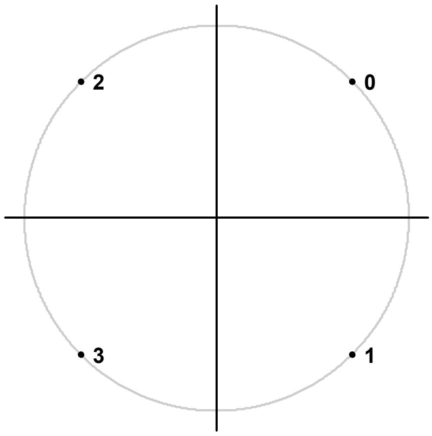


Fig. 4-7: Constellation diagram for QPSK including the symbol mapping for CDMA2000 FWD and DVB S2

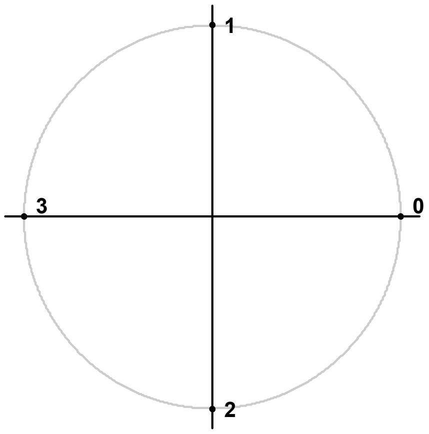


Fig. 4-8: Constellation diagram for QPSK (GRAY) including the symbol mapping

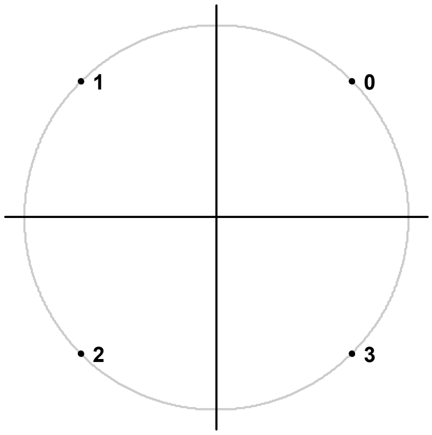


Fig. 4-9: Constellation diagram for QPSK (NATURAL) including the symbol mapping

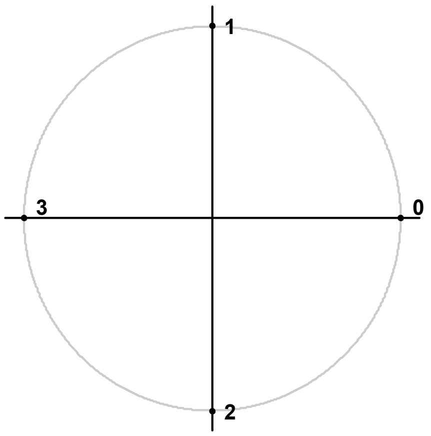


Fig. 4-10: Constellation diagram for QPSK including the symbol mapping for WCDMA

8PSK

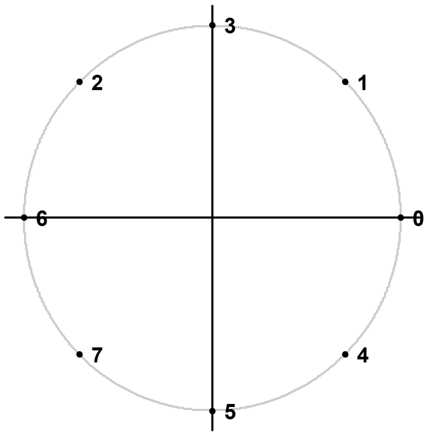


Fig. 4-11: Constellation diagram for 8PSK (GRAY) including the symbol mapping

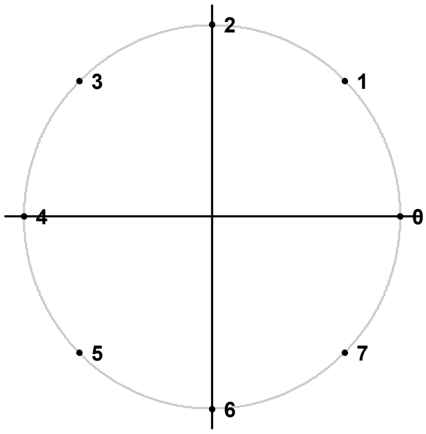


Fig. 4-12: Constellation diagram for 8PSK (NATURAL) including the symbol mapping

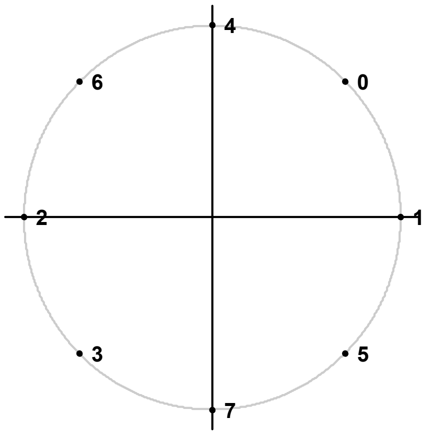


Fig. 4-13: Constellation diagram for 8PSK including the symbol mapping for DVB S2

4.1.3.2 Rotating PSK

A rotating PSK modulation is basically a PSK modulation in which additional phase shifts occur. These phase shifts depend on the symbol number, e.g. for a π/4-QPSK, the third symbol has an additional phase offset of (3-1)*π/4. This offset has the same effect as a rotation of the basic system of coordinates by the offset angle after each symbol.

The method is highly important in practical applications because it prevents signal transitions through the zeros in the I/Q plane. This reduces the dynamic range of the modulated signal and the linearity requirements for the amplifier.

In practice, the method is used for 3π/8-8PSK, for example, and (in conjunction with phase-differential coding) for π/4-DQPSK.

Symbol mapping

The logical constellation diagram for 3π/8-8PSK comprises 8 points that correspond to the modulation level (see figure 4-14). A counter-clockwise offset (rotation) of 3π/8 is inserted after each symbol transition.

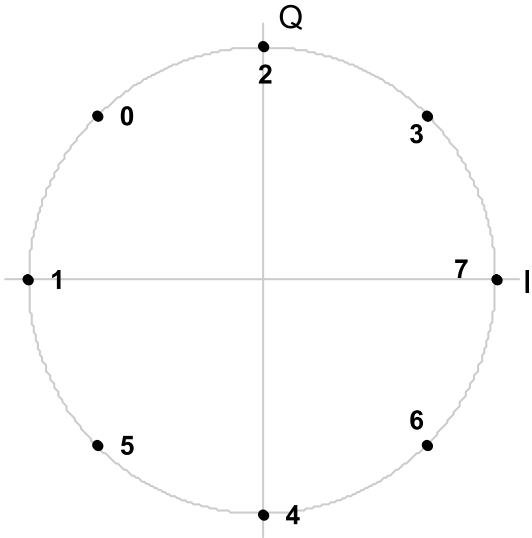


Fig. 4-14: Constellation diagram for 3π/8 8PSK before rotation including the symbol mapping for EDGE

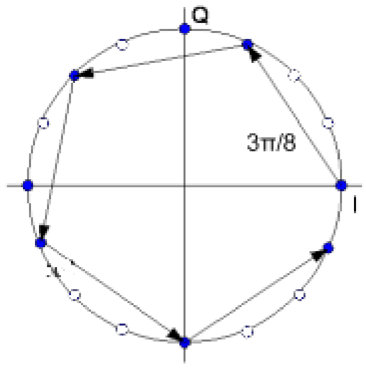


Fig. 4-15: I/Q symbol stream after 3π/8 rotation in I/Q plane if the symbol number "7" is transmitted six times in a row

4.1.3.3 Differential PSK

With differential PSK, the information is represented in the phase shift between two consecutive decision points. The absolute position of the complex sample value at the decision point does not carry information.

In the physical constellation diagram, the constellation points at the symbol decision points obtained after ISI-free demodulation are shown (as with common PSK methods). This diagram corresponds to the display on the analyzer. The position of the constellation points is standard-specific. For example, some QPSK standards define the constellation points on the diagonals, while other standards define the coordinate axes.

In table 4-2, the symbols are assigned to phase shifts. The QPSK (INMARSAT) mapping corresponds to simple QPSK with phase-differential coding.

Tables table 4-3 and table 4-4 show two types of differential 8PSK modulation.

Another type of differential PSK modulation is shown in table 4-3.

Other types of modulation using differential coding method are described in chapter 4.1.3.4, "Rotating Differential PSK Modulation", on page 27.

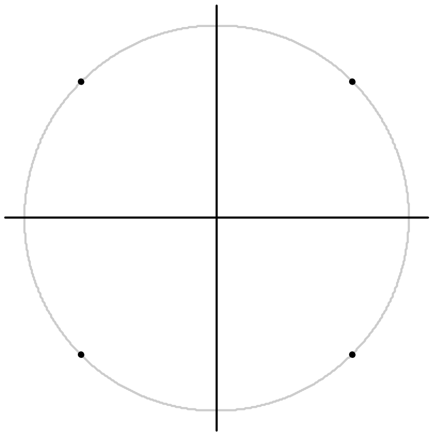


Fig. 4-16: Constellation diagram for DQPSK (INMARSAT and NATURAL) including the symbol mapping

Table 4-2: DQPSK (INMARSAT)

Logical symbol mapping				
Modulation symbol (binary indication: MSB, LSB)	00	01	10	11
Phase shift	0°	-90°	+90°	180°

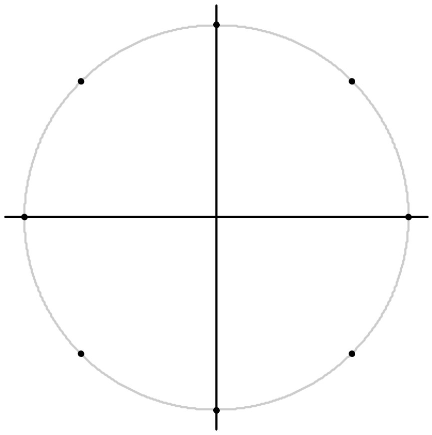


Fig. 4-17: Constellation diagram for D8PSK including the symbol mapping for APCO25, APCO25 Phase 2, GRAY, NATURAL and TETRA

Table 4-3: D8PSK (NATURAL)

Logical symbol mapping								
Modulation symbol (binary indication: MSB, LSB)	000	001	010	011	100	101	110	111
Phase shift	0°	45°	90°	135°	180°	225°	270°	315°

Table 4-4: D8PSK (GRAY)

Logical symbol mapping								
Modulation symbol (binary indication: MSB, LSB)	000	001	010	011	100	101	110	111
Phase shift	0°	45°	135°	90°	270°	315°	225°	180°

4.1.3.4 Rotating Differential PSK Modulation

Phase-differential modulation is frequently combined with an additional phase shift (e.g. π/4 DQPSK = π/4 phase shift modulation + differential modulated 4PSK).

The logical mapping diagram corresponds to the diagram for DPSK.

The physical constellation diagram shows the symbol decision points obtained after ISI-free demodulation.

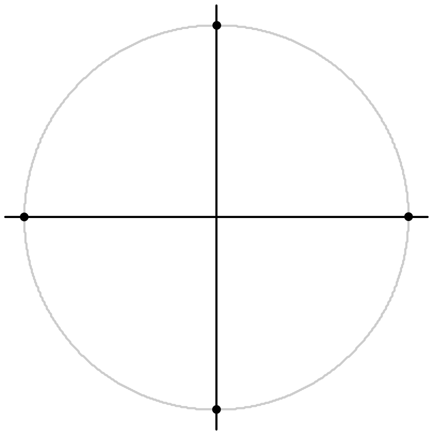


Fig. 4-18: Constellation diagram for π/4 DQPSK including the symbol mapping for APCO25 Phase 2, NADC, NATURAL, PDC, PHS, TETRA and TFTS; the π/4 rotation is already compensated for

Table 4-5: π/4 DQPSK (NADC, PDC, PHS, TETRA)

Logical symbol mapping				
Modulation symbol (binary indication: MSB, LSB)	00	01	10	11
Phase shift	0°+45°	90°+45°	-90°+45°	-180°+45°

Table 4-6: π/4 DQPSK (TFTS)

Logical symbol mapping				
Modulation symbol (binary indication: MSB, LSB)	00	01	10	11
Phase shift	-180°+45°	90°+45°	-90°+45°	0°+45°

Table 4-7: π/4 DQPSK (Natural)

Logical symbol mapping				
Modulation symbol (binary indication: MSB, LSB)	00	01	10	11
Phase shift	0°+45°	90°+45°	-180°+45°	-90°+45°

Table 4-8: APCO25 and APCO25Phase2

Logical symbol mapping				
Modulation symbol (binary indication: MSB, LSB)	00	01	10	11
Phase shift	0°+45°	90°+45°	-90°+45°	-180°+45°

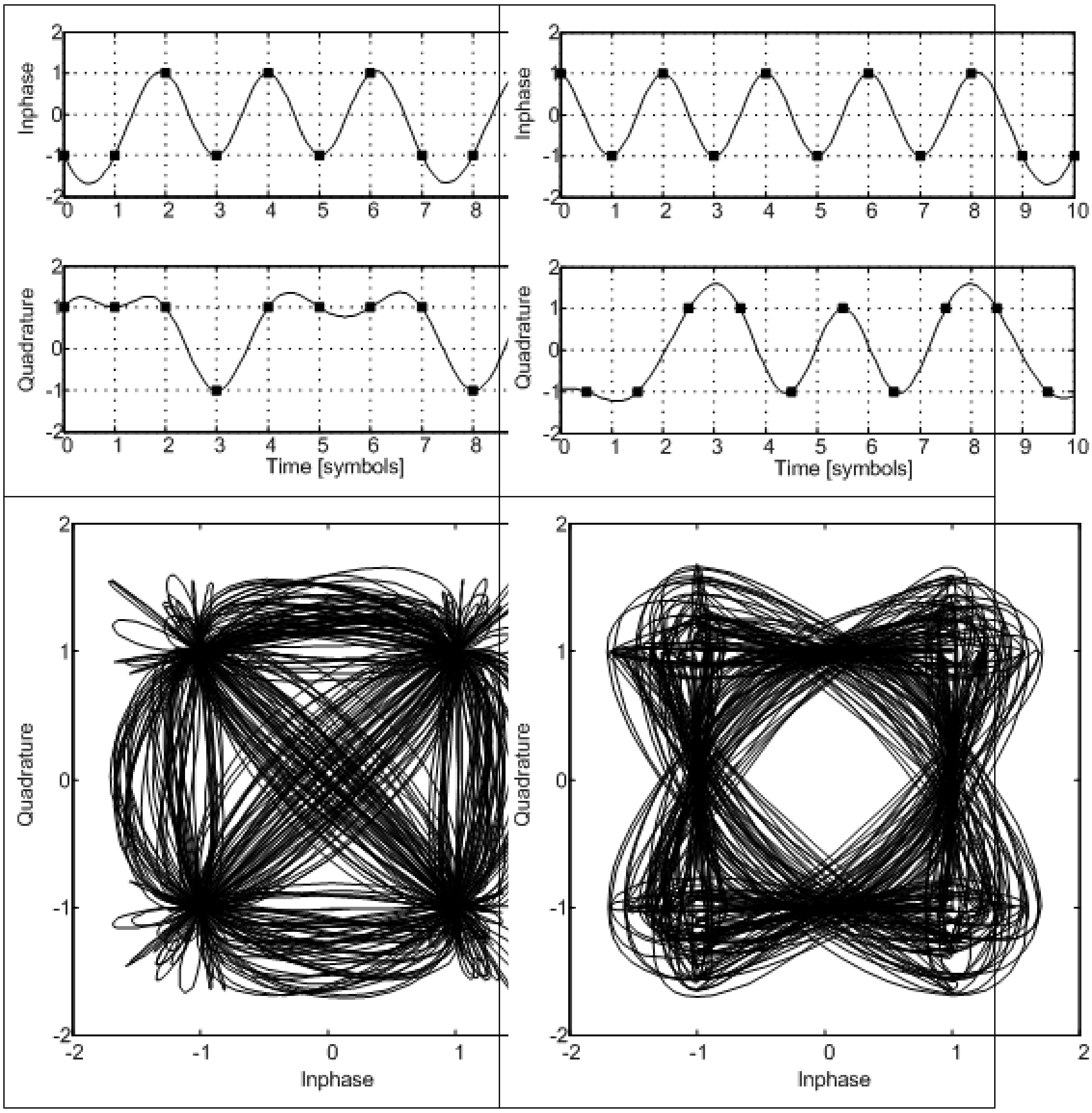
4.1.3.5 Offset QPSK

Offset QPSK differs from “normal” QPSK in the fact that the Q component is delayed by half a symbol period against the I component in the time domain. Hence, the symbol time instants of the I and the Q component do not coincide. The concept of Offset QPSK is illustrated in the diagrams below.

Derivation of OQPSK

Table 4-9: I/Q diagram and constellation diagram

QPSK	**OQPSK (delayed Q component)**
PSK vector diagram with alpha = 0.35	OQPSK vector diagram with alpha = 0.35



Offset QPSK reduces the dynamic range of the modulated signal (w.r.t. "normal" QPSK) and, therefore, the demands on amplifier linearity by avoiding zero crossings.

A distinction is made in the analyzer display:

In the Vector I/Q result display of the measurement (or reference) signal, the time delay is not compensated for. The display corresponds to the physical diagram shown in (table 4-9)

In the Constellation I/Q result display of the measurement (or reference) signal, the time delay is compensated for. The display corresponds to the logical mapping as in figure 4-19.

OQPSK

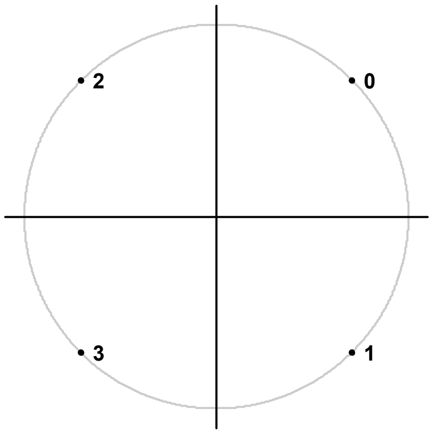


Fig. 4-19: Constellation diagram for OQSK (GRAY) including the symbol mapping

4.1.3.6 Frequency Shift Keying (FSK)

To illustrate symbol mappings for FSK modulations, the symbol numbers are marked in the logical mapping diagram versus the instantaneous frequency. An instantaneous frequency of zero in the baseband corresponds to the input frequency of the analyzer.

2FSK (NATURAL)

With 2FSK, the symbol decision is made by a simple frequency discriminator:

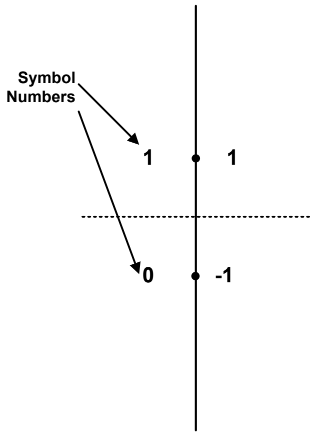


Fig. 4-20: Constellation diagram for 2FSK (NATURAL) including the logical symbol mapping

4FSK

With 4FSK, the symbol decision is made by a frequency discriminator with 3 decision thresholds (-2/3; 0; +2/3) normalized to the FSK reference deviation.

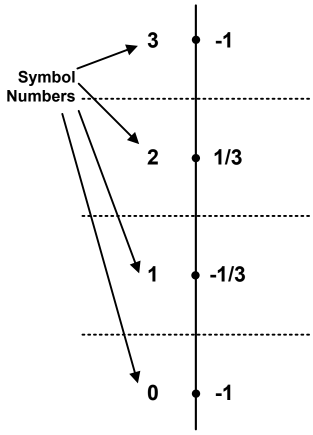


Fig. 4-21: Constellation diagram for 4FSK (NATURAL) including the logical symbol mapping

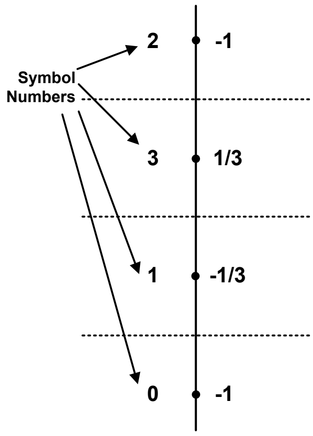


Fig. 4-22: Constellation diagram for 4FSK (GRAY) including the logical symbol mapping

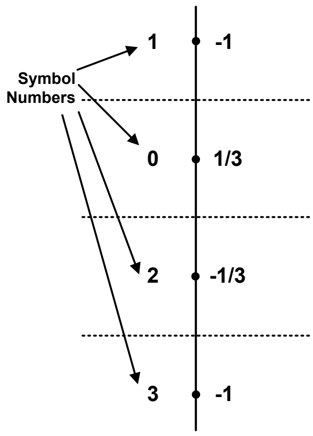


Fig. 4-23: Constellation diagram for 4FSK for APCO C4FM and APCO Phase 2 including the logical symbol mapping

4.1.3.7 Minimum Shift Keying (MSK)

MSK modulation causes modulation-dependent phase shifts of +/- 90° which can be shown in an I/Q constellation diagram. As with PSK, demodulation is performed by evaluation of the phase positions.

Table 4-10: MSK (NATURAL)

Logical symbol mapping		
Modulation symbol (binary indication: MSB, LSB)	0	1
Phase shift	-90°	+90°

Table 4-11: MSK (GSM)

Logical symbol mapping		
Modulation symbol (binary indication: MSB, LSB)	0	1
Phase shift	+90°	-90°

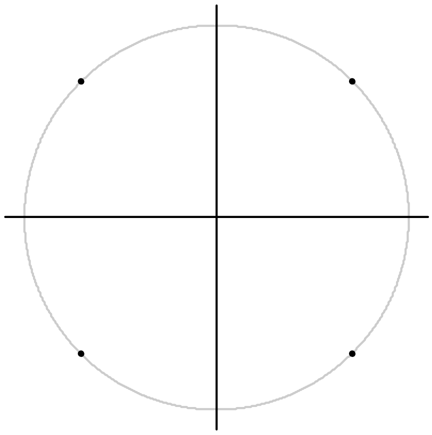


Fig. 4-24: MSK (for GSM and NATURAL) and DMSK Constellation Diagram including the symbol mapping

Similar to PSK, differential coding can also be used with MSK. In this case, too, the information is represented by the transition of two consecutive symbols. The block diagram of the coder is shown below.

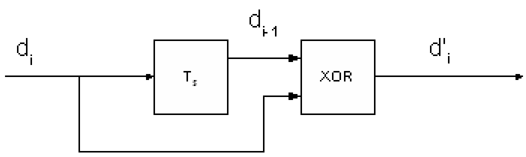


Fig. 4-25: DMSK: differential encoder in the transmitter

d_i input symbol {0;1} of differential encoder

d_{i-1} input symbol delayed by the symbol period Ts

d'_i output symbol {0;1} of differential encoder

The logical symbol mapping is then performed on the XOR-coded bitstream d'.

4.1.3.8 Quadrature Amplitude Modulation (QAM)

In the case of QAM the information is represented by the signal amplitude and phase.

The symbols are arranged in a square constellation in the I/Q plane.

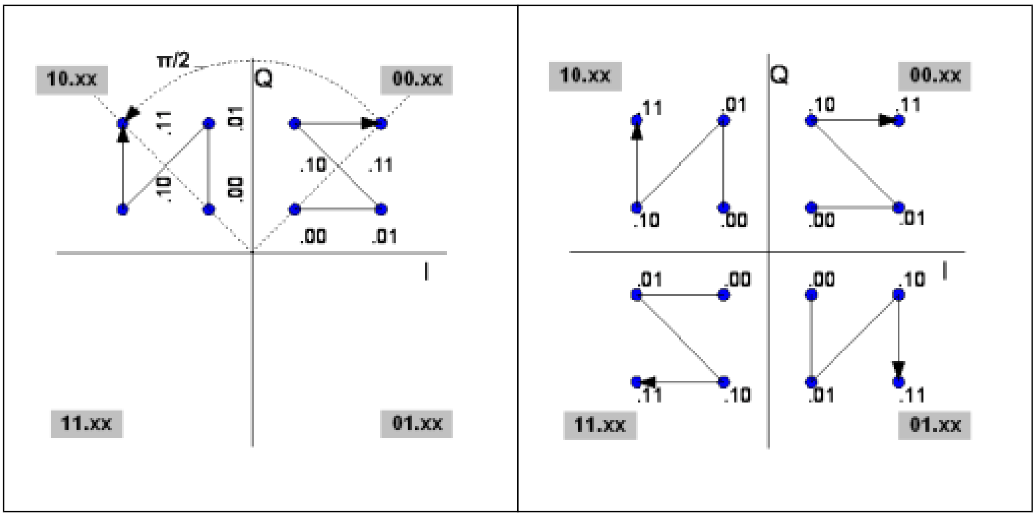
To ensure reliable demodulation, symbol numbers should be distributed evenly with respect to the symbol alphabet.

As a rule of thumb, the **result length** should correspond to at least 8 times the modulation order. For example, with 64 QAM, a result length of at least 8*64 = 512 symbols should be used.

QAM Mappings

The following QAM mappings are obtained from the mapping of the 1st quadrant, which is always rotated by π/2 for the subsequent quadrants and supplemented by a (GRAY-coded) prefix for each quadrant.

Table 4-12: Derivation of QAM mappings



In the following diagrams, the symbol mappings are indicated in hexadecimal and binary form.

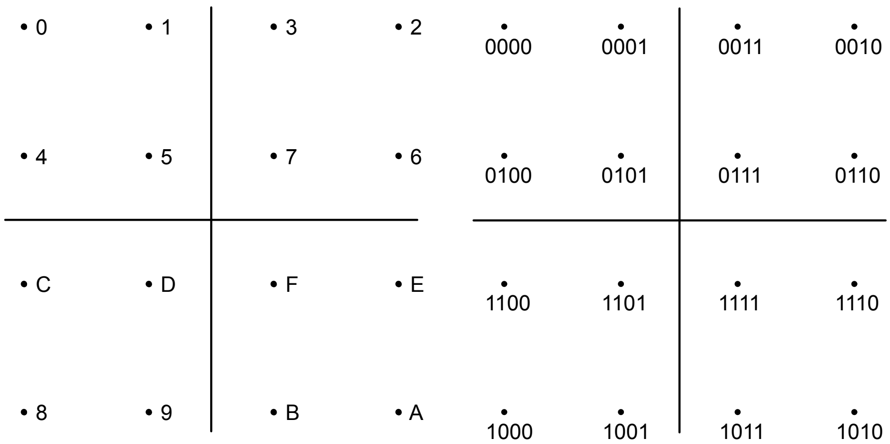


Fig. 4-26: Constellation diagram for 16QAM (GRAY) including the logical symbol mapping (hexadecimal and binary)

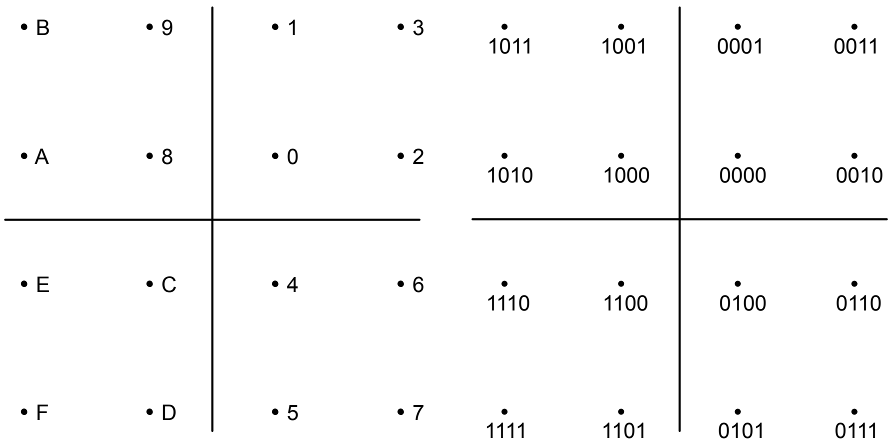


Fig. 4-27: Constellation diagram for 16QAM including the logical symbol mapping for EDGE (hexadecimal and binary)

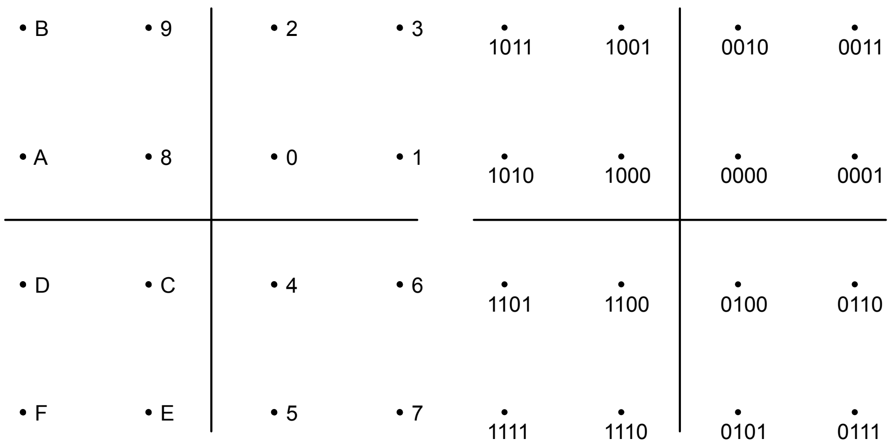


Fig. 4-28: Constellation diagram for 16QAM including the logical symbol mapping for DVB-C (hexadecimal and binary)

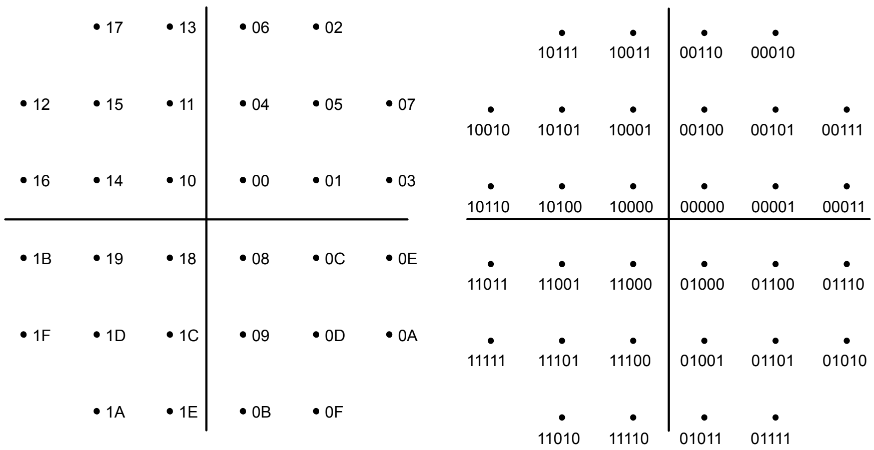


Fig. 4-29: Constellation diagram for 32QAM including the logical symbol mapping for DVB-C (hexadecimal and binary)

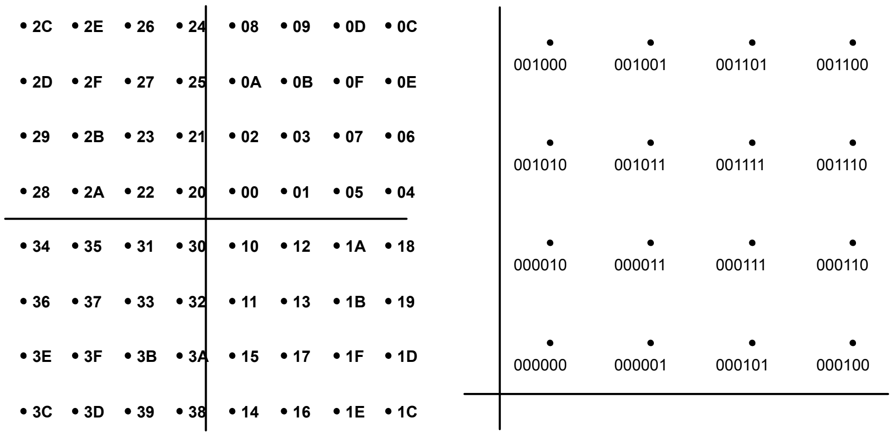


Fig. 4-30: Constellation diagram for 64QAM including the logical symbol mapping for DVB-C (hexadecimal and binary); the binary form shows the upper right section of the diagram only.

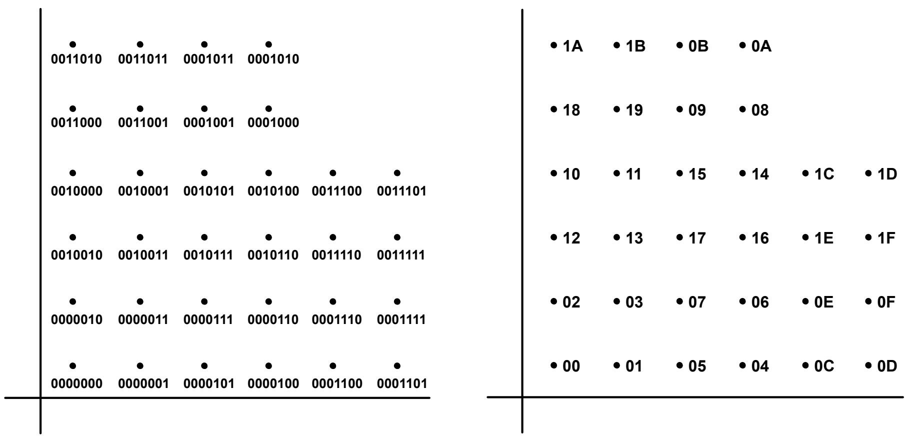


Fig. 4-31: Constellation diagram for 128QAM including the logical symbol mapping (hexadecimal and binary); the figure shows the upper right sections of the diagram only

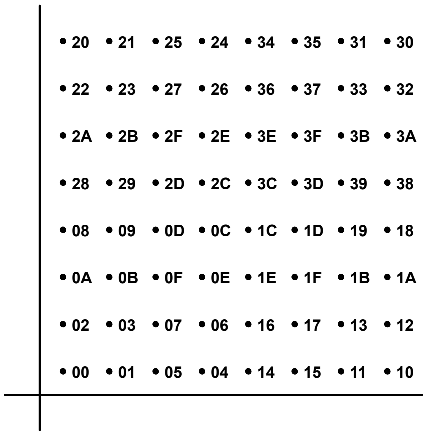


Fig. 4-32: Constellation diagram for 256QAM including the logical symbol mapping (hexadecimal); the figure shows the upper right section of the diagram only

4.1.3.9 User QAM

In the case of a User QAM modulation, the information can be represented by the the signal amplitude and/or the signal phase.

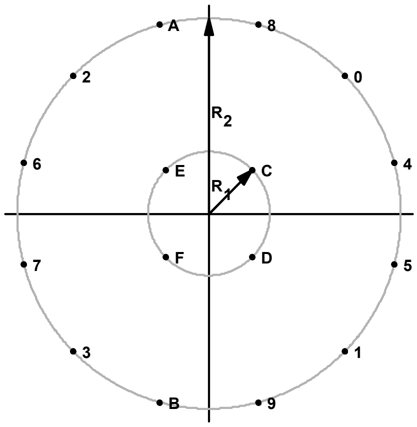


Fig. 4-33: Constellation diagram for 16APSK including the logical symbol mapping for DVB-S2

For DVB-S2 16APSK mappings, the ratio of the outer circle radius to the inner circle radius (γ = R2/R1) depends on the utilized code rate and complies with table 4-13.

Table 4-13: Optimum constellation radius ratio γ (linear channel) for 16APSK

Code Rate	Modulation / coding spectral efficiency	γ
2/3	2.66	3.15
3/4	2.99	2.85
4/5	3.19	2.75
5/6	3.32	2.70
8/9	3.55	2.60
9/10	3.59	2.57

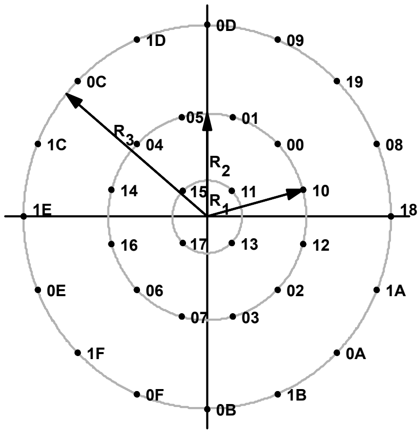


Fig. 4-34: Constellation diagram for 32APSK including the logical symbol mapping for DVB-S2

For DVB-S2 32APSK mappings, the ratio of the middle circle radius to the inner circle radius (γ_1 = R2/R1) and the ratio of the outer circle radius to the inner circle radius (γ_2 depend on the utilized code rate and comply with table 4-14.

Table 4-14: Optimum constellation radius ratios γ_1 and γ_2 (linear channel) for 32APSK

Code Rate	Modulation / coding spectral efficiency	γ_1	γ_2
2/3	3.74	2.84	5.27
3/4	3.99	2.72	4.87
4/5	4.15	2.64	4.64
5/6	4.43	2.54	4.33
8/9	4.49	2.53	4.30

4.1.4 Predefined Standards and Settings

In the "Digital Standards" menu, predefined basic settings for standards can be selected and user-defined standards stored (see "Digital Standards" on page 100).

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 4-15: List of predefined standards and settings

Folder	Standard	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
GSM	GSM_Nor-malBurst	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_TSC0 (...) GSM_TSC7	148	Pattern to Center	0.5 - 147.25
	GSM_Syn-chroniza-tionBurst	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_SB0 (...) GSM_SB2	148	Pattern to Center	3 - 144
	GSM_Fre-quency-Burst	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_FB0 GSM_FB01	148	Pattern to Center	3 - 144
	GSM_AccessBurst	DMSK GSM	270.83333 kHz	GMSK NONE	0.3	✓	✓	GSM_AB0 (...) GSM_AB2	88	Pattern to Center	8 - 85
	EDGE_8PSK	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
	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
TETRA	TETRA_Discontinuous-Downlink	π/4-DQPSK TETRA	18 kHz	RRC RRC	0.35	✓	-	TETRA_S1 ... TETRA_S3	246	Burst to Center	0 - 244

Folder	Standard	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
	TETRA_Continuous-Downlink	π/4-DQPSK TETRA	18 kHz	RRC RRC	0.35	✓	-	TETRA_E TETRA_S	255	Burst to Center	0 - 244
3GPP	3G_WCDMA	QPSK WCDMA	3.84 MHz	RRC RRC	0.22	-	-	-	800	Capture/ Left	-
CDMA	CDMA2000_1X_FWD	QPSK CDMA2K_FWD	1.2288 MHz	CDMA 2000 1X FWD CDMA 2000 1X FWD	-	-	-	-	800	Capture/ Left	-
	CDMA2000_1X_REV	Offset QPSK Gray	1.2288 MHz	CDMA2000 1X Reverse CDMA2000 1X Reverse	-	-	-	-	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 APCO25 C4FM	-	-	-	-	200	Capture Left	-
Bluetooth	DH1	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	366	Burst to Center	2 - 363.75
	DH3	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	1622	Burst to Center	2 - 1619.75
	DH5	2FSK Natural	1 MHz	GMSK None	0.5	✓	-	-	2870	Burst to Center	2 - 2867.75
DECT	DECT_P32_FixedPart	2FSK Natural	1.152 MHz	GMSK None	0.5	✓	✓	DECT_PP DECT_PP_Prolonged	424	Capture Left	0 - 799.75

Folder	Standard	Modulation Mapping	Symbol rate	Transmit Filter Meas.Filter	Alpha/BT	Search for Burst	Search for Pattern	Pattern	Result length	Alignment	Evaluation Range
	DECT_P32_Portable-Part	2FSK Natural	1.152 MHz	GMSK None	0.5	✓	✓	DECT_FP DECT_FP_Prolonged	424	Capture Left	-
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	ZIG-BEE_BPSK_868M_300K	BPSK Natural	300 kHz	RC None	1.0	✓	-	-	1000	Busrt to Center	-
	ZIG-BEE_BPSK_915M_600K	BPSK Natural	600 kHz	RC None	1.0	✓	-	-	1000	Burst to Center	-
	ZIG-BEE_OQPSK_2450M_1M	Offset-QPSK Gray	1 MHz	Half Sine -	-	✓	-	-	1000	Burst to Center	-

4.1.5 Demodulation Overview

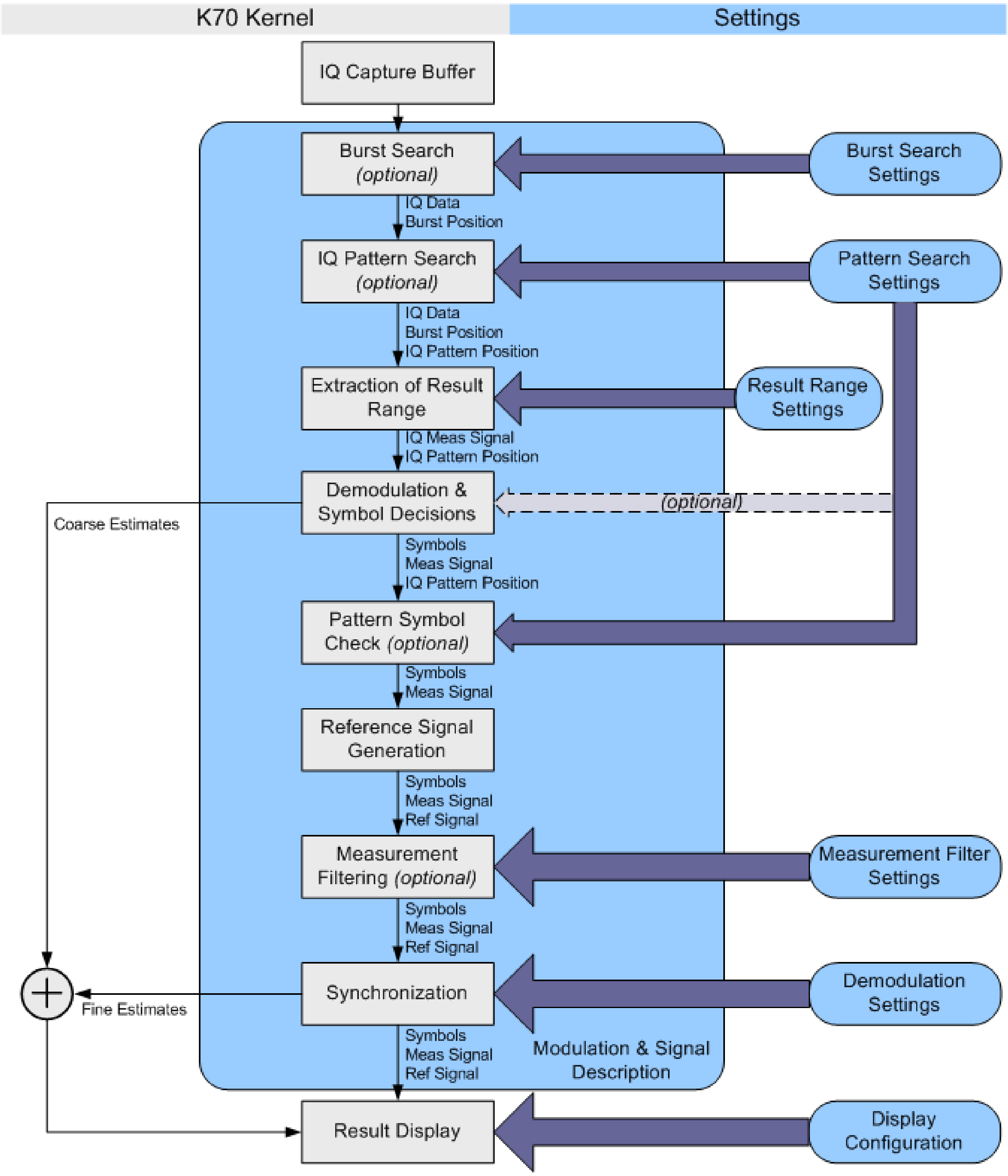


Fig. 4-35: Demodulation stages of the vector signal analysis option

The figure 4-35 provides an overview of the demodulation stages of the vector signal analysis option. The function blocks of the signal processing kernel can be found at the left (in grey) and their appropriate settings at the right (in blue).

Burst Search

In this stage, the Capture Buffer is searched for bursts that comply with the signal description. The search itself can be switched on or off via the "Burst Search" dialog (see "Burst Search", on page 144). A list of the detected bursts is passed on to the next processing stage.

IQ Pattern Search

The "IQ Pattern Search" is performed on the Capture Buffer. This means the R&S FSV-K70 option modulates the selected pattern according to the transmit filter (Tx filter) and the modulation scheme. Subsequently, it searches the Capture Buffer for this IQ pattern, i.e. the IQ waveform of the pattern. It is assumed that patterns can only appear within bursts, i.e. the IQ pattern search range is limited to the bursts detected by the Burst Search stage. If the burst search is switched off, the whole Capture Buffer is searched for the IQ pattern. A list of all detected IQ patterns is passed on to the next processing stage. It is important to note that the R&S FSV-K70 option can only search for one pattern at a time.

The pattern search can be switched on or off via the "Pattern Search" dialog (see "Pattern Search", on page 146).

Extraction of Result Range

The Result Range can be aligned to a burst, a pattern or simply the start of the Capture Buffer (see "Result Range", on page 152). Within this stage, the Result Range is cut from the Capture Buffer starting at a point that is specified by the user, e.g. the start of a detected burst. The R&S FSV-K70 option automatically takes into account filter settling times by making the internal buffers sufficiently longer than the selected Result Range.

Demodulation & Symbol Decisions

This stage operates on the extracted Result Range and aims at making the correct symbol decisions. Within this stage, a coarse synchronization of the carrier frequency offset, the carrier phase, the scaling and the timing takes place. Furthermore, an automatically selected internal receive filter (Rx filter) is used in order to remove the inter-symbol interference as effectively as possible. The outputs of this stage are the (coarsely) synchronized measurement signal and the symbol decisions (bits). The symbol decisions are later used for the "Pattern Symbol Check" stage and for the "Reference Signal Generation" stage.

Pattern Symbol Check

The "IQ Pattern Search" stage can only detect whether the similarity between the IQ pattern and the Capture Buffer exceeds a certain threshold and, in this way, find the most likely positions where a pattern can be found.

Within this stage, the R&S FSV-K70 checks whether the pattern symbols (bits) really coincide with the symbol decisions at the pre-detected position. E.g. if one out of 20 symbols does not coincide, the "IQ Pattern Search" stage might detect this IQ pattern, but the "Pattern Symbol Check" stage will decline it.

Note that this stage is only active if the pattern search is switched on.

Reference Signal Generation

The ideal reference signal is generated based on the detected symbols and the specifications of the signal model, i.e. the modulation scheme and the transmit filter (Tx filter).

Measurement Filtering

Both the measurement signal and the reference signal are filtered with the specified measurement filter.

Synchronization

In this stage, the measurement signal and the reference signal are correlated. For PSK, QAM and MSK modulated signals, an estimation algorithm is used in order to obtain estimates for the signal amplitude, signal timing, carrier frequency error, phase error, IQ offset, gain imbalance, quadrature error and the amplitude droop. Alternatively, it is possible to disable the estimation algorithm.

For FSK modulated signals, estimates for the signal amplitude, signal timing, carrier frequency error, FSK deviation error and the carrier frequency drift are calculated. The measurement signal is subsequently corrected with these estimates. Compensation for FSK deviation error and carrier frequency drift can be enabled or disabled.

For more information on synchronization see

- "Estimation", on page 51
- "Demodulation", on page 156

Result Display

The selected measurement results are displayed on the screen(s). Configuration of the screens can be performed via the "Display Configuration" dialog (see "Display Configuration", on page 162).

A more detailed description of the most important stages is given in the following sections.

4.1.5.1 Burst Search

The burst search is performed only if it is switched on. Otherwise, this stage is skipped. It is recommended that you switch the burst search on if the signal is bursted. This ensures that all internal estimators are operated in time ranges where the burst power ramping is up.

In order to eliminate amplitude variations caused by noise or the modulation itself, the instantaneous power of the whole capture buffer is computed and then a moving average filter is applied. The length of this filter is automatically determined with the help of the user settings.

The filtered power of the capture buffer is subsequently compared to an automatically chosen threshold and the rising and falling edges of bursts are identified. With the help of the detected edges and some further processing, it is possible to decide whether the burst "candidates" comply with the user settings.

All bursts must have a length between ("Min Burst Length" – "Search Tolerance") and ("Max Burst Length" + "Search Tolerance") to be accepted. See "Continuous Signal / Burst Signal" on page 136 and "Search Tolerance" on page 146 for a more detailed description of these parameters.

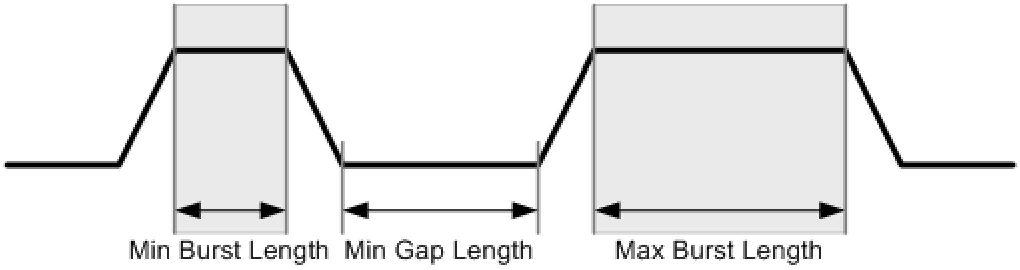


Fig. 4-36: Burst Search parameters

You can influence the robustness of the burst search directly by entering the correct minimum gap length (see "Min Gap Length" on page 146), minimum burst length and maximum burst length. Refer to figure 4-36 for an illustration of the three parameters.

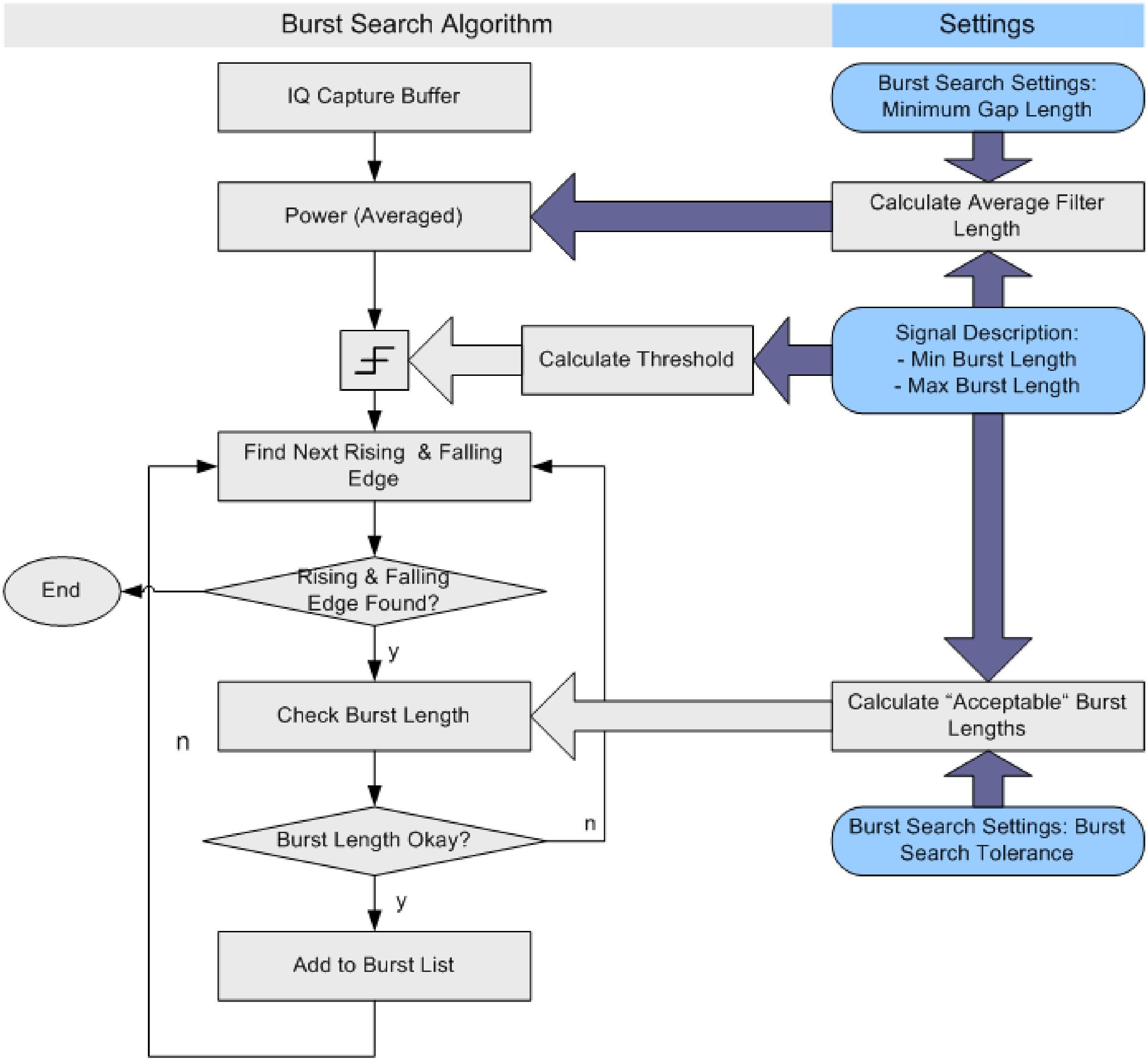


Fig. 4-37: Burst search algorithm

4.1.5.2 I/Q Pattern Search

The I/Q pattern search is performed only if it is switched on. Otherwise, this stage is skipped. The main benefit of the I/Q pattern search is that it enables an alignment of the result range to the pattern. Furthermore, this stage can function as a filter: If the burst search and I/Q pattern search are switched on, and the parameter "Meas Only If Pattern Was Found" is set to true, only bursts with the correct pattern are demodulated (see "Meas only if a pattern was found" on page 147).

During the I/Q pattern search stage, the capture buffer is searched for an I/Q pattern by trying different time and frequency hypotheses. The IQ pattern is generated internally, based on the specified symbol number of the pattern and the signal description (i.e. modulation scheme and transmit filter). The IQ pattern search can also be referred to as the I/Q waveform. An I/Q pattern is considered detected if the correlation metric, i.e. the correlation value between the ideal IQ pattern and capture buffer, exceeds a specified "I/Q Correlation Threshold" (see "I/Q Correlation Threshold" on page 148.)

If the burst search is switched on, the I/Q pattern search only searches the I/Q pattern in bursts previously detected by the burst search. Furthermore, it only finds the first I/Q pattern within each burst. If the burst search is switched off, the I/Q pattern search searches for the I/Q pattern in the entire capture buffer.

4.1.5.3 Demodulation and Symbol Decisions

This stage operates on the Result Range and aims to make the correct symbol decisions. The algorithm is illustrated in figure 4-38 using the example of a QPSK modulation. After timing and scaling recovery, a frequency offset and phase offset estimator is employed.

After this coarse synchronization, the R&S FSV-K70 option makes symbol decisions, i.e. recovers which symbols were transmitted by the device under test (DUT).

Typically, the employed estimators are "non-data-aided" (NDA) estimators. This means that they operate on an unknown data sequence. Since the local oscillators (LO) of the transmitter (device under test) and the receiver (analyzer) are normally not coupled, their phase offset with respect to each other is unknown. The unknown transmission delay between DUT and analyzer adds a further unknown phase offset.

Due to this unknown phase offset, the result of the demodulation can be ambiguous with respect to the absolute phase position because of the rotational symmetry of e.g. a PSK constellation. For example, in the case of non-differential QPSK modulation, the measurement signal, the reference signal and the decided IQ symbols may have a constant phase offset of {0, π/2, π, or 3π/2}. This offset can only be detected and eliminated if a pattern was successfully detected at symbol level (see also chapter 4.1.5.4, "Pattern Symbol Check", on page 47).

If modulation types are used where the information is represented by the phase transition, e.g. differential PSK or MSK, the absolute phase position is not an issue. Thus, the ambiguity of the starting phase does not have an influence on the symbol decisions.

If the measurement signal contains a known pattern, it is also possible to use a "data-aided" (DA) estimator at this stage. This means that the estimator operates on a known data sequence, i.e. the pattern. If the signal contains a pattern, it is possible to choose between the above-described non-data-aided estimator and the data-aided estimator with the flag "Use Pattern For Sync" on page 158. If the data-aided estimator is employed, the phase ambiguitiy can be resolved at this stage.

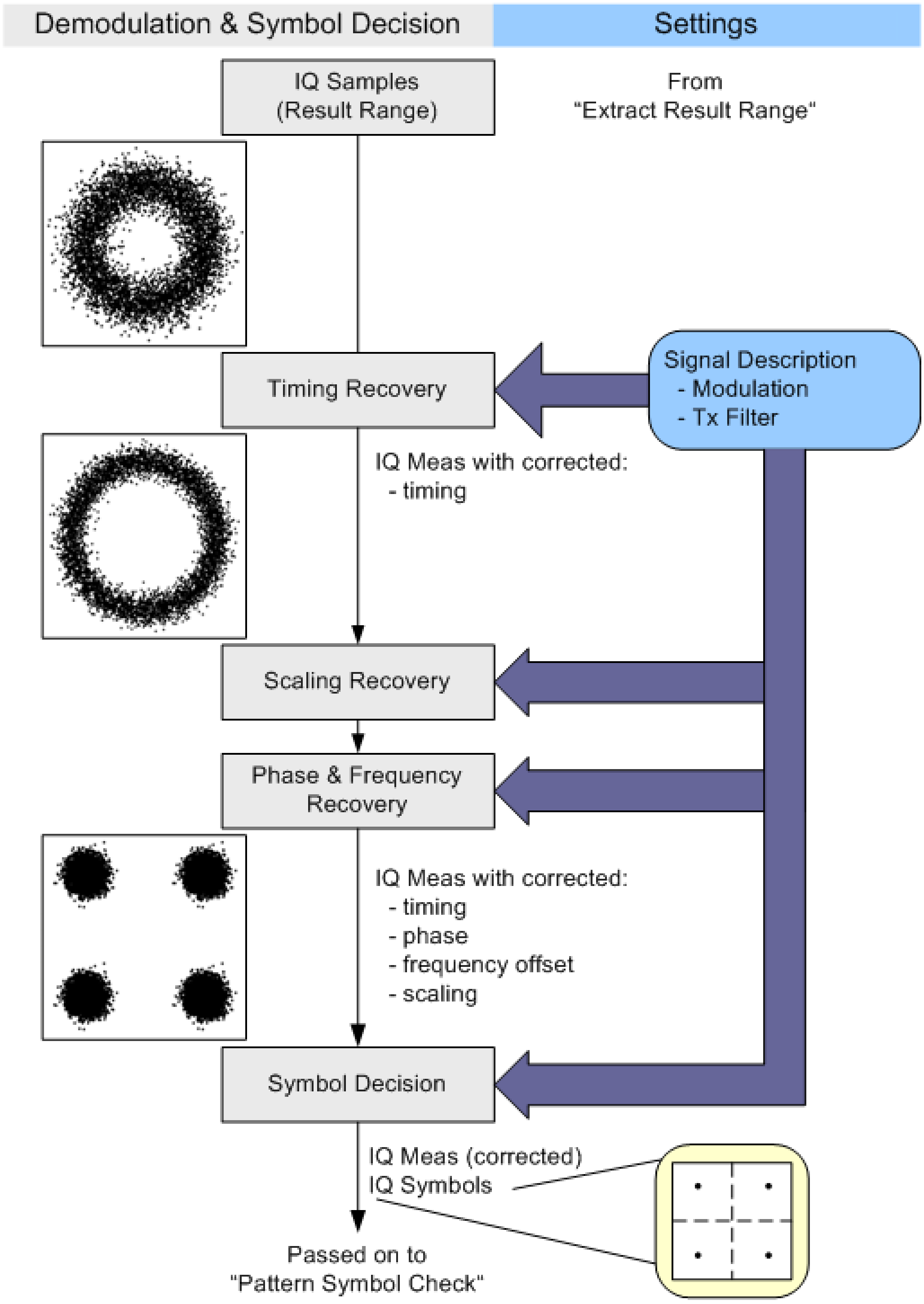


Fig. 4-38: Demodulation and Symbol Decision algorithm

4.1.5.4 Pattern Symbol Check

This stage performs a bit-by-bit comparison between the selected pattern and the demodulated bits. It is important to note that this comparison is only performed at positions that have been identified by the IQ pattern search as possible pattern positions. The algorithm and a simple example are illustrated in figure 4-39.

First, the pattern candidate bits are extracted from the whole bitstream calculated by the "Demodulation & Symbol Decisions" stage. This means that the symbol stream is cut at the position that has been detected by the I/Q Pattern Search as the start of the pattern. The extracted sequence is then compared to the selected pattern.

If the demodulation has been ambiguous with respect to the absolute phase position, the extracted sequence needs to be compared to all possible rotated versions of the selected pattern. For example, in the case of QPSK modulation, the rotational symmetry has the order four, i.e. there are four pattern hypotheses. If the extracted sequence coincides with one of the hypotheses, the pattern is declared as "found" and the absolute phase corresponding to the appropriate hypothesis is passed on. Both the symbol decisions and the IQ measurement signal are then rotated with this pattern phase (for the whole result range), thus resolving the phase ambiguity.

For more information refer to:

- chapter 4.1.5.3, "Demodulation and Symbol Decisions", on page 46
- chapter 4.1.5.2, "I/Q Pattern Search", on page 45

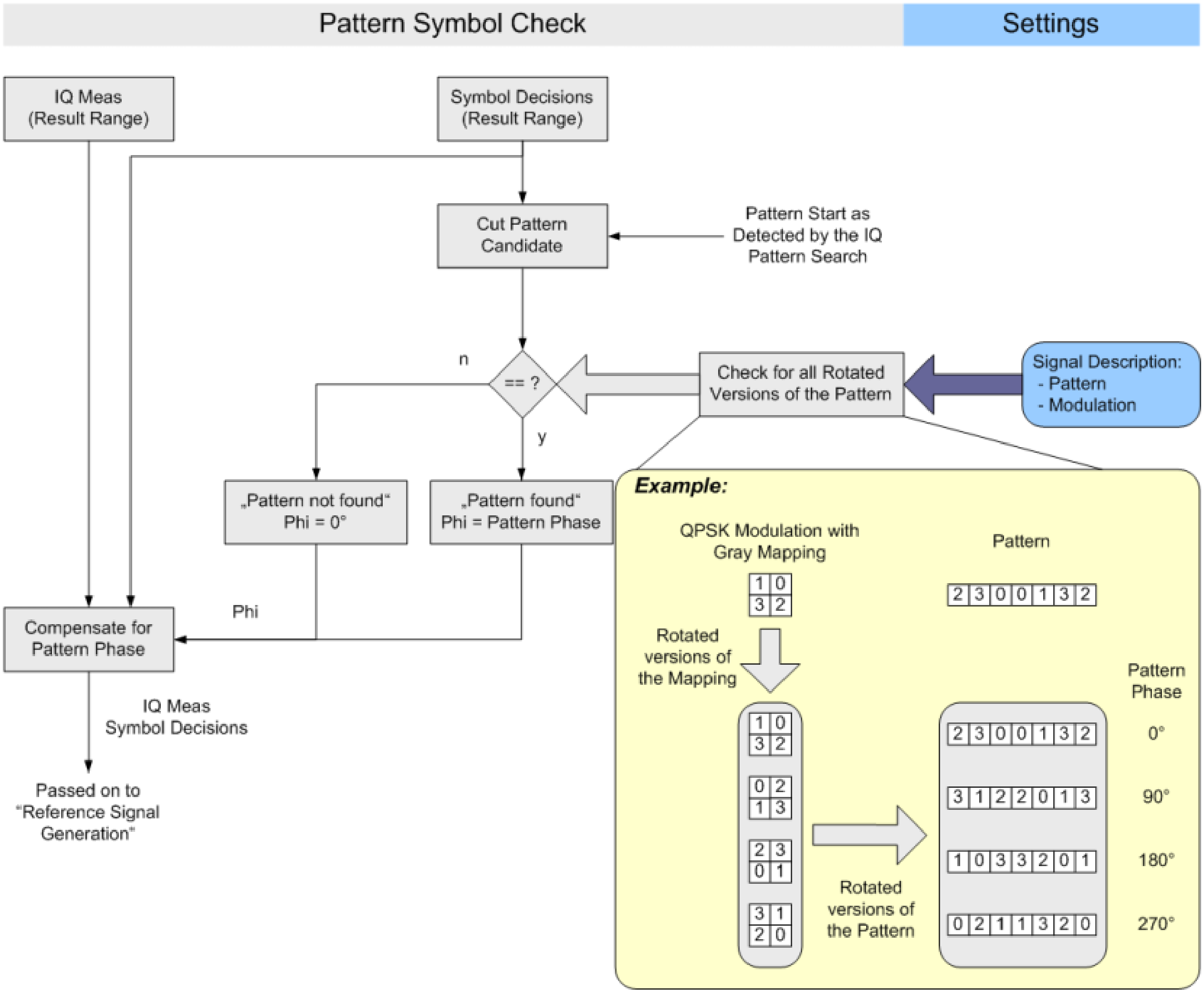


Fig. 4-39: Pattern Symbol Check algorithm

4.1.6 Signal Model, Estimation and Modulation Errors

This section describes the signal and error models used within the R&S FSV-K70 VSA option. The estimation algorithms used to quantify specific modulation errors are then outlined. The chapter is divided into two parts:

4.1.6.1 PSK, QAM and MSK Modulation

Error Model

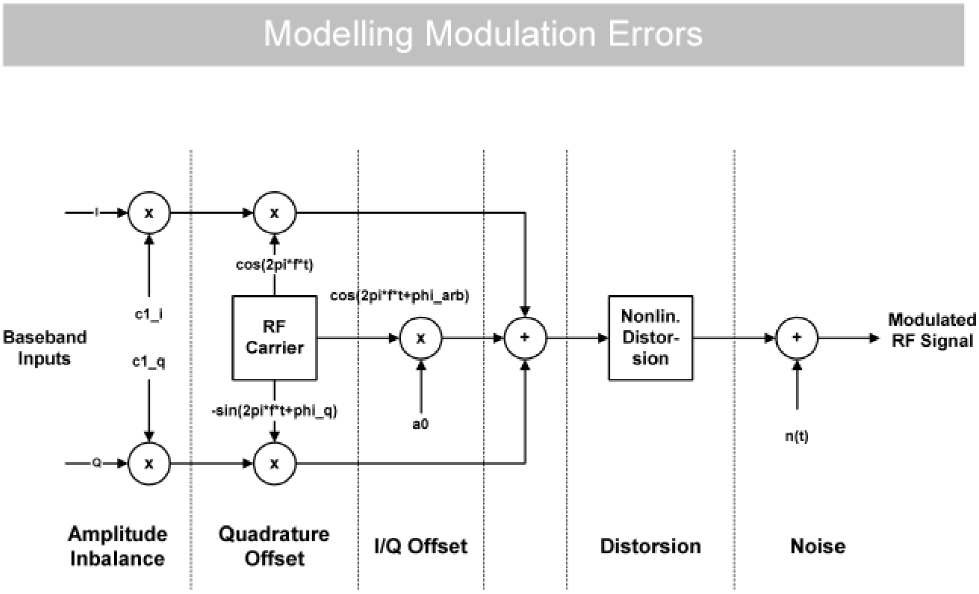


Fig. 4-40: Modelling Modulation Errors

The measured signal model for PSK, QAM and MSK modulation is depicted in figure 4-40 and can be expressed as

$$MEAS(t) = \left(g_I \cdot REF_I(t-\tau) + c_I + j \cdot \left(g_Q \cdot REF_Q(t-\tau) + c_Q\right) e^{j \cdot \vartheta}\right) e^{j \cdot (2\pi f_0 t + \varphi) - \alpha t} + n(t)$$

where:

$REF_I(t)$ and $REF_Q(t)$ are the inphase and quadrature component of the reference signal

g_I and g_Q are the effects of the gain imbalance

c_I and c_Q are due to an IQ offset

ϑ is the quadrature error

α corresponds to the amplitude droop

f_0 is the carrier frequency offset

φ corresponds to the carrier phase offset

τ is the timing offset

n(t) is a disturbing additive noise process of unknown power.

Estimation

The R&S FSV-K70 option includes two synchronization stages. The first stage has already been described in the context of the "Demodulation & Symbol Decisions" block (see chapter 4.1.5.3, "Demodulation and Symbol Decisions", on page 46).

The second stage is realized within the "Synchronization" block. Here, the measurement signal is matched to the reference signal by minimizing the mean square of the error vector magnitude. This is done by selecting the optimum parameter vector $\hat{x}$:

$$\hat{x} = \arg\min_{x}\left\{\sum_{t}\left|MEAS(t) - REF(t,\tilde{x})\right|^2\right\}$$

The minimization takes place at the sample instants specified by the "estimation points per symbol" parameter, i.e.

$$t = n \cdot T_E$$

with T_E denoting the sampling period used for estimation.

Details on the estimation model and also the parameter vector can be found in chapter 4.1.6, "Signal Model, Estimation and Modulation Errors", on page 49.

Subsequently, the measurement signal is corrected with the determined parameter vector. Note that with a subset of the parameters, you can enable or disable correction (see "Demodulation", on page 156).

Estimation ranges

The "estimation ranges" are determined internally according to the signal description:

- For continuous signals, the estimation range corresponds to the entire result range, since it can then be assumed that the signal consists of valid modulated symbols at all time instants.
- For bursted signals, the estimation range corresponds to the overlapping area of the detected burst and the "Result Range". Furthermore, the Run-In/Run-Out ranges (see "Continuous Signal / Burst Signal" on page 136) are explicitly excluded from the estimation range.

In the special case that the signal is indicated as a "burst signal", but is so highly distorted that the burst search cannot detect a burst, the estimation range corresponds to the pattern and (if an offset of the pattern is indicated) the useful part of the burst from its start to the pattern start.

Modulation Errors

Error vector (EV)

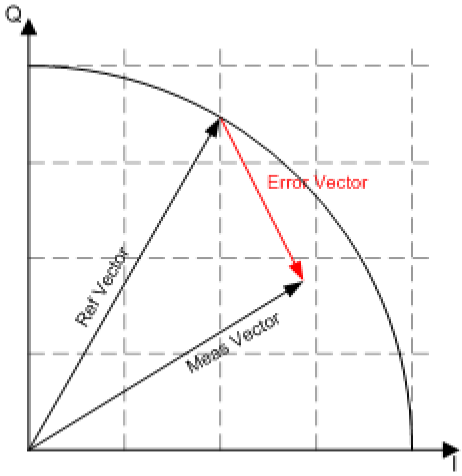


Fig. 4-41: Modulation error: error vector

The error vector is the difference between the measurement signal vector (Meas vector) and the reference signal vector (Ref vector).

Error Vector Magnitude (EVM)

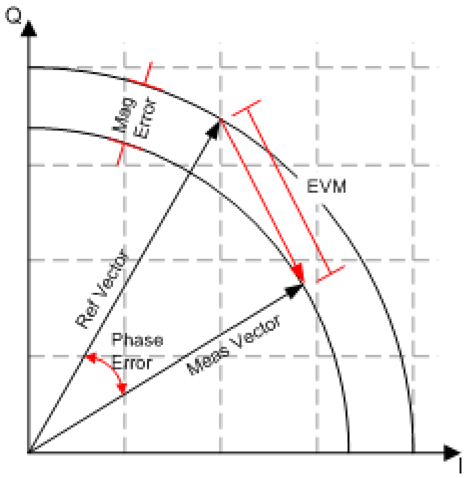


Fig. 4-42: Modulation error: EVM, magnitude error, phase error

The magnitude of the error vector in the diagram is specified as the error vector magnitude (EVM). It is commonly normalized to the mean reference power. The EVM should not be confused with the magnitude error, see below.

Magnitude Error

The magnitude error is defined as the difference between the measurement vector magnitude and the reference vector magnitude (see figure 4-42).

Phase Error

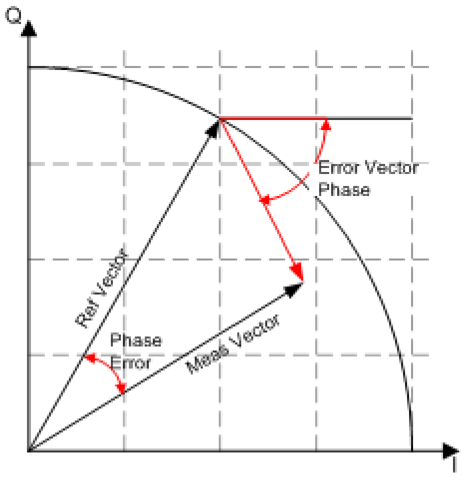


Fig. 4-43: Modulation error: Phase error, error vector phase

The phase error is the phase difference between the measurement vector and the reference vector.

$$PHASE\_ERR(t) = PHASE_{MEAS}(t) - PHASE_{REF}(t)$$

This measurement parameter is of great importance for MSK modulation measurements.

The phase error should not be confused with the error vector phase. The error vector phase is the absolute phase of the error vector (see figure 4-43).

The effects of the different modulation errors in the transmitter on the result display of the analyzer are described on the next pages. All diagrams show the equivalent, complex baseband signal.

Modulation Error Ratio (MER)

The modulation error ratio (MER) is closely related to EVM:

$$MER = -20 \cdot \log_{10}(EVM)$$

where the EVM is normalized to the mean reference power.

I/Q Offset (Origin Offset)

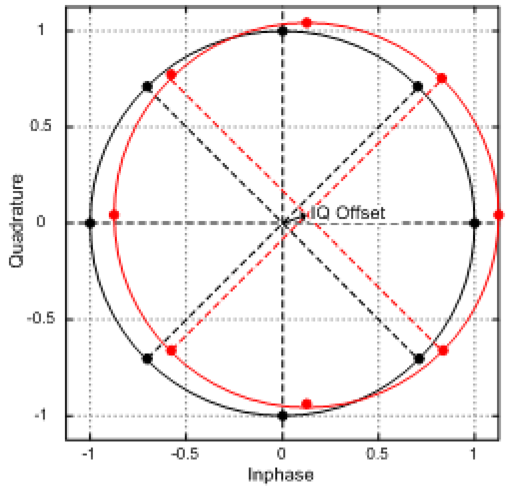


Fig. 4-44: Effect of an I/Q or origin offset after demodulation and error compensation

figure 4-44 shows the effect of an I/Q offset in the transmitter.

The I/Q offset can be compensated for if the corresponding option is selected in the demodulation settings. In this case, the offset does not affect the EVM.

Gain Imbalance

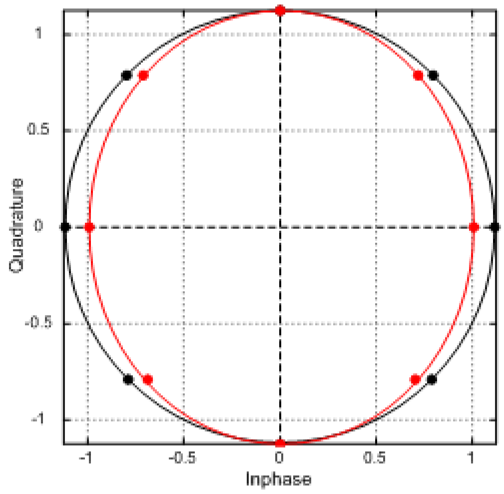


Fig. 4-45: Effect of gain imbalance

The gain difference in the I and Q channels during signal generation in the transmitter is referred to as gain imbalance. The effect of this error on the constellation diagram and the unit circle are shown in figure 4-45. In the example, the gain in the I channel is slightly reduced which causes a distortion of coordinates in the I direction. The unit circle of the ideal constellation points has an elliptic shape.

The gain imbalance can be compensated for if the corresponding option is selected in the demodulation settings. In this case, the imbalance does not affect the EVM.

Note that the gain imbalance is not estimated (and cannot be compensated for) in a BPSK signal.

Preconditions for Gain Imbalance and Quadrature Error measurements

The distortions "gain imbalance" and "quadrature error" can only be measured without ambiguity, if the following two conditions are fullfilled:

- a pattern is detected
- the modulation is a non-differential, non-rotating QAM or PSK

Otherwise, only the measurement parameter "IQ Imbalance", which is a combination of the gain imbalance and the quadrature error, is significant.

Quadrature Error

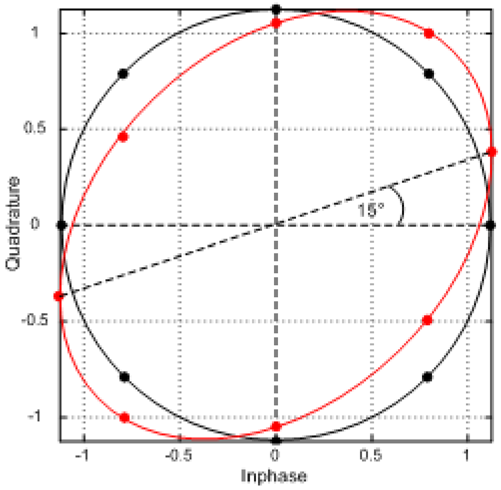


Fig. 4-46: Effect of Quadrature Error

The quadrature error is another modulation error which is shown in figure figure 4-46.

In this diagram, the I and Q components of the modulated carrier are of identical amplitude but the phase between the two components deviates from 90°.

This error also distorts the coordinates. In the example in figure figure 4-46 the Q axis is shifted.

Note that the quadrature error is not estimated (and cannot be compensated for) in a BPSK signal.

I/Q Imbalance

The effect of quadrature error and gain imbalance are combined to form the error parameter I/Q imbalance.

$$B_{[lin]} = \frac{\left| g_I - g_Q \cdot e^{j\theta} \right|}{\left| g_I + g_Q \cdot e^{j\theta} \right|}$$

where g_I and g_Q are the gain of the inphase and the quadrature component and θ represents the quadrature error.

The I/Q imbalance can be compensated for if the corresponding option is selected in the demodulation settings. In this case, the I/Q imbalance does not affect the EVM.

Note that the I/Q imbalance is not estimated (and cannot be compensated for) in a BPSK signal.

Amplitude Droop

The decrease of the signal power over time in the transmitter is referred to amplitude droop.

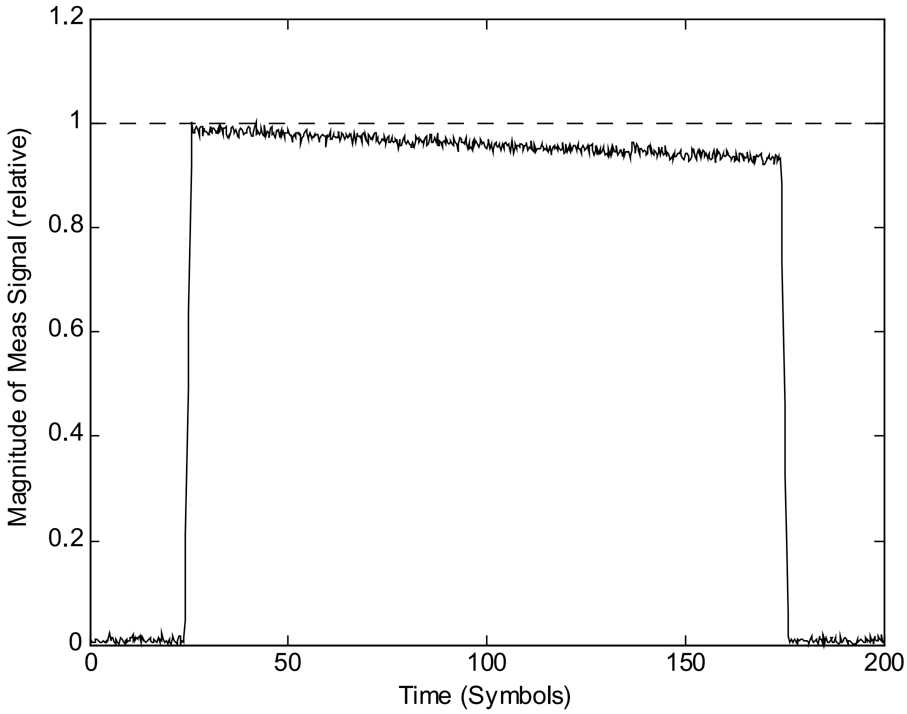
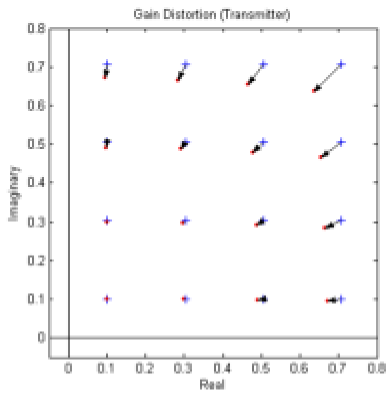
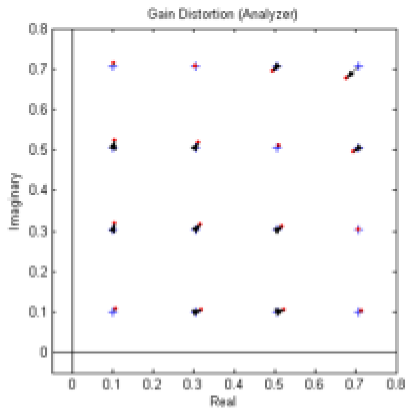


Fig. 4-47: Effect of amplitude droop

Gain Distortion

Table 4-16: Effect of nonlinear amplitude distortions

Nonlinear distortions: amplitude distortion (transmitter)	Amplitude distortion (analyzer)
	

The table 4-16 illustrates the effect of nonlinear amplitude distortions on a 64QAM signal (only the 1st quadrant is shown). The transfer function is level-dependent: the highest effects occur at high input levels while low signal levels are hardly affected. The signal is scaled in the analyzer so that the average square magnitude of the error vector is minimized. The table 4-16 shows the signal after scaling.

Table 4-17: Amplitude transfer functions

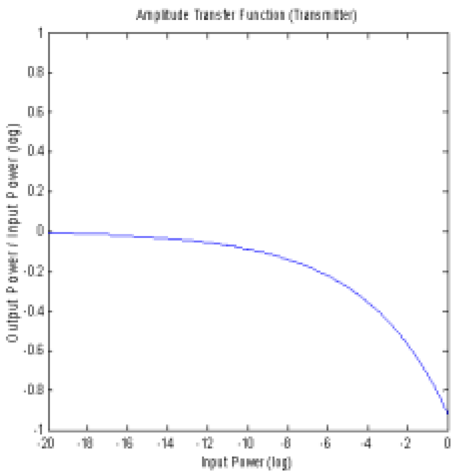
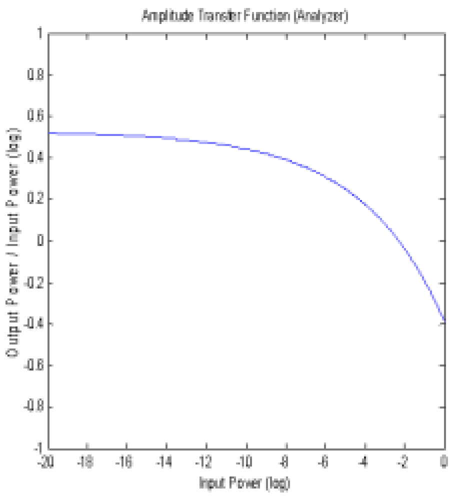
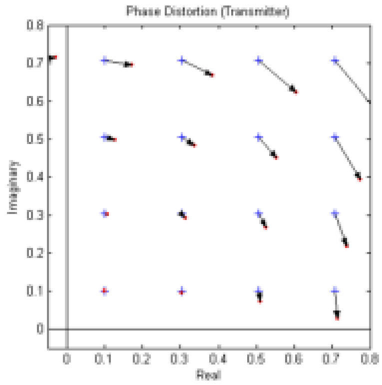
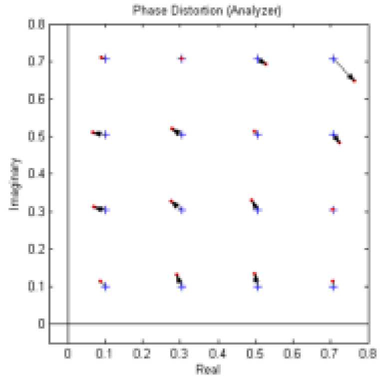
Amplitude transfer function (transmitter)	Amplitude transfer function (analyzer)
	

table 4-17 shows a logarithmic display of the amplitude transfer functions. The analyzer trace is shifted against the transmitter trace by this scale factor.

Phase Distortion

Table 4-18: Effect of nonlinear phase distortions

Nonlinear distortions: phase distortion (transmitter)	Phase distortion (analyzer)
	

The table 4-18 illustrates the effect of nonlinear phase distortions on a 64QAM signal (only the 1st quadrant is shown). The transfer function is level-dependent: the highest effects occur at high input levels while low signal levels are hardly affected. These effects are caused, for instance, by saturation in the transmitter output stages. The signal is scaled in the analyzer so that the average square magnitude of the error vector is minimized. The table 4-18 shows the signal after scaling.

Table 4-19: Phase transfer functions

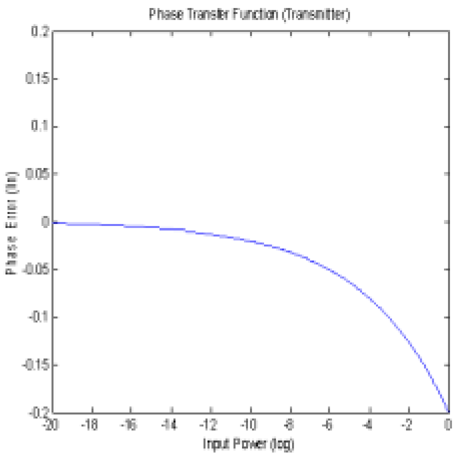
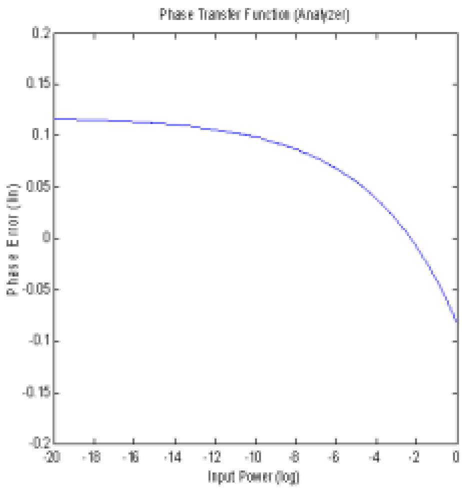
Nonlinear distortions: phase distortion (transmitter)	Phase distortions (analyzer)
	

table 4-19 show a logarithmic display of the phase transfer functions. The analyzer trace is shifted by the phase described above as against the transmitter trace.

Noise

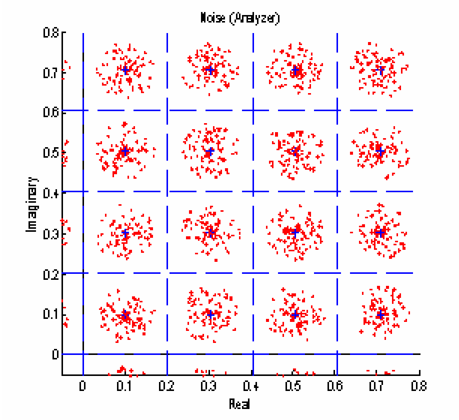


Fig. 4-48: Additive noise

The figure 4-48 shows a 64QAM signal (only the 1st quadrant is shown) with additive noise. The symbol decision thresholds are also shown.

The noise signal forms a "cloud" around the ideal symbol point in the constellation diagram. Exceeding the symbol decision boundaries leads to wrong symbol decisions and increases the bit error rate.

Similar displays are obtained in case of incorrect transmitter filter settings. When an incorrect filter is selected, crosstalk occurs between neighbouring symbol decision points instead of the ISI-free points. The effect increases the more the filtering deviates from actual requirements.

The two effects described cannot be distinguished in the I/Q constellation diagram but in statistical and spectral analyses of the error signal.

4.1.6.2 FSK Modulation

Signal Model

Frequency shift keying (FSK) involves the encoding of information in the frequency of a transmitted signal. As opposed to other modulation formats such as PSK and QAM, the FSK process is a non-linear transform of the transmitted data into the transmitted waveform.

A sequence of symbols $\{s_i\}$ are modulated using a "frequency pulse" *g(t)* to form the instantaneous frequency of the transmitted complex baseband waveform, denoted by $f_{REF}(t)$ and defined as:

$$f_{REF}(t) = h \cdot \sum_i s_i g(t - i \cdot T)$$

where $f_{Symb}=1/T$ is the symbol rate and *h* is a scaling factor, termed the modulation index. The transmitted (or reference) FSK signal is formed by frequency modulation of the instantaneous frequency:

$$REF(t) = e^{j \cdot 2 \cdot \pi \cdot \int_{\infty}^{t} f_{REF}(u) du} = e^{j \cdot \varphi_{REF}(t)}$$

where $\varphi_{REF}(t)$ denotes the phase of the transmitted waveform. In the analyzer-K70 a continuous phase FSK signal is assumed, which is ensured by the integral in the expression for *REF(t)*. A graphical depiction of the reference waveform generation is shown below in Figure figure 4-49.

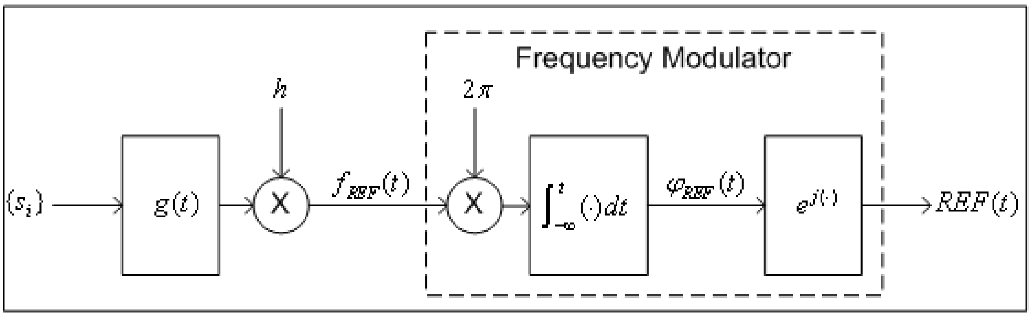


Fig. 4-49: Reference complex baseband FSK signal generation

Reference Deviation

The transmitted symbols $\{s_i\}$ are assumed to be chosen from a finite and real-valued constellation of *M* values; $\{\varsigma_1, \varsigma_2, ..., \varsigma_M\}$. The maximum absolute constellation point is denoted by ς_{MAX}. The maximum phase contribution of a data symbol is given by:

$$\phi_{MAX} = 2 \cdot \pi \cdot h \cdot \varsigma_{MAX} \int_{-\infty}^{\infty} g(t) \cdot dt$$

The reference deviation of the FSK signal is defined as:

$$\Lambda_{REF} = \frac{\phi_{MAX}}{2 \cdot \pi \cdot T} = \frac{1}{T} h \cdot \varsigma_{MAX} \int_{-\infty}^{\infty} g(t) \cdot dt$$

In the R&S FSV-K70 the frequency pulse filter is normalized such that

$$\int_{-\infty}^{\infty} g(t) \cdot dt = \frac{1}{2}$$

and the constellation for *M* FSK is assumed to be *{±1, ±3, ..., ±(M-1)}*, which implies . The expression for the reference deviation in terms of the modulation index is therefore given by:

$$\Lambda_{REF} = \frac{1}{2} \cdot h \cdot (M - 1) \cdot f_{Symb}$$

The above formula provides the necessary calculation for measurement of an FSK signal with known symbol rate and modulation index.

Calculation examples:

The GSM standard describes the transmission of binary data using MSK (i.e. 2FSK) modulation with a modulation index of *h=1/2* at a symbol rate of 270.8333 KHz. The reference deviation is therefore given by:

$$\Lambda_{REF} = \frac{1}{2} \cdot \left(\frac{1}{2}\right) \cdot (2-1) \cdot (270.8333\,\text{kHz}) = 67.7083\,\text{kHz}$$

The APCO Project 25 standard (phase 2) defines a H-CPM signal (i.e. 4FSK) with a modulation index of *h=1/3* and a symbol rate of 6 KHz. The reference deviation is:

$$\Lambda_{REF} = \frac{1}{2} \cdot \left(\frac{1}{3}\right) \cdot (4-1) \cdot (6\,\text{kHz}) = 3\,\text{kHz}$$

Error Model

The FSK measurement model used assumes that signal distortions in both the magnitude and phase/frequency are present, as well as additive noise. The measured signal model is expressed as:

$$MEAS(t) = A_{DIST}(t) \cdot e^{j \cdot \varphi_{DIST}(t)} + n(t)$$

with

n(t) is a disturbing additive noise process of unknown power,

$A_{DIST}(t)$ is the distorted magnitude model and

$\varphi^{DIST(t)}$ is the distorted phase model.

The magnitude model is given by:

$$A_{DIST}(t) = K \cdot e^{-\alpha \cdot t}$$

with

K is a constant scaling factor which can be interpreted as the system gain and

α is the amplitude droop in Nepers per second.

The phase model is given by:

$$\varphi_{DIST}(t) = B \cdot \varphi_{REF}(t-\tau) + C \cdot t + \tfrac{1}{2} D \cdot t^2 + \phi$$

with

B is a scaling factor which results in a reference deviation error,

C is a carrier frequency offset in radians per second,

D is a frequency drift in radians per second per second,

τ is a timing offset in seconds and

ϕ is a phase offset in radians.

For the above phase model, an equivalent frequency distortion model may be expressed as:

$$f_{DIST}(t) = B \cdot f_{REF}(t-\tau) + f_0 + f_d \cdot t$$

with

B is the scaling factor which results in a reference deviation error,

$f_0 = C/(2 \cdot \pi)$ is a carrier frequency offset in Hz,

$f_0 = D/(2 \cdot \pi)$ is a frequency drift in Hz per second and

τ is the timing offset in seconds.

The measured signal model in terms of the instantaneous frequency and all distortion parameters is given by:

$$MEAS(t) = K \cdot e^{-\alpha \cdot t} \cdot e^{j \cdot \phi} \cdot e^{j \cdot 2 \cdot \pi \cdot \left[B \cdot \int_{-\infty}^{t} f_{REF}(u-\tau)du + f_0 \cdot t + \frac{1}{2} f_d \cdot t^2 \right]} + n(t)$$

Estimation

The estimation of the distortion parameters listed previously is performed separately for the magnitude and phase/frequency distortions, as illustrated in figure 4-50. It is noted that the estimation of the timing offset is performed only on the frequency of the signal, as the reference magnitude is assumed to be constant over the estimation range. For details on the estimation range, see "Estimation", on page 51.

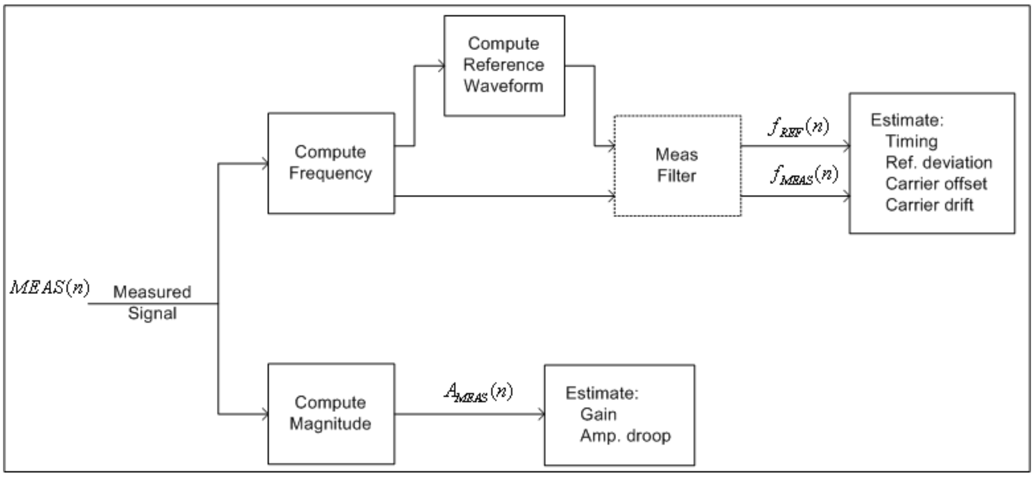


Fig. 4-50: FSK Estimation Strategy

In figure 4-50 *MEAS(n)* denotes the sampled (complex baseband) measured signal waveform. The magnitude samples are denoted $A_{MEAS}(n)$, while the instantaneous frequency samples of the measured and reference signals are denoted by $f_{MEAS}(n)$ and $f_{REF}(n)$ respectively. The dashed outline of the “Meas Filter” block indicates that this operation is optionally (de-) activated based on the corresponding user settings (see "Measurement Filter", on page 160).

For the estimation of the magnitude parameters, the following least-squares criterion is minimized:

$$C_{MAG}(K,\alpha)=\sum_{n}\left|A_{MEAS}(n)-K\cdot e^{-\alpha\cdot n\cdot T_E}\right|^2$$

with respect to the model parameters *K* and α, where T_E denotes the sampling period used for estimation (see "Estimation Points/Sym" on page 158).

For estimation of the frequency parameters, the following least-squares criterion is minimized:

$$C_{FREQ}(B,f_0,f_d,\tau)=\sum_{n}\left|f_{MEAS}(n)-\left[B\cdot f_{REF}(n;\tau)+f_0+f_d\cdot n\cdot T_E\right]\right|^2$$

with respect to the model parameters *B*, f_0, f_d and τ. The term denotes the reference instantaneous frequency with a (possibly fractional) delay of samples.

For FSK modulation the default sampling period used for estimation is the capture sampling period.

Modulation Errors

A 2FSK signal is generated using a GMSK frequency pulse. Examples of carrier drift and reference deviation are shown in figure 4-51 and figure 4-52 respectively.

Carrier frequency drift

A carrier frequency drift is modeled as a linear change in the carrier frequency with respect to time. The effect of carrier drift on the instantaneous frequency of an FSK signal is illustrated in figure 4-51.

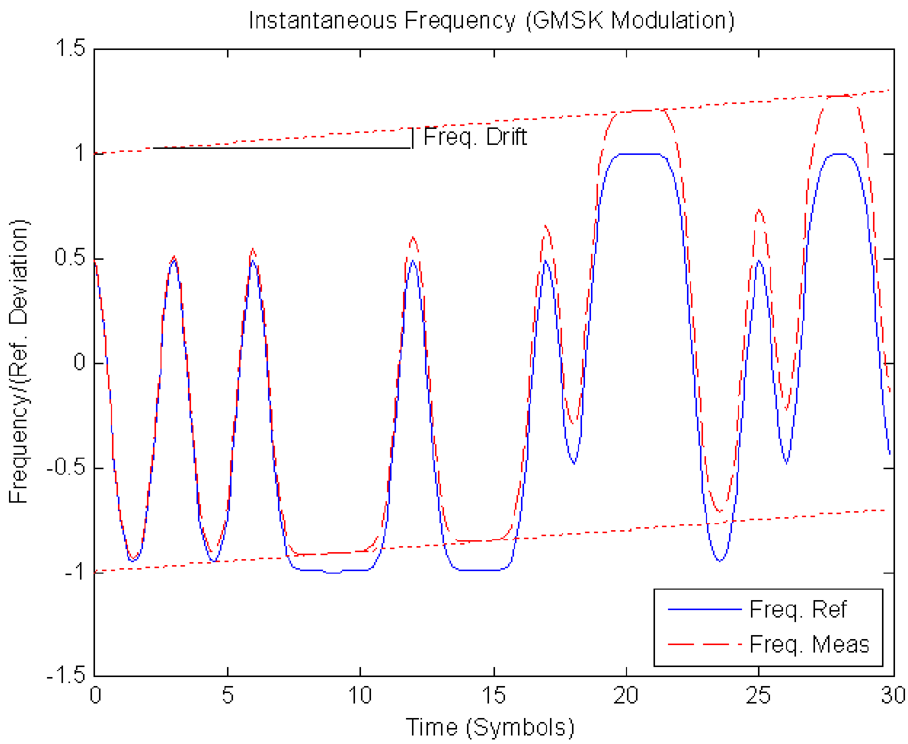


Fig. 4-51: The reference and distorted instantaneous frequency of a GMSK signal with a carrier frequency drift

FSK deviation error

The FSK deviation error is the difference between the measured frequency deviation and the reference frequency deviation as entered by the user (see "FSK Ref Deviation" on page 134). The evidence of a deviation error in the instantaneous frequency of an FSK signal is demonstrated in figure 4-52.

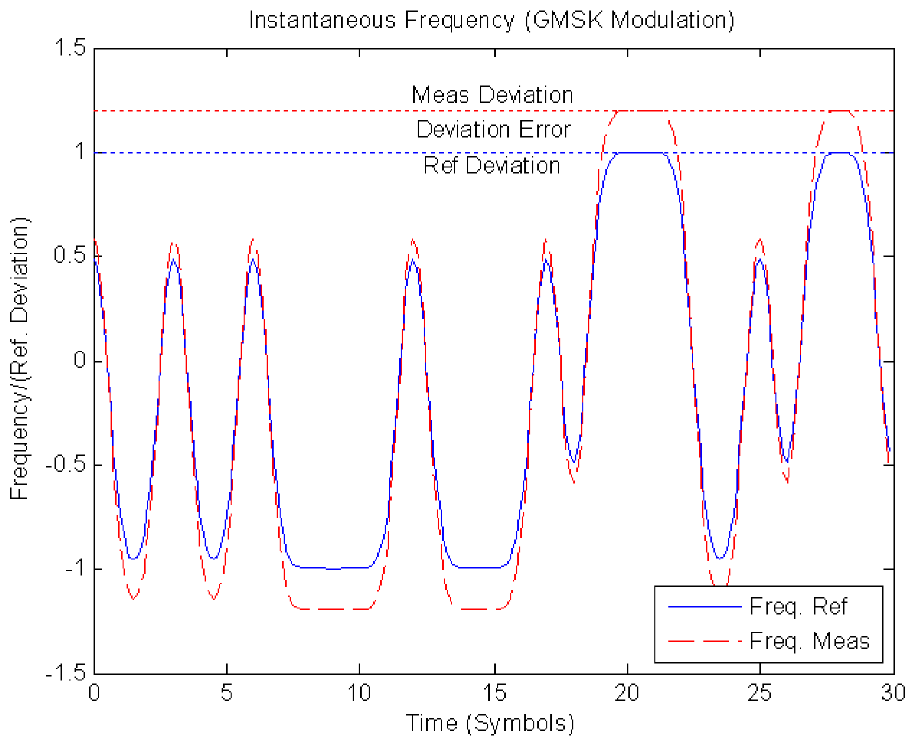


Fig. 4-52: The reference and measured instantaneous frequency of a GMSK signal with reference deviation error

4.2 First Measurements – Getting Started

With the help of a few sample measurements for the digital GSM and EDGE standards, this chapter gives a quick introduction to typical vector analyzer measurements. The individual measurements are in logical order and should familiarize the user gradually with the measurements required of general vector signal analysis.

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

- 1 test transmitter (GSM-compatible), preferably R&S SMU (1141.2005.02)
- 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.

4.2.1 Connecting the Transmitter and Analyzer

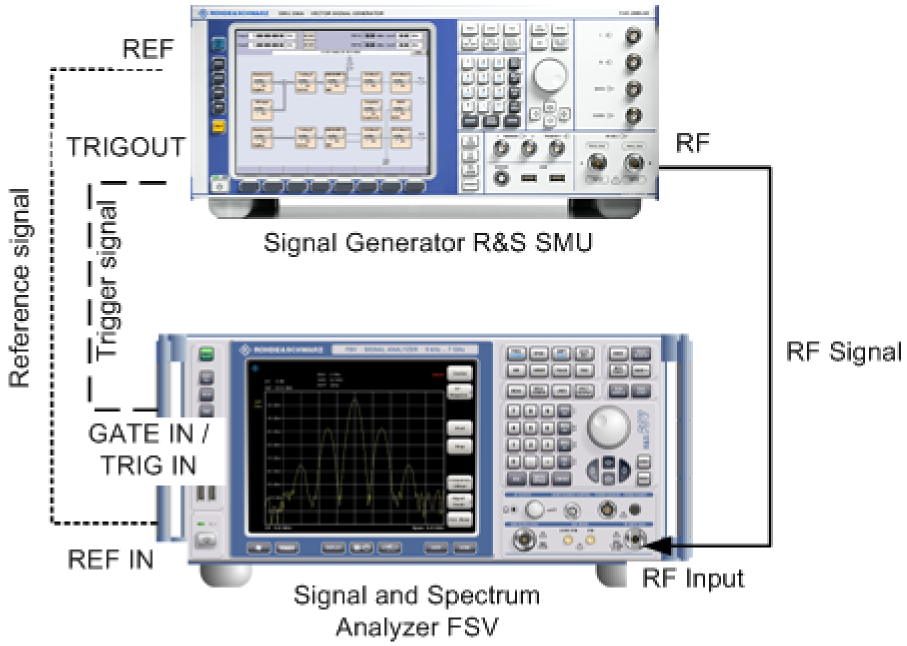


Fig. 4-53: Connection to a test transmitter (for example R&S FSV)

4.2.2 Basic Settings of Test Transmitter

The following frequency and level settings are made on the test transmitter for the measurements below:

Table 4-20: Basic settings of test transmitter for first measurements

Parameter	Setting
Level	0 dBm
Frequency	2 GHz

Transmitter settings for the various measurements are described below.

Basic settings for GSM/EDGE

- Digital standard: *GSM/EDGE*
- State: *ON*

EDGE Single Burst

Measurement 1

1. Save/Recall Frame
2. Get predefined Frame

3. EDGE0

4.2.3 Basic Analyzer Settings for EDGE Measurements

In the default setting after PRESET, the analyzer is in the analyzer mode.

In this mode the following settings must be made:

Table 4-21: Basic instrument settings

Parameter	Setting
Frequency	2 GHz
Reference level	+6 dBm

The following settings of the R&S FSV-K70 option are enabled after the vector signal analyzer mode and the digital standard "GSM > EDGE_NormalBurst" are selected.

Table 4-22: Basic setting for vector signal analysis measurements

Parameter	Setting
Digital standard	EDGE_NormalBurst
Sweep	CONTINUOUS
Burst search	ON
Pattern search	ON
Pattern	EDGE_TSC0
Display mode	Screen A: EVM Screen B: Result Summary Screen C: Magnitude (Capture buffer) Screen D: Symbol Table

4.2.4 Measurement 1: Demodulation of a Single EDGE Burst

Objective of the measurement:

- Demodulation of a single EDGE burst and result display
- Switchover of result display to "I/Q VECTOR"
- Disabling the measurement filter and measuring the raw transmitter signal

Instrument settings:

- Transmitter: GSM default setting: *EDGE Single Burst*
- Analyzer: Digital GSM standard: *EDGE_NormalBurst*
- "Adjust Ref Level"

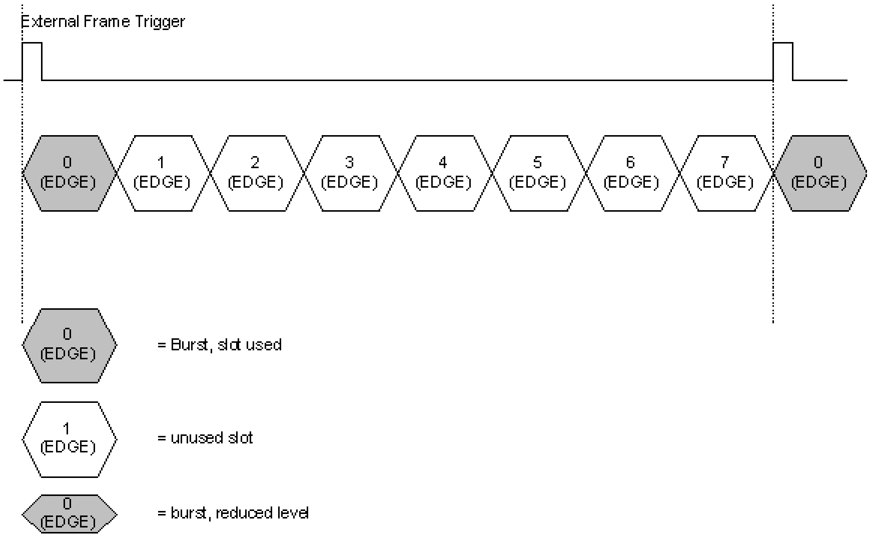


Fig. 4-54: Measurement 1: Frame structure

The burst numbers in the drawing correspond to the timeslots of the GSM frame structure.

The transmitter settings cause a single EDGE burst in time slot 0. The time slots 1 to 7 are not assigned.

Measurement:

The figure 4-55 shows a typical result display of the analyzer for the EDGE standard.

In screen A of the result display, the magnitude of the error vector is plotted over time; in screen B, numeric error values in the range of the evaluation lines are listed. In screen C, the symbol table (including the highlighted pattern) is displayed.

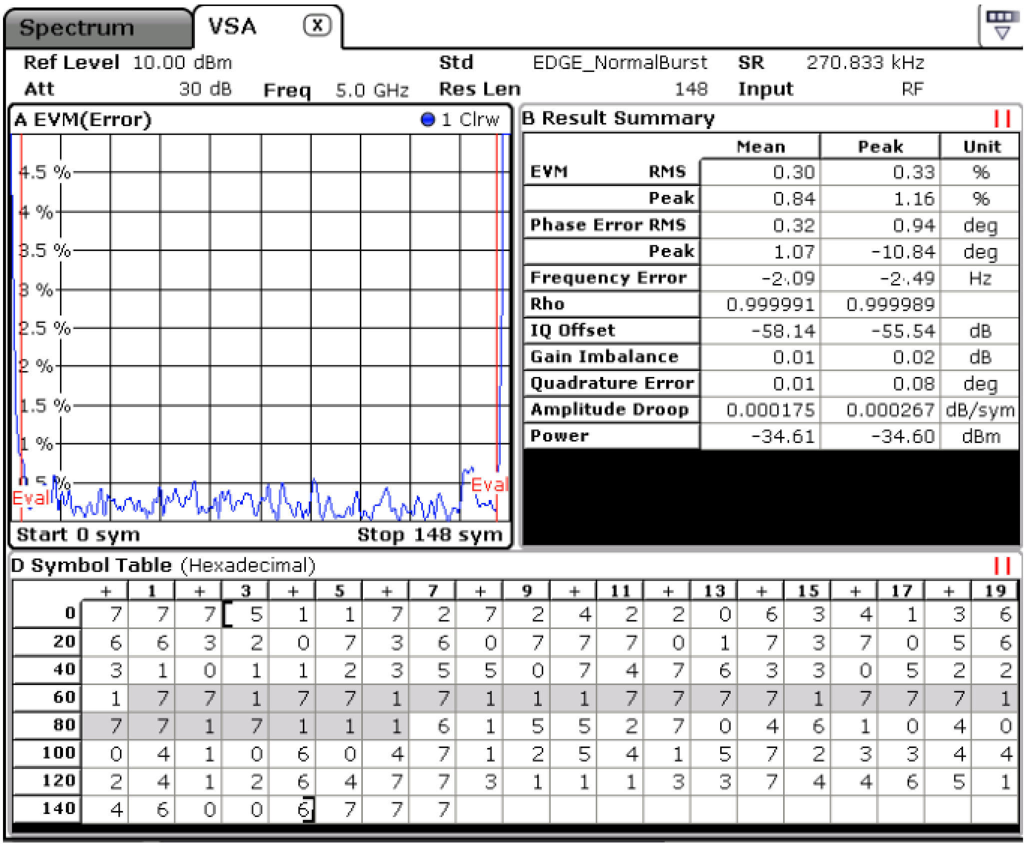


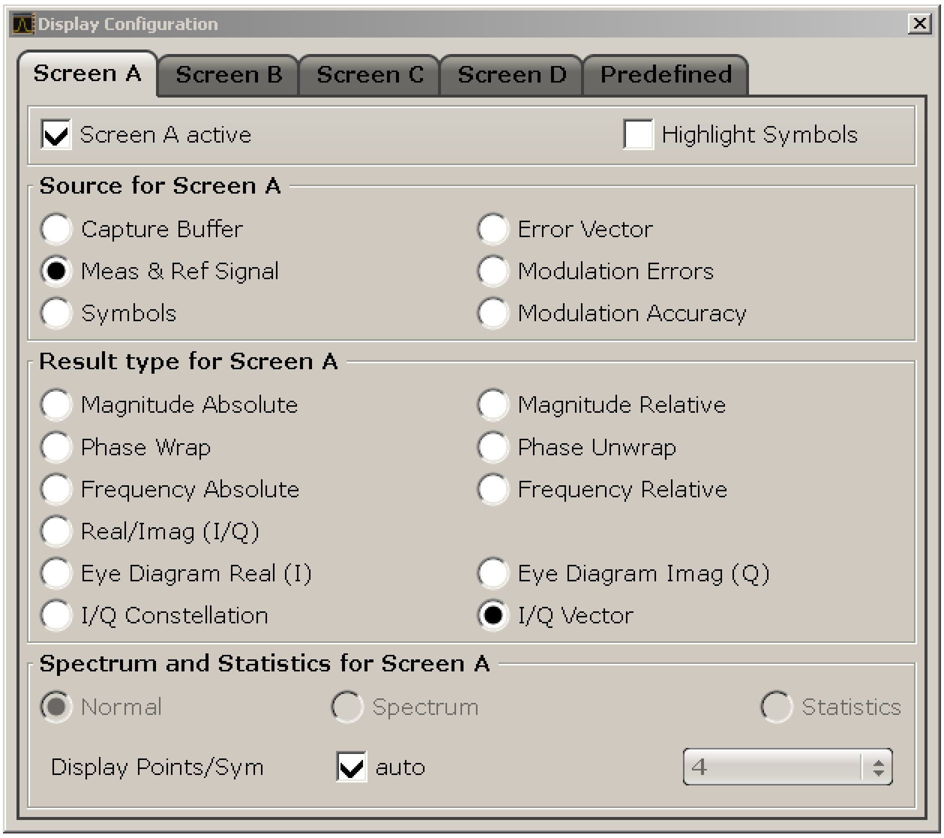
Fig. 4-55: Measurement 1: Result display of analyzer

For this kind of measurement with adequately set reference level and synchronization of reference oscillators between transmitter and analyzer, the following results should be displayed.

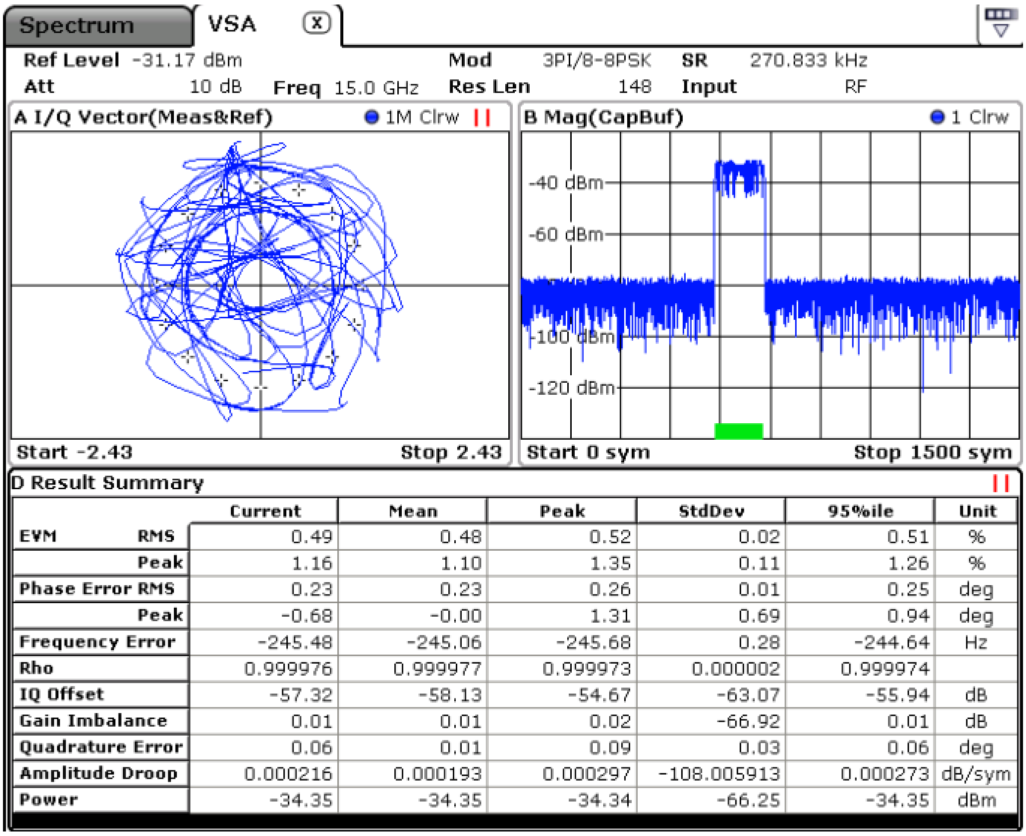
RMS EVM:	<0.5 %
Center frequency error:	<2 Hz

The EDGE measurement should be performed with the measurement filter prescribed by ETSI. If the digital standard "EDGE" is selected, this filter is automatically switched on.

In order to display the I/Q Vector digarm of the measurement signal, define the following Display Configuration settings by selecting the MEAS key and then "Display Config".



If you turn off the measurement filter using "MEAS CONFIG > Demod/Meas Filter > Measurement Filter", Type: "NONE", the measurement is performed on the raw transmitter signal (before filtering with the measurement filter). The associated display is shown in figure 4-56.



		Current	Mean	Peak	StdDev	95%ile	Unit
EVM	RMS	0.49	0.48	0.52	0.02	0.51	%
	Peak	1.16	1.10	1.35	0.11	1.26	%
Phase Error	RMS	0.23	0.23	0.26	0.01	0.25	deg
	Peak	-0.68	-0.00	1.31	0.69	0.94	deg
Frequency Error		-245.48	-245.06	-245.68	0.28	-244.64	Hz
Rho		0.999976	0.999977	0.999973	0.000002	0.999974	
IQ Offset		-57.32	-58.13	-54.67	-63.07	-55.94	dB
Gain Imbalance		0.01	0.01	0.02	-66.92	0.01	dB
Quadrature Error		0.06	0.01	0.09	0.03	0.06	deg
Amplitude Droop		0.000216	0.000193	0.000297	-108.005913	0.000273	dB/sym
Power		-34.35	-34.35	-34.34	-66.25	-34.35	dBm

Fig. 4-56: Measurement 1: Measurement without a measurement filter

Switching off the measurement filter may also influence the numeric result display: high-frequency noise components are then no longer suppressed.

4.3 Instrument Functions for Vector Signal Analysis

To open the VSA menu

If the "Vector Signal Analysis" (VSA) mode is not the active measurement mode, press the MODE key and select the "VSA" softkey.

If the "VSA" mode is already active, press the HOME key. The "VSA" menu is displayed.

After activation, the contents of the menus are adapted to the functions of the VSA option. The menus of the option are described in chapter 4.3.2, "Softkeys and Menu Overview for Vector Signal Analysis (R&S FSV-K70)", on page 99

SCPI command: `INSTrument:SELect` on page 238

Menu and Softkey Description

Apart from the "Span", "Bandwidth", "Marker Functions" and "Lines" menus, which are not available in the "VSA" mode, all menus not mentioned below are provided as described for the base unit.

The MEAS key opens a submenu identical to the "VSA" menu, and additionally displays the "Display Configuration", on page 162 dialog box when pressed.

Measurement Result Display

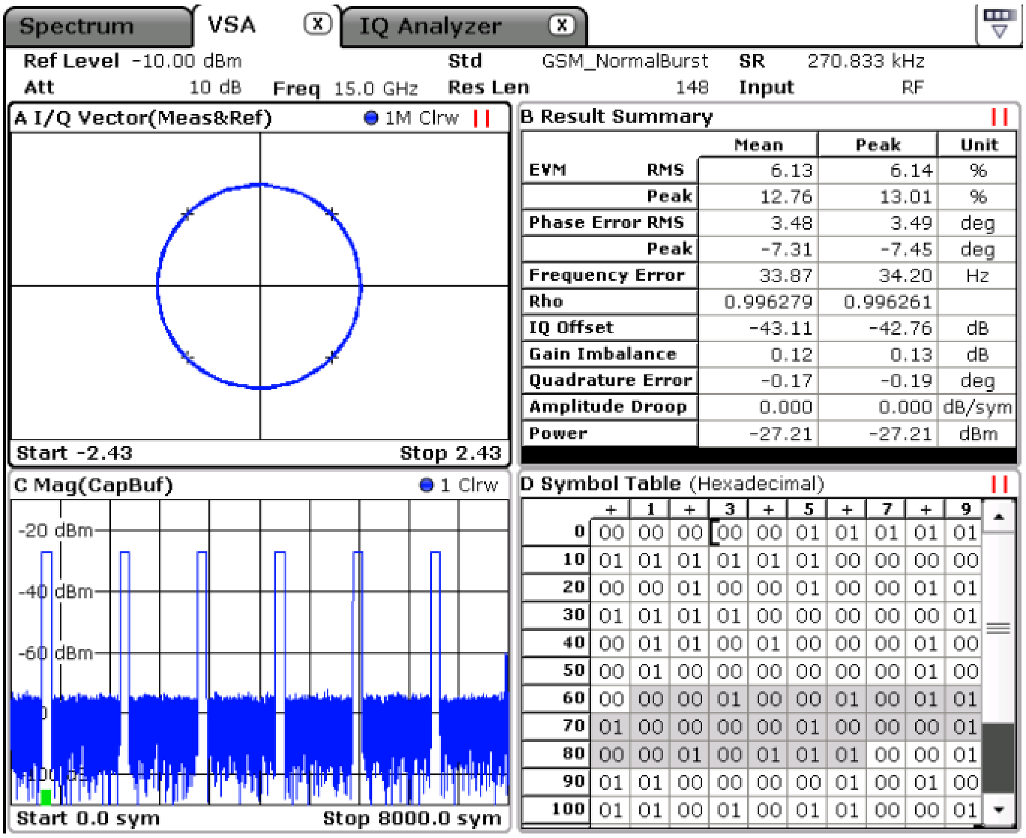
Various different result displays for VSA measurements are available. The different display types are described in chapter 4.3.1, "Measurement Result Display", on page 73.

Further Information

- chapter 4.3.4.1, "Trace Mode Overview", on page 179
- chapter 4.3.4.2, "ASCII File Export Format", on page 181

4.3.1 Measurement Result Display

Various different result displays for VSA measurements are available. You select the display using the "Display Config" softkey in the "VSA" menu (see "Display Configuration", on page 162), or by pressing the MEAS key. Which result types are available depends on the selected data source. Furthermore, for some result types, you can display either spectral, statistical, or time domain results. You can define which part of the signal is to be evaluated and configure the alignment of the result range (see "Result Range and Evaluation Range Settings", on page 152). You can also define how detailed the trace is displayed (Display Points/Sym parameter in the "Display Configuration" dialog).



4.3.1.1 Result types

The following result types are available, depending on the source type:

Magnitude Absolute

Magnitude of the source signal; the actual signal amplitude is displayed

$$Mag_{MEAS}(t) = |MEAS(t)|$$

with $t = n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

Available for source types:

- Capture Buffer
- Meas & Ref Signal

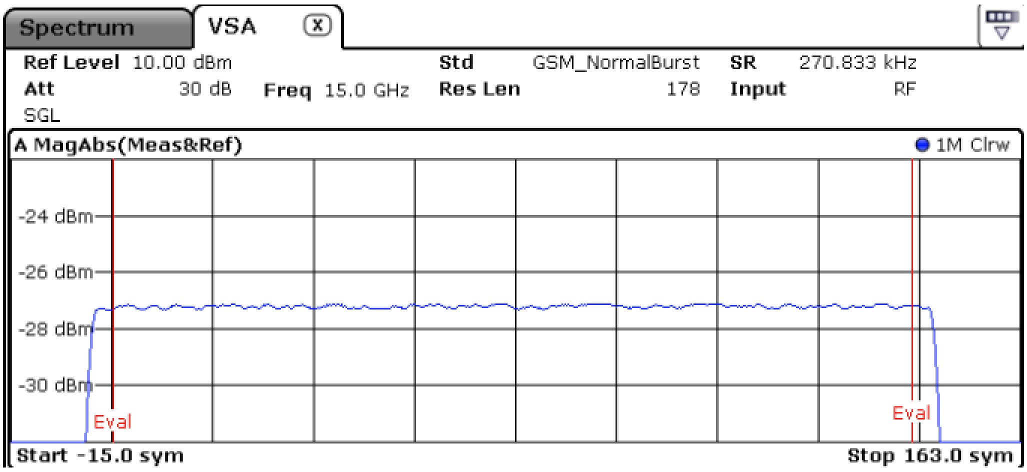


Fig. 4-57: Result display "Magnitude Absolute" in normal mode

Magnitude Relative

Magnitude of the source signal; the signal amplitude is scaled to the ideal reference signal

Available for source types:

- Meas & Ref Signal

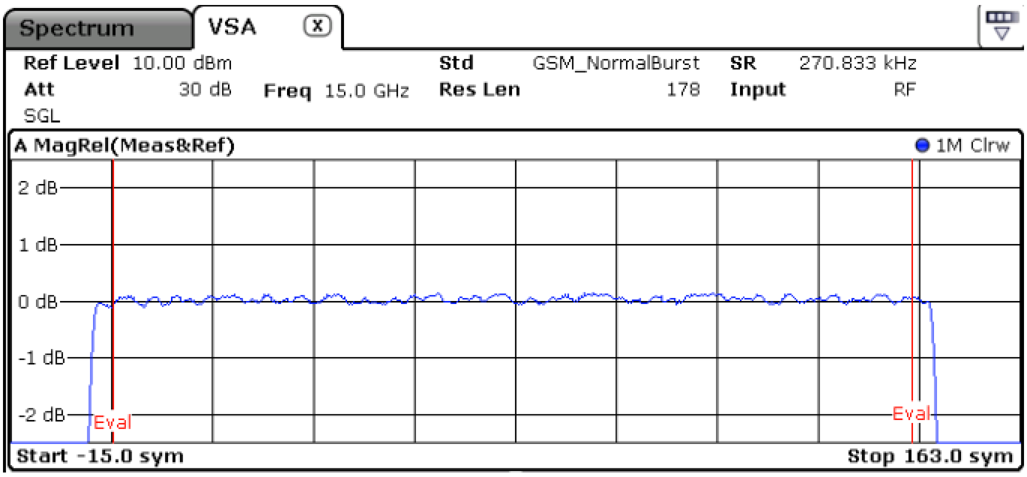


Fig. 4-58: Result display "Magnitude Relative" in normal mode

Phase Wrap

The phase or argument of the signal; the display is limited to the phase value range of [-180°, 180°]

$$Phase_{MEAS}(t) = \angle(MEAS(t))$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

Available for source types:

- Meas & Ref Signal

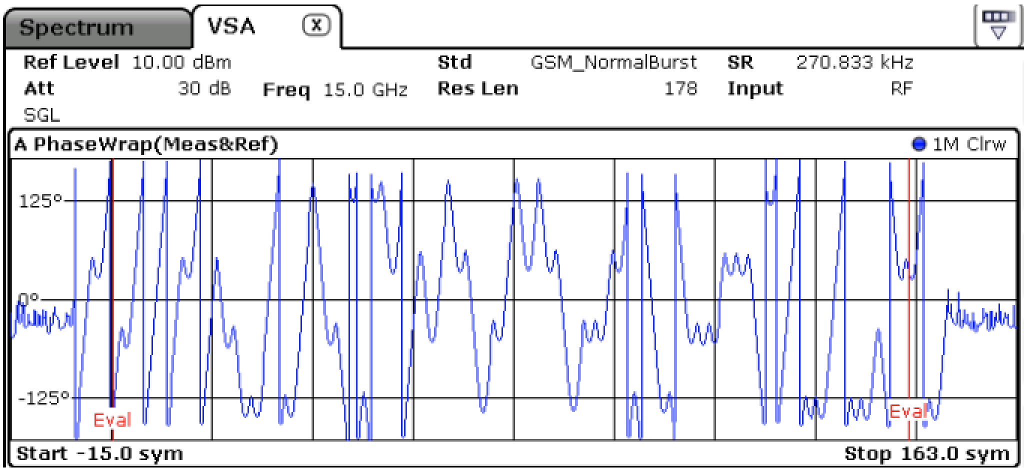


Fig. 4-59: Result display "Phase Wrap" in normal mode

Phase Unwrap

The phase of the signal; the display is not limited to [-180°, 180°].

Available for source types:

- Meas & Ref Signal

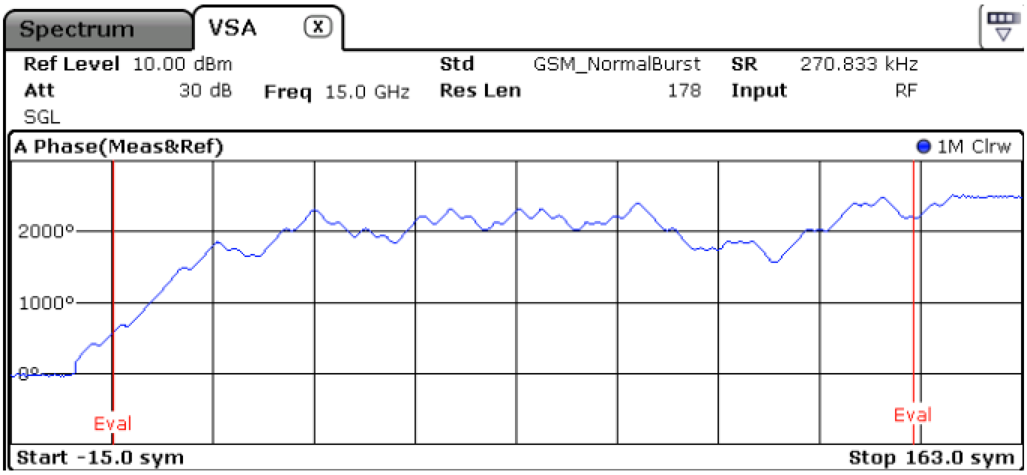


Fig. 4-60: Result display "Phase Unwrap" in normal mode

Frequency Absolute

The instantaneous frequency of the signal source; the absolute value is displayed in Hz.

$$FREQ_{MEAS}(t) = \frac{1}{2 \cdot \pi} \frac{d}{dt} \angle MEAS(t)$$

with $t = n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

This measurement is mainly of interest when using the MSK or FSK modulation, but can also be used for the PSK/QAM modulations. However, since these modulations can have transitions through zero in the I/Q plane, in this case you might notice uncritical spikes. This is due to the fact that the phase of zero (or a complex value close to zero) is of limited significance, but still influences the result of the instantaneous frequency measurement.

Available for source types:

- Meas & Ref Signal

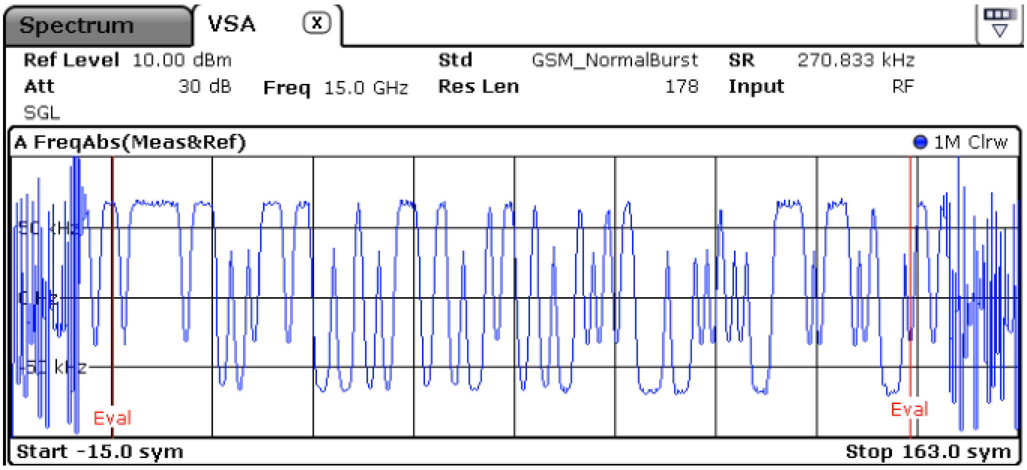


Fig. 4-61: Result display "Frequency Absolute" in normal mode

Frequency Relative

The instantaneous frequency of the signal source.

The results are normalized to the symbol rate (PSK and QAM modulated signals), the estimated FSK deviation (FSK modulated signals) or one quarter of the symbol rate (MSK modulated signals).

$$FREQ_{MEAS}(t)=\frac{1}{2\cdot\pi}\frac{d}{dt}\angle MEAS(t)$$

with $t=n\cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

This measurement is mainly of interest when using the MSK or FSK modulation, but can also be used for the PSK/QAM modulations. See also the note for Frequency Absolute.

Available for source types:

- Meas & Ref Signal

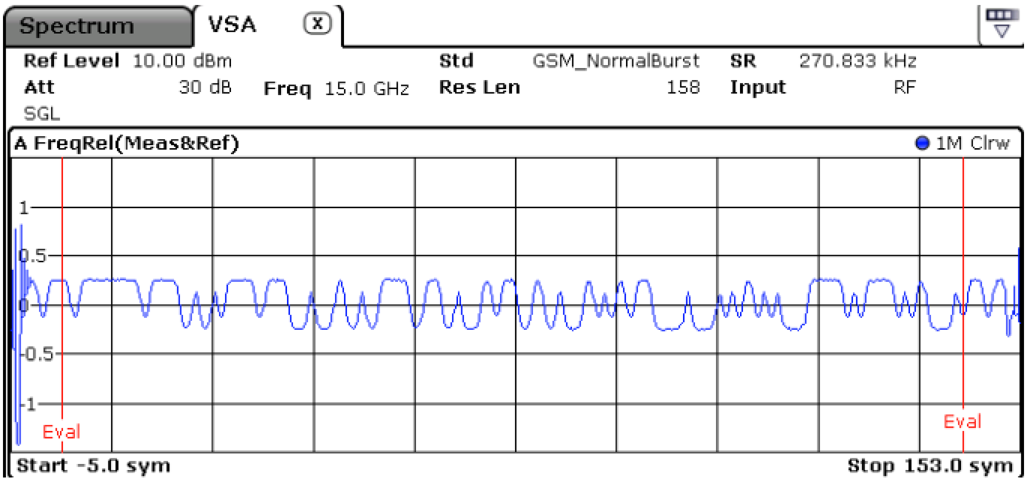


Fig. 4-62: Result display "Frequency Relative" in normal mode

Real/Imag (I/Q)

Real and imaginary part of the measurement or reference signal in separate measurement diagrams; the x-axis (scaled in time units or symbols) is identical for both diagrams

The scaling of the capture buffer is

- relative to the current reference level if you are using the RF input and
- relative to the full scale level if you are using the I/Q input

Available for source types:

- Capture Buffer
- Meas & Ref Signal
- Error Vector

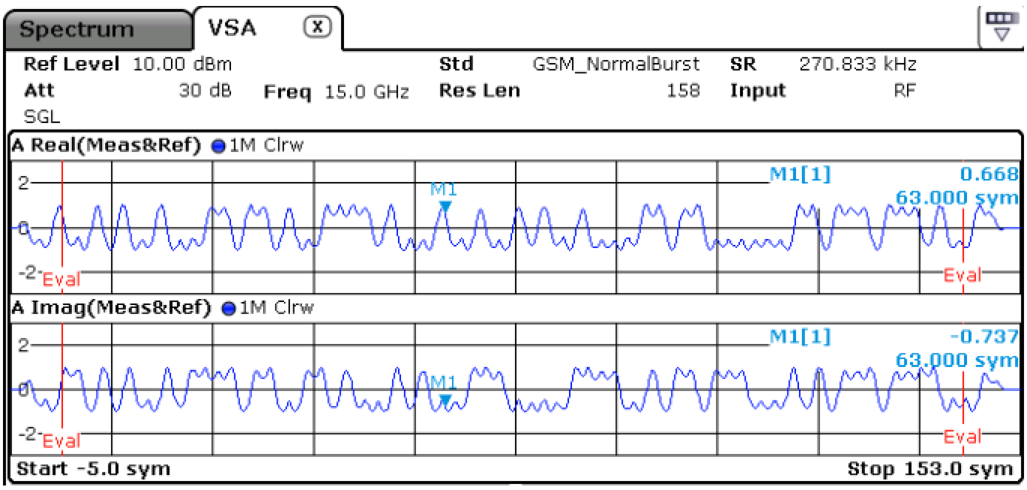


Fig. 4-63: Result display "Real/Imag (I/Q)" in normal mode

Eye Diagram Real (I)

The eye pattern of the inphase (I) channel; the x-axis value range is from -1 to +1 symbols (MSK: -2 to +2)

Available for source types:

- Meas & Ref Signal

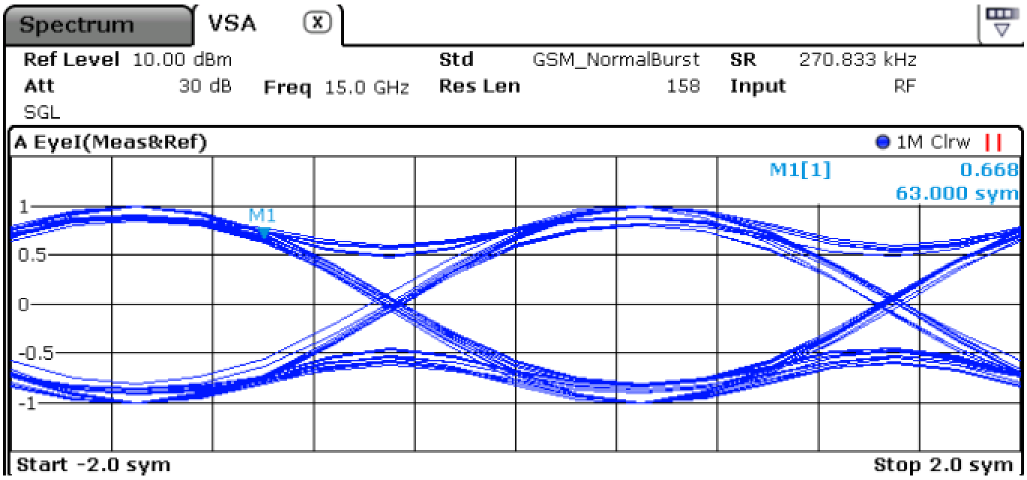


Fig. 4-64: Result display "Eye Diagram Real (I)" in normal mode

Eye Diagram Imag (Q)

The eye pattern of the quadrature (Q) channel; the x-axis range is from -1 to +1 symbols (MSK: -2 to +2)

Available for source types:

- Meas & Ref Signal

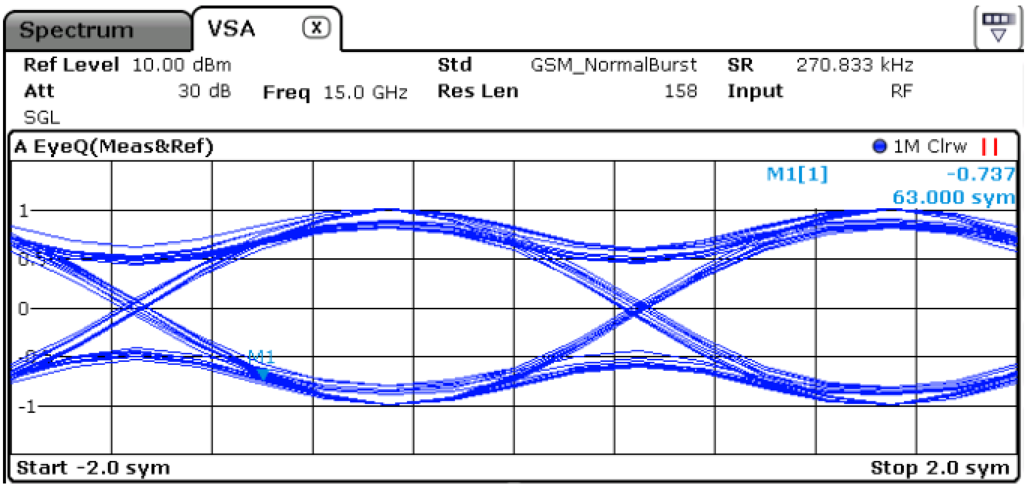


Fig. 4-65: Result display "Eye Diagram Imag (Q)" in normal mode

Eye Diagram Frequency

Shows the eye diagram of the currently measured frequencies and/or the reference signal. The time span of the data depends on the evaluation range (capture buffer).

Available for source types:

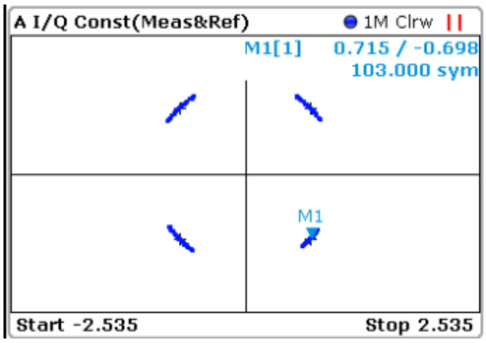
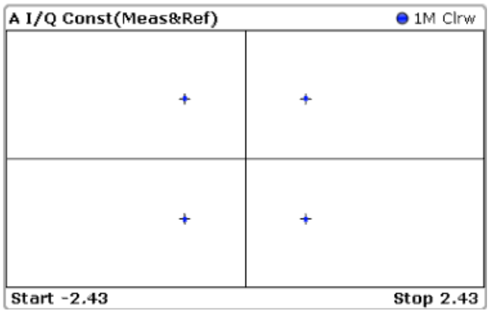
- Meas & Ref Signal

Constellation I/Q

The complex source signal (without inter-symbol interference) as an X/Y plot; only the symbol decision instants are drawn and not connected

Available for source types:

- Meas & Ref Signal

MSK	QPSK
	

Vector I/Q

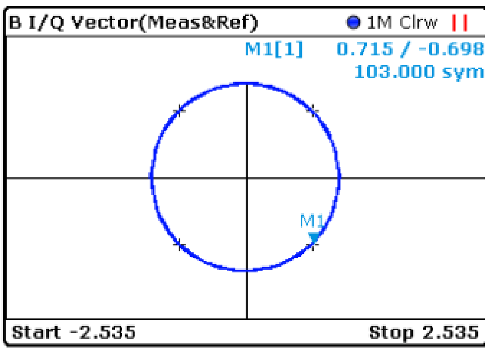
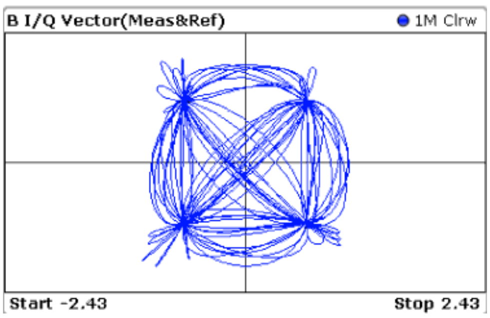
The complex source signal as an X/Y plot; all available samples (as defined by the display points per symbol parameter (see "Display Points/Sym" on page 165)) are drawn and connected.

The scaling of the capture buffer is

- relative to the current reference level if you are using the RF input and
- relative to the full scale level if you are using the I/Q input

Available for source types:

- Meas & Ref Signal
- Error Vector

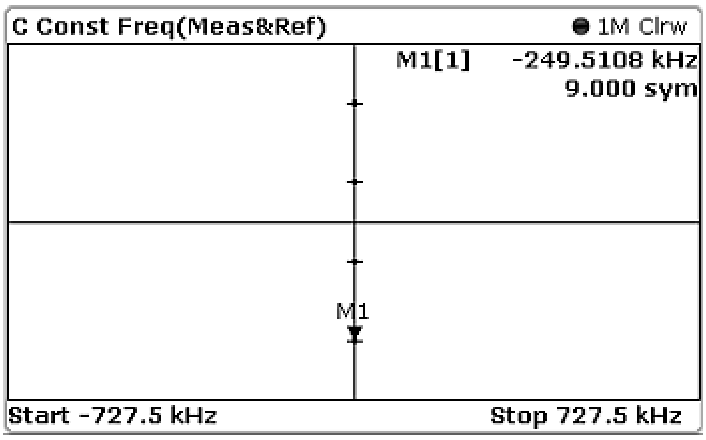
MSK	QPSK
	

Constellation Frequency

The instantenous frequency of the source signal (without inter-symbol interference) as an X/Y plot; only the symbol decision instants are drawn and not connected.

Available for source types:

- Meas & Ref Signal

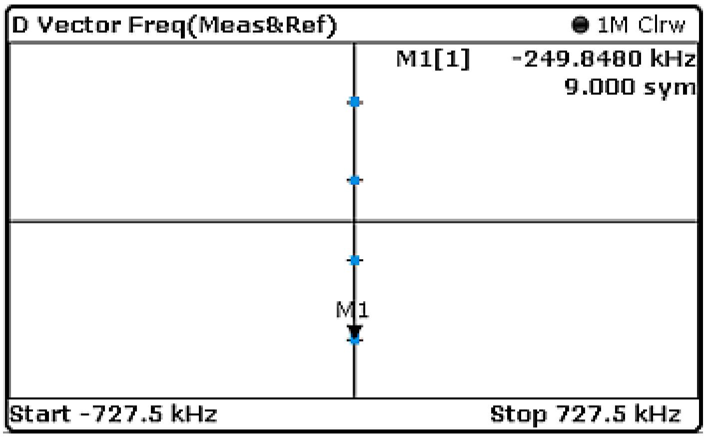


Vector Frequency

The instantenous frequency of the source signal as an X/Y plot; all available samples (as defined by the display points per symbol parameter (see "Display Points/Sym" on page 165)) are drawn and connected.

Available for source types:

- Meas & Ref Signal



Symbol Table

Symbol numbers are displayed as a table. Each symbol is represented by an entry in the table. The symbols can be displayed in binary, octal, hexadecimal or decimal format.

Example:

A Symbol Table (Binary)

	+	1	+	3	+	5	+	7	+	9	+	11	+	13	+	15	+	17	+	19	+	21	+	23	+
0	01	01	00	01	00	10	00	01	10	01	11	00	00	10	11	11	01	10	11	00	11	01	00	00	11
25	10	11	11	00	00	11	11	11	11	10	00	00	11	11	01	11	11	00	01	01	11	00	11	00	10
50	00	00	10	01	01	00	11	10	11	01	00	01	11	10	01	11	11	00	11	01	10	00	10	10	10
75	01	00	01	11	00	01	10	11	01	01	01	11	00	01	00	11	00	01	00	01	00	00	00	00	10

Fig. 4-66: Result display for "Symbols" in binary mode

If a pattern search is active, a found pattern is indicated in the symbol table, as well.

Error Vector Magnitude (EVM)

Displays the error vector magnitude as a function of symbols or time.

$$EVM(t) = \frac{EV(t)}{C}$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

The normalization constant C is chosen according to the EVM normalization. By default C^2 is the mean power of the reference signal.

$$C = \sqrt{\frac{1}{K} \sum_k |REF(k \cdot T)|^2}$$

and

$$T = \text{duration of symbol periods}$$

Note that $k=0.5 \cdot n \cdot T$ for Offset QPSK with inactive Offset EVM.

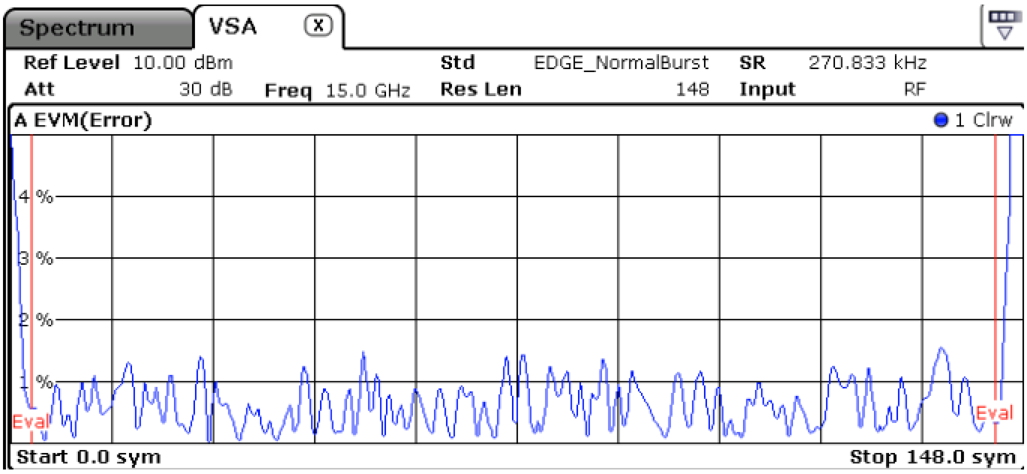


Fig. 4-67: Result display "Error Vector Magnitude" in normal mode

Available for source types:

- Error Vector

Magnitude Error

Displays the magnitude error of the measurement signal with respect to the reference signal (as a function of symbols over time)

$$MAG\_ERR(t) = MAG_{MEAS}(t) - MAG_{REF}(t)$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

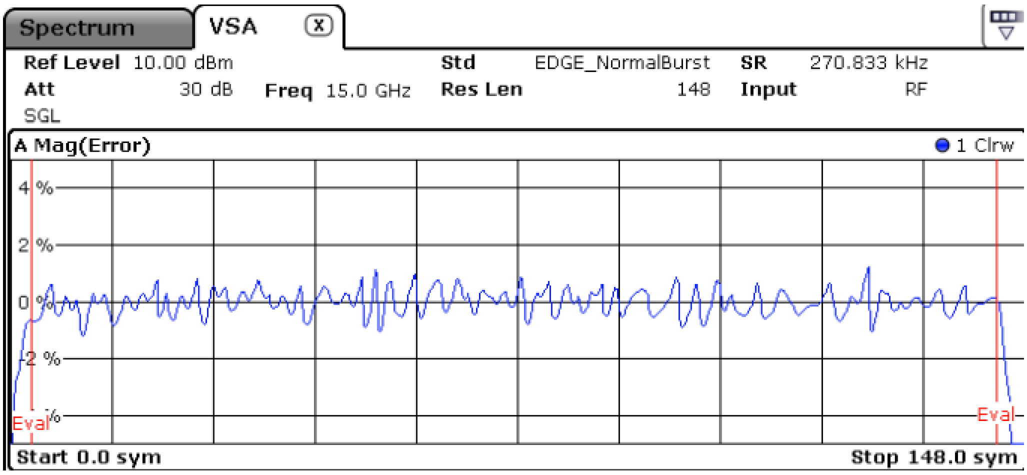


Fig. 4-68: Result display "Magnitude Error" in normal mode

Available for source types:

- Modulation Errors

Phase Error

Displays the phase error of the measuremente signal with respect to the reference signal as a function of symbols over time.

$$PHASE\_ERR(t) = PHASE_{MEAS}(t) - PHASE_{REF}(t)$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

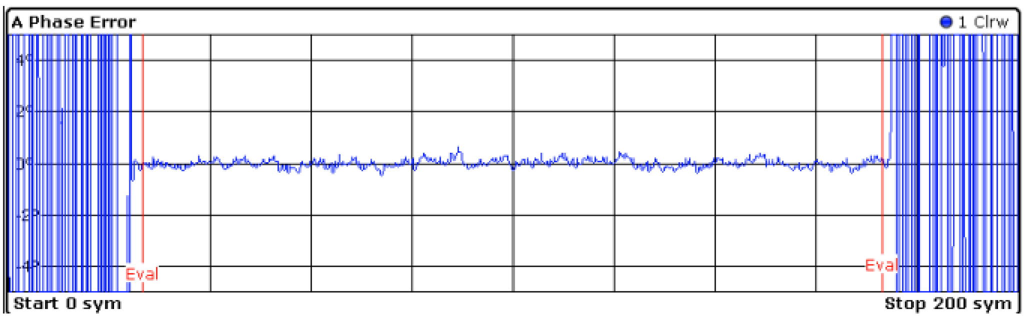


Fig. 4-69: Result display "Phase Error" in normal mode

Available for source types:

- Modulation Errors

Frequency Error Absolute

Displays the error of the instantaneous frequency in Hz of the measurement signal with respect to the reference signal as a function of symbols over time.

$$FREQ\_ERR(t) = FREQ_{MEAS}(t) - FREQ_{REF}(t)$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

Note that this measurement does not consider a possible carrier frequency offset. This has already been compensated for in the measurement signal.

This measurement is mainly of interest when using the MSK or FSK modulation, but can also be used for the PSK/QAM modulations. However, since these modulations can have transitions through zero in the I/Q plane, in this case you might notice uncritical spikes. This is due to the fact that the phase of zero (or a complex value close to zero) has in fact limited significance, but still influences the result of the current frequency measurement.

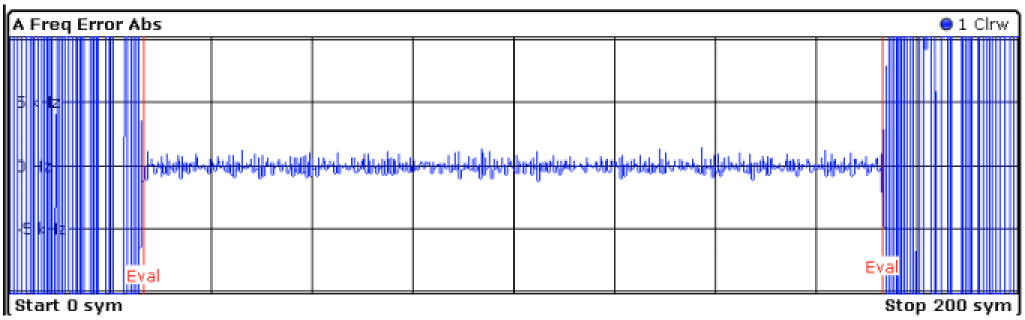


Fig. 4-70: Result display "Frequency Error Absolute" in normal mode

Available for source types:

- Modulation Errors

Frequency Error Relative

Displays the error of the instantaneous frequency of the measurement signal with respect to the reference signal as a function of symbols over time.

The results are normalized to the symbol rate (PSK and QAM modulated signals), the estimated FSK deviation (FSK modulated signals) or one quarter of the symbol rate (MSK modulated signals).

$$FREQ\_ERR(t) = FREQ_{MEAS}(t) - FREQ_{REF}(t)$$

with $t=n \cdot T_D$ and T_D=the duration of one sampling period at the sample rate defined by the display points per symbol parameter (see "Display Points/Sym" on page 165).

This measurement is mainly of interest when using the MSK or FSK modulation, but can also be used for the PSK/QAM modulations. See also the note for Frequency Error Absolute.

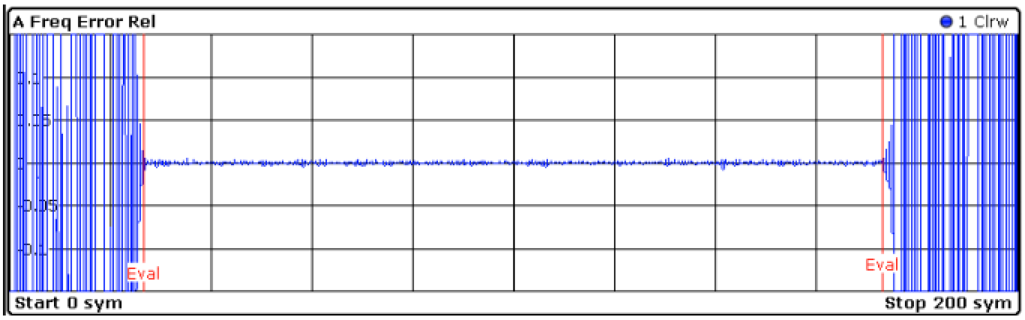


Fig. 4-71: Result display "Frequency Error Relative" in normal mode

Available for source types:

- Modulation Errors

Result Summary

Shows the Modulation Accuracy results in a table.

Depending on the modulation type you are using, the result summary shows different measurement results.

Details concerning the specific measurement results can be found in chapter 4.6.1, "Formulae", on page 298.

PSK, QAM and MSK modulation

		Current	Mean	Peak	StdDev	95%ile	Unit
EVM	RMS	0.20	0.21	0.28	0.02	0.23	%
	Peak	0.47	0.59	1.00	0.09	0.73	%
MER	RMS	53.96	53.76	51.09	-75.63	52.65	dB
	Peak	46.57	44.65	40.00	-60.63	42.72	dB
Phase Error	RMS	0.13	0.18	0.62	0.07	0.32	deg
	Peak	0.60	-0.70	-7.25	1.50	3.29	deg
Magnitude Error	RMS	0.10	0.11	0.14	0.01	0.12	%
	Peak	0.31	0.13	0.49	0.28	0.38	%
Carrier Frequency Error		-145.37	-144.88	-148.25	1.45	-142.49	Hz
Rho		0.999996	0.999996	0.999992	0.000001	0.999995	
IQ Offset		-51.27	-50.81	-49.40	-59.25	-49.79	dB
IQ Imbalance		-64.16	-62.28	-69.54	-75.79	-59.96	dB
Gain Imbalance		0.01	0.01	0.02	-69.63	0.02	dB
Quadrature Error		0.01	0.02	0.06	0.01	0.04	deg
Amplitude Droop		0.000016	0.000011	0.000071	-110.597191	0.000055	dB/sym
Power		-6.91	-6.71	-6.33	-19.32	-6.38	dBm

Fig. 4-72: Result summary display for "Modulation Accuracy"

If the result summary display is not given the entire screen width or height, only the information indicated by an *) below is displayed (see also "Display Configuration", on page 162). If the result summary is queried using remote commands, all available information is provided.

For more information see "PSK, QAM and MSK Modulation", on page 301.

The following results are displayed:

- ***) EVM** (Error Vector Magnitude) - RMS/Peak
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:EVM` on page 194
- **MER** (Modulation Error Ratio) - RMS/Peak
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:SNR` on page 204
- ***) Phase Error** - RMS/Peak
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:PERRor` on page 202
- **Magnitude Error** - RMS/Peak
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MERRor` on page 200
- ***) Carrier Frequency Error**
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:CFERror` on page 193
- ***) Rho**
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:RHO` on page 203
- ***) I/Q Offset**
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:OOFFset` on page 201
- **I/Q Imbalance**
  Not for BPSK.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:IQIMbalance` on page 199
- ***) Gain Imbalance**
  Not for BPSK.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:GIMBalance` on page 199
- ***) Quadrature Error**
  Not for BPSK.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:QERRor` on page 202
- ***) Amplitude Droop**
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:ADRoop` on page 192

- ***) Power**
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MPOWer` on page 200

For each result, the analyzer calculates and shows various statistical values:

- Current value
- ***)** Mean value
  To calculate the mean value, the analyzer averages the results using the statistic count that you have set.
  For more information see
  –
- ***)** Peak value
- StdDev (standard deviation)
- 95%ile (95 percentile; only for continuous sweep or sweep count > 1)
  Compared to 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.
- ***)** Unit

FSK modulation

A Result Summary

		Current	Mean	Peak	StdDev	95%ile	Unit
Frequency Error	RMS	92.01	92.01	92.01	0.00	---	%
	Peak	-230.75	-230.75	-230.75	0.00	---	%
Magnitude Error	RMS	40.93	40.93	40.93	0.00	---	%
	Peak	-97.27	-97.27	-97.27	0.00	---	%
FSK Deviation Error		-447050.28	-447050.28	-447050.28	0.00	---	Hz
FSK Meas Deviation		352950	352950	352950	0.00	---	Hz
FSK Ref Deviation		800000	800000	800000	0	---	Hz
Carrier Frequency Error		137573.84	137573.84	137573.84	0.00	---	Hz
Carrier Frequency Drift		-1483.23	-1483.23	-1483.23	0.00	---	Hz/sym
Power		-80.72	-80.72	-80.72	0.00	---	dBm

- **Frequency Error - RMS/Peak**
  Shows the average (RMS) and peak frequency error in %. The frequency error is the difference of the measured frequency and the reference frequency.
  The frequency error is normalized to the estimated FSK deviation.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:DERRor` on page 196
- **Magnitude Error - RMS/Peak**
  Shows the average (RMS) and peak magnitude error in %. The magnitude error is the difference of the measured magnitude to the magnitude of the reference signal.
  The magnitude error is normalized to the mean magnitude of the reference signal.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MERRor` on page 200
- **FSK Deviation Error**
  Shows the deviation error of FSK modulated signals in Hz. The FSK deviation error is the difference of the FSK deviation of the measured signal and the FSK reference deviation you have set.

SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FDERror` on page 195

- **FSK Meas Deviation**
  Shows the estimated deviation of FSK modulated signals in Hz.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:MDEViation` on page 197
- **FSK Ref Deviation**
  Shows the reference deviation you have set in Hz.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:RDEViation` on page 198
- **Carrier Frequency Error**
  Shows the mean carrier frequency offset in Hz.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:CFERror` on page 193
- **Carrier Frequency Drift**
  Shows the mean carrier frequency drift in Hz per symbol.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:CFDRift` on page 196
- **Power**
  Shows the power of the measured signal.
  SCPI command: `CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MPOWer` on page 200

Basis of evaluation

The majority of the values that are displayed in the Result Summary are calculated over the "Evaluation Range" (see "Evaluation Range", on page 154). They are evaluated according to the setting of the Display Points/Sym parameter. For example, if "Display Points/Symbol" is "1", only the symbol instants contribute to the result displayed in the result summary.

Table 4-23: Results calculated over the evaluation range

PSK, MSK, QAM	FSK
EVM	Frequency Error
MER	Magnitude Error
Phase Error	Power
Magnitude Error	
Rho	
Power	

The following results that are based on internal estimation algorithms (see chapter 4.1.6, "Signal Model, Estimation and Modulation Errors", on page 49) are calculated over the "Estimation range" (see also "Estimation", on page 51).

Table 4-24: Results calculated over the estimation range

PSK, MSK, QAM	FSK
Carrier Frequency Error	FSK Deviation Error
I/Q Offset	FSK Measurement Deviation
I/Q Imbalance	Carrier Frequency Error
Gain Imbalance	Carrier Frequency Drift
Quadrature Error	
Amplitude Droop	

Current value

In the "Current" column, the value evaluation for the current evaluation is displayed. For example, the EVM Peak value in the current sweep corresponds to the peak of the trace values within the evaluation range for the current sweep (as indicated by marker 1 in figure 4-73).

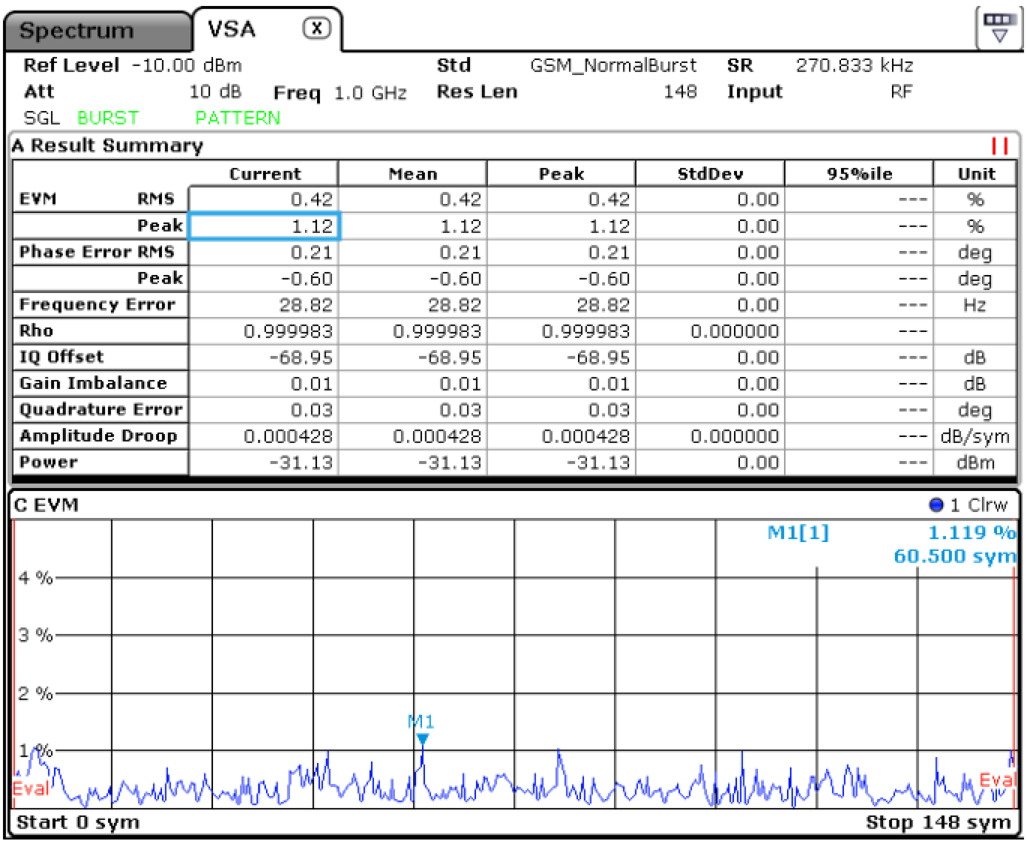


Fig. 4-73: Example for result summary with current EVM peak value marked

If you want to compare the trace values to the results of the Result Summary, make sure to match the displayed points per symbol of the trace and of the Result Summary. Refer to "Display Points/Sym" on page 165 for details.

Mean value

In the "Mean" column, the linear mean of the values that are in the "Current" column is displayed. Note that if the values are in a logarithmic representation, e.g. the I/Q Offset, the linear values are averaged.

Peak value

In the "Peak" column, the maximum value that occurred during several evaluations is displayed. Note that when the value can be positive and negative, e.g. the phase error, the maximum absolute value (maintaining its sign) is displayed. The peak value of Rho is handled differently, since its minimum value represents the worst case. In that case, the minimum value is displayed.

Standard Deviation

The value for the standard deviation is calculated on the linear values and then converted to the displayed unit.

95-percentile

The 95-percentile value is based on the distribution of the current values. Since the phase error and the magnitude error can usually be assumed to be distributed around zero, the 95-Percentile for these values is calculated based on their absolute values. Again, the Rho value is handled differently. Here, the 5-Percentile is displayed, since the lowest Rho value represents the worst case.

4.3.1.2 Normal (Time/Symbol) Displays

Normal displays show the results in the time domain or as symbols.

Table 4-25: Available time/symbol displays depending on source type

Source Type	Result Type
Capture Buffer	Magnitude Absolute
	Real/Imag (I/Q)
Meas & Ref Signal	Magnitude Absolute
	Magnitude Relative
	Phase Wrap
	Phase Unwrap
	Frequency Absolute
	Frequency Relative
	Real/Imag (I/Q)
	Eye Diagram Real (I)
	Eye Diagram Imag (Q)
	Eye Diagram Frequency

Source Type	Result Type
	I/Q Constellation
	I/Q Vector
	Constellation Frequency
	Vector Frequency
Symbols	Binary
	Octal
	Decimal
	Hexadecimal
Error Vector	EVM
	Real/Imag (I/Q)
	I/Q Vector
Modulation Errors	Magnitude Error
	Phase Error
	Frequency Error Absolute
	Frequency Error Relative
Modulation Accuracy	Result Summary

4.3.1.3 Spectral Displays

Spectral evaluations can be carried out for all result displays that show the time or symbols on the x-axis.

Note that the spectrum is only calculated over the evaluation range.

Table 4-26: Available spectral displays depending on source type

Source Type	Result Type
Capture Buffer	Magnitude Absolute
	Real/Imag (I/Q)
Meas & Ref Signal	Magnitude Absolute
	Magnitude Relative
	Phase Wrap
	Phase Unwrap
	Frequency Absolute
	Frequency Relative

Source Type	Result Type
	Real/Imag (I/Q)
Error Vector	EVM
	Real/Imag (I/Q)
Modulation Errors	Magnitude Error
	Phase Error
	Frequency Error Absolute
	Frequency Error Relative

For real input signals, the spectrum between the frequencies 0 and (symbol rate*capture oversampling/2) is displayed; for complex input signals (REAL/IMAG and Error REAL/IMAG), the spectrum between +/- (symbol rate*capture oversampling/2) is displayed.

The input signal is subjected to a fast Fourier transformation (FFT) with 4096 points, and the magnitude is calculated and displayed. If the basic result display is too long, the total length is divided into several subblocks of 4096 points each and the results are averaged. The subblocks overlap each other by 25% of the block length. In addition, the input signal or the subblocks are evaluated with a FLATTOP window.

If the valuation range is active, the FLATTOP window is also restricted to the area inside the evaluation lines. Following the FFT, the spectrum magnitude is calculated and displayed. figure 4-74 and figure 4-75 show examples of such spectral evaluations. The upper trace shows the basic diagram in each case, while the lower trace shows the associated spectral evaluations.

The top part of figure 4-74 shows EVM versus time; the spectrum of the EVM signal is shown at the bottom. In figure 4-75, the FFT is applied to the complex signal (REAL/IMAG, top). The bottom diagram shows the spectrum. Since the input signal is complex, a two-sided spectrum is shown. In both cases, the time range for the FFT is restricted by the activated evaluation lines so that, for example, burst edges are not included.

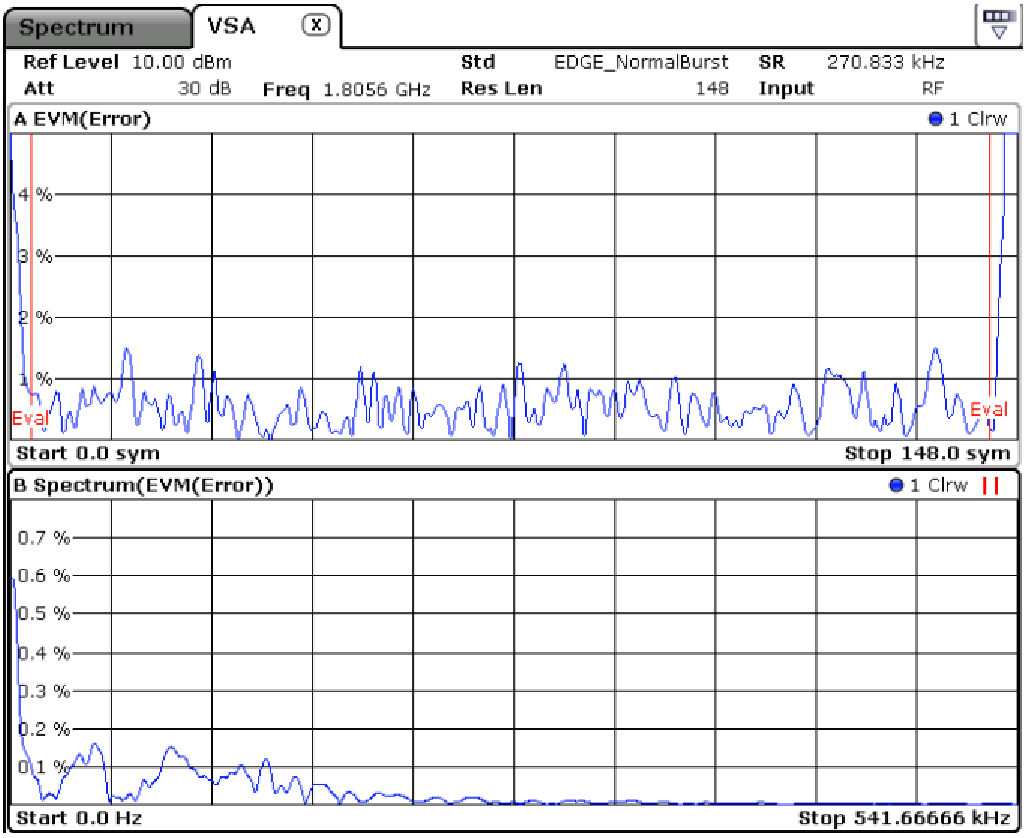


Fig. 4-74: Spectrum diagram: Single-sided display for real input signals

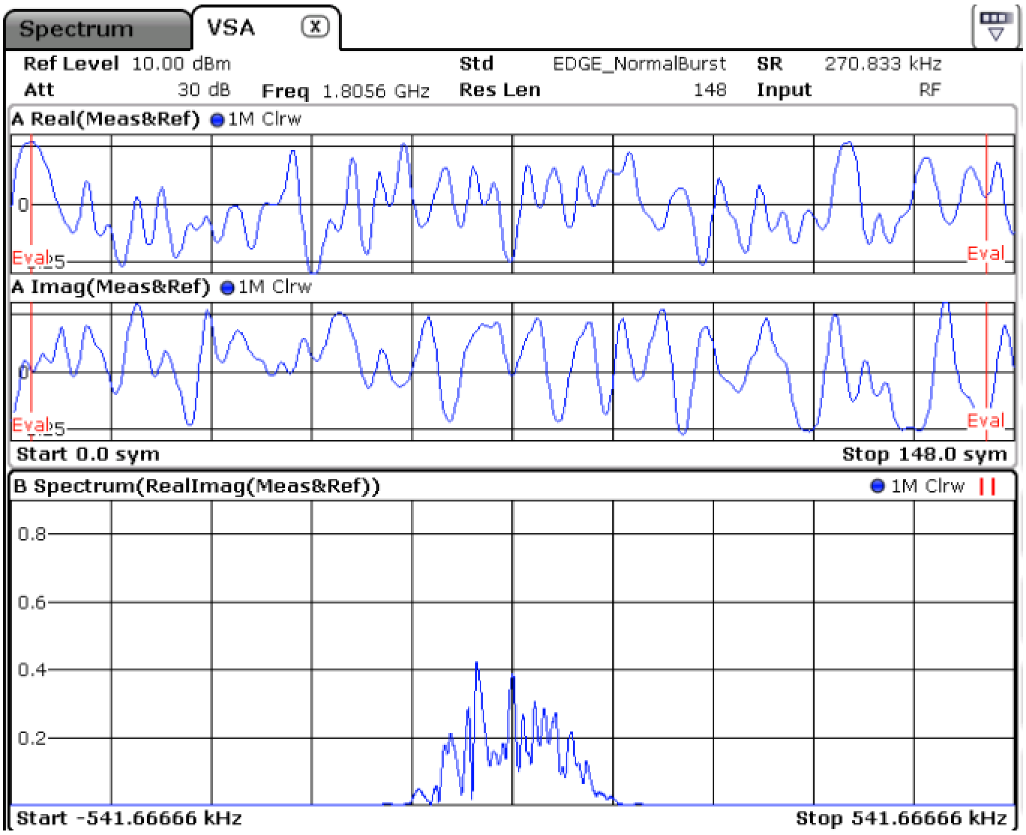


Fig. 4-75: Spectrum diagram: Two-sided display for complex input signals

4.3.1.4 Statistical Displays

Statistical evaluations can be carried out for all result displays that show the time or symbols on the x-axis. They show the distribution (i.e. probabilities of occurrence) of the values as a set of bars.

Note that only samples within the evaluation range contribute to the statistic measurement.

In all statistical displays a vertical line shows the value of the 95% percentile.

Table 4-27: Available statistical displays depending on source type

Source Type	Result Type
Capture Buffer	Magnitude Absolute
	Real/Imag (I/Q)
Meas & Ref Signal	Magnitude Absolute
	Magnitude Relative
	Phase Wrap
	Phase Unwrap

Source Type	Result Type
	Frequency Absolute
	Frequency Relative
	Real/Imag (I/Q)
Error Vector	EVM
	Real/Imag (I/Q)
Modulation Errors	Magnitude Error
	Phase Error
	Frequency Error Absolute
	Frequency Error Relative

For complex displays (REAL/IMAG and Error REAL/IMAG), a separate statistics diagram is calculated for the real and imaginary parts.

The input signal of the basic display is quantized and the probability of occurrence is shown by a bargraph. The quantization can be set via the number of bars in the display area by using the "Range > X-Axis Quantize" parameter (see "Ranges (statistic measurements)" on page 104). In the basic setting, 101 bars are used.

The figure 4-76 shows an example of a statistical evaluation. The lower window (C) shows the basic diagram (EVM), while the upper window (A) shows the associated distribution of the EVM.

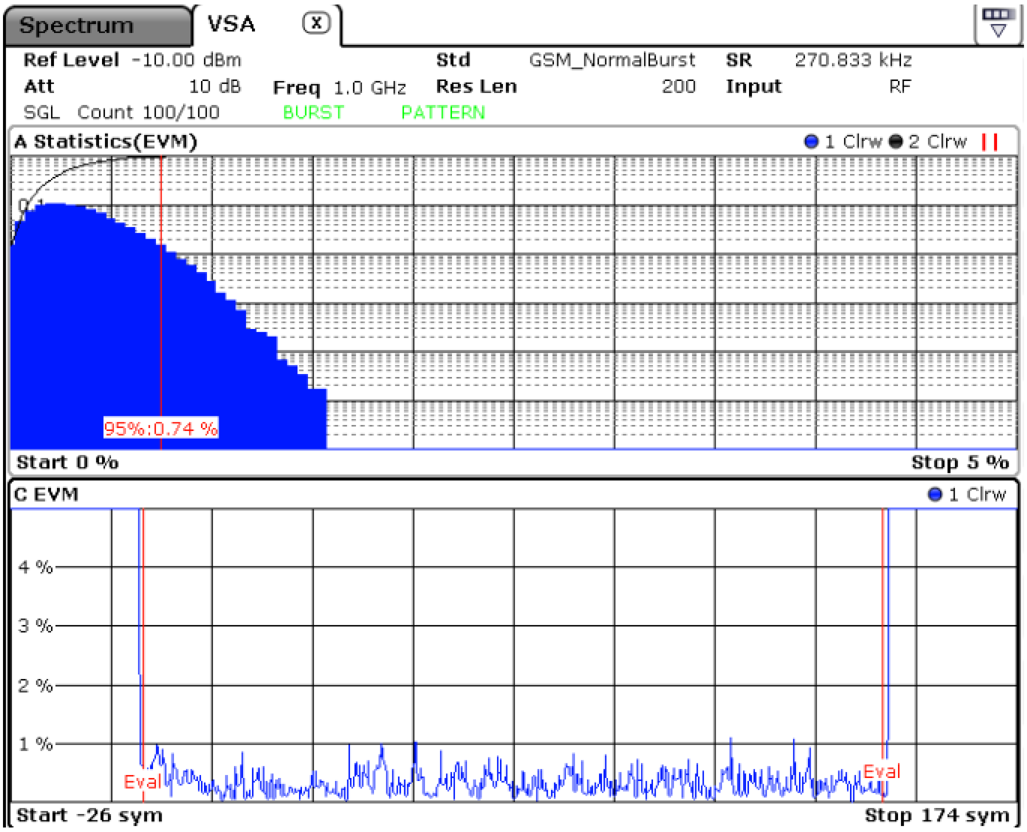


Fig. 4-76: Error vector magnitude (bottom), EVM distribution (top)

4.3.1.5 Displayed Measurement Settings

The channel bar above the result screens displays the most important measurement settings. Depending on the result type, the following information may be displayed in the channel bar:

Editing settings in the channel bar

Some settings that are displayed in the channel bar can easily be edited by touching the setting in the display (with a finger or mouse pointer). The corresponding (edit) dialog box is displayed in which you can edit the setting. For some settings, a context-sensitive menu is also available, see chapter 4.3.2.13, "Available Context Menus", on page 129.

Label	Description
Ref Level	Reference level, see "Reference Level" on page 103
Offset	Reference level offset, if defined, see "Ref Level Offset" on page 108

Label	Description
Att	Attenuation, see chapter 4.3.2.3, "Softkeys of the Amplitude Menu (R&S FSV-K70) ", on page 102
Freq	Frequency, see "Center" on page 102
Std	Digital standard, see "Digital Standards" on page 100
Mod	Modulation type, if no standard is active (or default standard is changed), see "Modulation Type" on page 132
Res Len	Result Length, see "Result Length" on page 153
Cap Len	Capture Length (instead of result length for capture buffer display), see "Capture Length" on page 141
SR	Symbol Rate, see "Symbol Rate" on page 134
Input	Input type of the signal source, see chapter 4.3.2.11, "Softkeys of the Input/Output menu (R&S FSV-K70)", on page 124
Burst	Burst search active (see "Auto/On/Off" on page 145)
Pattern	Pattern search active (see "Auto/On/Off" on page 147)

For more information on general measurement settings displayed in the channel bar, see the description of basic operations in the base unit.

4.3.1.6 Saving Measurement Results

After a data acquisition or measurement, you may like to save the results for further evaluation or documentation purposes. You can save a screenshot of the display to a file or print it, and you can export the trace data in ASCII format.

To print or store a screenshot

1. Press the PRINT key.
2. Press the "Device Setup" softkey.
3. To copy the screenshot to the clipboard or print it on a printer, select the corresponding option. Before you print to a printer, make sure a printer is installed (see the description in the base unit manual).
   To save the screenshot to a file, select the file format for your screenshot (e.g. `JPEG`) and then select the "Print to file" option.
4. Close the "Hardcopy Setup" dialog.
5. Press the "Colors" softkey and then "Select Print Color Set".
6. If you want the colors of your screenshot to be as they appear on the screen, select "Screen Colors (Hardcopy)".
7. Press the PRINT key again and then press the "Print Screen" softkey.
8. If you selected "Print to file", a file selection dialog box is opened. Specify the file location for your screenshot and press "Save".

To store a screenshot via remote control

`HCOP: DEV: LANG BMP`

Selects the data format.

`HCOP: DEST 'MMEM'`

Directs the hardcopy to a file.

`MMEM: NAME 'C: \R_S\instr\user\Print.bmp'`

Selects the file name. If the file `Print.bmp` already exists, it is replaced.

`HCOP`

Saves the hardcopy output into the file `Print.bmp`.

To save the I/Q data to a file and reload it

You can store the captured I/Q data to a file and reload it on the instrument again later.

1. Select a window that displays I/Q data.
2. Press the SAVE/RCL hardkey and then the "Save" softkey.
3. Define a file name for the data file.
4. Select "IQ Data" from the list of items to be stored.
5. Press "Save" to close the dialog and store the data to the file.
6. To load the data again later, press the SAVE/RCL hardkey and then the "Load" softkey. Select the file name with the stored data (`.dfl` extension).

To export the trace data in ASCII format

The analyzer can save your results as plain text in a text file.

1. Close all screens that are not relevant for your measurement results by disabling the "Screen X active" option in the "Display Config" dialog (see also "Screen X active" on page 163).
2. Press the TRACE key.
3. Press the "ASCII Trace Export" softkey.
4. Specify the file location to store the data to.
5. Select the "Mode": *Trace*.
   If you only want to save the I/Q samples of your capture buffer, select *RAW*.
6. To include all your parameter settings select "Header": *On*.
7. Select the format of the "Decimal Separator" (3.1416 or 3,1416).
8. Press "Save".

To export the data via remote control

`TRACe<screen>[:DATA]` on page 274

Example:

`:SENSe1:DDEMod:PRESet 'GSM_NB'`

Load GSM Normal Burst Standard.

`:INITiate1:CONTinuous OFF`

Switch to single sweep mode.

`:INITiate1:IMMediate`

Perform single sweep.

`:TRACe4? TRACe1`

Query the result symbols in screen D.

4.3.2 Softkeys and Menu Overview for Vector Signal Analysis (R&S FSV-K70)

4.3.2.1 Softkeys of the VSA menu (R&S FSV-K70)

The VSA menu provides basic functions for vector signal analysis. For information on configuring VSA measurements, see chapter 4.3.3, "Configuring VSA measurements", on page 129.

The following softkeys are available in the "VSA" and "MEAS" menus:

Settings Overview

Displays the main settings overview that visualizes the data flow of the Vector Signal Analyzer and summarizes the current settings. In addition, the "Settings Overview" dialog box provides access to the individual settings dialog boxes and allows you to restore default values.

For details on configuring the measurement and a description of the individual dialog boxes, see chapter 4.3.3.1, "Settings Overview", on page 130.

Digital Standards

Opens a submenu and a file selection dialog to manage predefined measurement settings for conventional mobile radio standards. See Managing standard settings files for details.

For an overview of predefined standards and settings see chapter 4.1.4, "Predefined Standards and Settings", on page 37.

Load Standard ← Digital Standards

Opens a file selection dialog to load a measurement settings file for a specific standard.

See Managing standard settings files for details.

SCPI command:

`[SENSe<n>]:DDEMod:PRESet[:STANdard]` on page 252

Save As Standard ← Digital Standards

Opens a file selection dialog to save the current measurement settings as a file for a specific standard.

SCPI command:

`[SENSe<n>]:DDEMod:STANdard:SAVE` on page 268

Delete Standard ← Digital Standards

Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standards" softkey.

SCPI command:

`[SENSe<n>]:DDEMod:STANdard:DELete` on page 268

Standard Defaults ← Digital Standards
Resets the instrument to the default settings of the currently used standard. If no standard is currently active, the previously active standard is used.

SCPI command:
`[SENSe<n>]:DDEMod:STANdard:PREset[:VALue]` on page 268

Restore Standard Files ← Digital Standards
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

SCPI command:
`[SENSe<n>]:DDEMod:FACTory[:VALue]` on page 245

New Folder ← Digital Standards
Creates a new folder in the file system in which you can save the settings file.

This function is only available if the "Save Current Settings as Standard" dialog box is open.

Display Config
Opens the "Display Configuration" dialog box to configure the measurement results display. See "Display Configuration", on page 162.

Restore Factory Settings
Opens a submenu that allows you to restore all standards and pattern settings on the instrument to the values predefined by Rohde & Schwarz available at the time of delivery.

Restore Standard Files ← Restore Factory Settings
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

SCPI command:
`[SENSe<n>]:DDEMod:FACTory[:VALue]` on page 245

Restore Pattern Files ← Restore Factory Settings
Restores the pattern files predefined by Rohde&Schwarz available at the time of delivery.

SCPI command:
`[SENSe<n>]:DDEMod:FACTory[:VALue]` on page 245

4.3.2.2 Softkeys of the Frequency Menu (R&S FSV-K70)

The FREQ key opens the "RF Settings" tab of the "Frontend & I/Q Capture Settings" dialog box and displays the "Frequency" menu, which contains the following softkeys.

Center
Opens an edit dialog box to enter the center frequency.

SCPI command:
`[SENSe:]FREQuency:CENTer` on page 271

Stepsize Auto/Man
Toggles between automatic step size or a fixed (manually defined) step size (CF Stepsize) for the center frequency.

SCPI command:
`[SENSe:]FREQuency:CENTer:STEP:AUTO` on page 272

CF Stepsize
Opens an edit dialog box to define the fixed step size for the center frequency. The softkey indicates the current setting.

This function is only available if "Stepsize Auto/Man" on page 102 is set to "Man".

SCPI command:
`[SENSe:]FREQuency:CENTer:STEP[:VALue]` on page 271

Frequency Offset
Opens an edit dialog box to enter a frequency offset that shifts the displayed frequency range by the specified offset. The softkey indicates the current setting. The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

SCPI command:
`[SENSe:]FREQuency:OFFSet` on page 272

4.3.2.3 Softkeys of the Amplitude Menu (R&S FSV-K70)

When you click the AMPT key, the "Amplitude" menu is displayed, which provides the following softkeys.

Reference Level

Defines the reference level in dBm.

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IFOVL" status display.

To get an ideal reference level, use Auto Level function. For more information, see

- "Auto Level" on page 108

SCPI command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 228

Ranges

Opens a submenu to define the display range for normal or spectral displays (see "Result Type Transformation" on page 164). For details on scaling see chapter 4.3.3.3, "Changing the Display Scaling", on page 170.

Y-Axis Range ← Ranges

Opens an edit dialog field to define the y-axis range.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 226

Y-Axis Reference Value ← Ranges

Opens an edit dialog field to define a reference value for the y-axis in the current unit. The y-axis is adapted so that the reference value is displayed at the Y-Axis Reference Position.

Note: The y-axis reference value is maintained even if the Y-Axis Range is changed.

For details see chapter 4.3.3.3, "Changing the Display Scaling", on page 170.

SCPI command:

`DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:RVALue` on page 225

Y-Axis Reference Position ← Ranges
Opens an edit dialog field to define a reference position for the y-axis as a percentage value, where 0 % refers to the bottom edge, 100 % refers to the top edge of the screen. The y-axis is adapted so that the Y-Axis Reference Value is displayed at the reference position.

For details see chapter 4.3.3.3, "Changing the Display Scaling", on page 170.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:RPOSition` on page 224

Y-Axis Autorange ← Ranges
Adapts the y-axis to the current measurement results (only once, not dynamically) in the focussed window.

To adapt the range of all screens together, use the Y-Axis Auto Range All Screens function. For more information, see

- "Y-Axis Auto Range All Screens" on page 109

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe]:AUTO[:VALue]` on page 226

Ranges (statistic measurements)
Opens a submenu to define the display range for statistic displays (see "Result Type Transformation" on page 164).

X-Axis Quantize ← Ranges (statistic measurements)
Defines the number of bars to be displayed in the graph, i.e. the granularity of classifications.

SCPI command:
`CALCulate<screen>:STATistics:SCALe:X:BCOunt` on page 218

X-Axis Reference Value ← Ranges (statistic measurements)
Opens an edit dialog field to define a reference value for the x-axis in the current unit.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:RVALue` on page 225

X-Axis Range ← Ranges (statistic measurements)
Opens an edit dialog field to define the x-axis range in the current unit.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:PDIVision` on page 224

y-Axis Max Value ← Ranges (statistic measurements)
Opens an edit dialog box to define the upper limit of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. The y-axis scaling is defined via the "Y-unit %/Abs" softkey (see "y-Unit %/Abs" on page 105). The distance between max and min value must be at least one decade.

SCPI command:
`CALCulate<n>:STATistics:SCALe:Y:UPPer` on page 219

y-Axis Min Value ← Ranges (statistic measurements)
Opens an edit dialog box to define the lower limit of the displayed probability range. Values in the range $1e^{-9}$ < *value* < *0.1* are allowed. The y-axis scaling is defined via the "y-Unit %/Abs" on page 105 softkey. The distance between max and min value must be at least one decade.

SCPI command:
`CALCulate<n>:STATistics:SCALe:Y:LOWer` on page 218

y-Unit %/Abs ← Ranges (statistic measurements)
Defines the scaling type of the y-axis. The default value is absolute scaling.

SCPI command:
`CALCulate<n>:STATistics:SCALe:Y:UNIT` on page 219

Default Settings ← Ranges (statistic measurements)
Resets the x- and y-axis scalings to their preset values for the current measurement window.

SCPI command:
`CALCulate<screen>:STATistics:PRESet` on page 217

Adjust Settings ← Ranges (statistic measurements)
Adjusts the x-axis scaling to the occurring statistical values.

SCPI command:
`CALCulate<screen>:STATistics:SCALe:AUTO` on page 218

Ranges (Symbol Table)
Opens a submenu to define the display mode for the symbol table.

Binary ← Ranges (Symbol Table)
Sets the symbol display to binary mode. This setting also affects the number of symbols displayed in each row.

Octal ← Ranges (Symbol Table)
Sets the symbol display to octal mode. This setting also affects the number of symbols displayed in each row.

Decimal ← Ranges (Symbol Table)
Sets the symbol display to decimal mode. This setting also affects the number of symbols displayed in each row.

Hexadecimal ← Ranges (Symbol Table)
Sets the symbol display to hexadecimal mode. This setting also affects the number of symbols displayed in each row.

Units
Opens a submenu to define the units for the x- and y-axis.

X-Axis Unit ← Units
Opens an edit dialog field to define the x-axis unit as seconds or symbols.

SCPI command:
`CALCulate<screen>:X:UNIT:TIME` on page 221

Y-Axis Unit ← Units
Opens an edit dialog field to define the y-axis unit according to the displayed measurement type.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 229

Capture Unit ← Units
Defines the unit in which the data is captured: seconds or signals. The unit is also applied to the trigger offset and the grids of all active measurements.

SCPI command:
`CALCulate<screen>:X:UNIT:TIME` on page 221

Preamp On/Off (option RF Preamplifier, B22/B24)
Switches the preamplifier on or off.

If option R&S FSV-B22 is installed,the preamplifier is only active below 7 GHz.

If option R&S FSV-B24 is installed, the preamplifier is active for all frequencies.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

SCPI command:
`INPut:GAIN:STATe` on page 238

RF Atten Manual/Mech Att Manual
Opens an edit dialog box to enter the attenuation, irrespective of the reference level. If electronic attenuation is activated (option R&S FSV-B25 only; "El Atten Mode Auto" softkey), this setting defines the mechanical attenuation.

The mechanical attenuation can be set in 10 dB steps.

The RF attenuation can be set in 5 dB steps (with option R&S FSV-B25: 1 dB steps). The range is specified in the data sheet. If the defined reference level cannot be set for the set RF attenuation, the reference level is adjusted accordingly.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

Note: Values under 10 dB can only be entered via the numeric keypad or via remote control command in order to protect the input mixer against overload.

The RF attenuation defines the level at the input mixer according to the formula:

"$level_{mixer}$ = $level_{input}$ – RF attenuation"

The maximum mixer level allowed is -10 dBm. mixer levels above this value may lead to incorrect measurement results, which are indicated by the "OVLD" status display.

SCPI command:

`INPut:ATTenuation` on page 233

RF Atten Auto/Mech Att Auto

Sets the RF attenuation automatically as a function of the selected reference level. This ensures that the optimum RF attenuation is always used. It is the default setting.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

SCPI command:

`INPut:ATTenuation:AUTO` on page 234

El Atten On/Off

This softkey switches the electronic attenuator on or off. This softkey is only available with option R&S FSV-B25.

When the electronic attenuator is activated, the mechanical and electronic attenuation can be defined separately. Note however, that both parts must be defined in the same mode, i.e. either both manually, or both automatically.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

- To define the mechanical attenuation, use the RF Atten Manual/Mech Att Manual or RF Atten Auto/Mech Att Auto softkeys.
- To define the electronic attenuation, use the El Atten Mode (Auto/Man) softkey.

Note: This function is not available for stop frequencies (or center frequencies in zero span) >7 GHz. In this case, the electronic and mechanical attenuation are summarized and the electronic attenuation can no longer be defined individually. As soon as the stop or center frequency is reduced below 7 GHz, this function is available again.
When the electronic attenuator is switched off, the corresponding RF attenuation mode (auto/manual) is automatically activated.

SCPI command:

`INPut:EATT:AUTO` on page 237

El Atten Mode (Auto/Man)

This softkey defines whether the electronic attenuator value is to be set automatically or manually. If manual mode is selected, an edit dialog box is opened to enter the value. This softkey is only available with option R&S FSV-B25, and only if the electronic attenuator has been activated via the El Atten On/Off softkey.

Note: This function is not available for stop frequencies (or center frequencies in zero span) >7 GHz. In this case, the electronic and mechanical attenuation are summarized and the electronic attenuation can no longer be defined individually. As soon as the stop or center frequency is reduced below 7 GHz, electronic attenuation is available again. If the electronic attenuation was defined manually, it must be re-defined.

The attenuation can be varied in 1 dB steps from 0 to 30 dB. Other entries are rounded to the next lower integer value.

To re-open the edit dialog box for manual value definition, select the "Man" mode again.

If the defined reference level cannot be set for the given RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is output.

SCPI command:

`INPut:EATT:AUTO` on page 237

`INPut:EATT` on page 237

Ref Level Offset

Opens an edit dialog box to enter the arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The setting range is ±200 dB in 0.1 dB steps.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 228

Input (AC/DC)

Toggles the RF input of the analyzer between AC and DC coupling.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

SCPI command:

`INPut:COUPling` on page 234

4.3.2.4 Softkeys of the Auto Set Menu (R&S FSV-K70)

The AUTO SET displays the "Auto Set" menu, which contains the following softkeys.

Auto Level

Defines the optimal reference level for the current measurement automatically. The measurement time for automatic leveling can be defined using the Settings softkey.

SCPI command:

`[SENSe<n>]:ADJust:LEVel` on page 243

Settings

Opens a submenu to define settings for automatic leveling.

Possible settings are:

- "Meas Time Manual" on page 109
- "Meas Time Auto" on page 109

Meas Time Manual ← Settings
Opens an edit dialog box to enter the duration of the level measurement in seconds. The level measurement is used to determine the optimal reference level automatically (see the "Auto Level" softkey, "Auto Level" on page 108). The default value is 1 ms.

SCPI command:
`[SENSe:]ADJust:CONFigure:LEVel:DURation` on page 243

Meas Time Auto ← Settings
The level measurement is used to determine the optimal reference level automatically (see the Auto Level softkey).

This softkey resets the level measurement duration for automatic leveling to the default value depending on the signal description (see "Signal Description", on page 135).

Y-Axis Autorange
Adapts the y-axis to the current measurement results (only once, not dynamically) in the focussed window.

To adapt the range of all screens together, use the Y-Axis Auto Range All Screens function. For more information, see

- "Y-Axis Auto Range All Screens" on page 109

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe]:AUTO[:VALue]`
on page 226

Y-Axis Auto Range All Screens
Adapts the y-axis to the current measurement values (only once, not dynamically) in all measurement windows.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe]:AUTO:ALL`
on page 227

4.3.2.5 Softkeys of the Sweep Menu (R&S FSV-K70)

The SWEEP key displays the "Sweep" menu, which contains the following softkeys.

Continuous Sweep
Sets the continuous sweep mode: the sweep takes place continuously according to the trigger settings. This is the default setting. The trace averaging is determined by the Statistic Count.

SCPI command:
`INIT:CONT ON`, see `INITiate<n>:CONTinuous` on page 232

Single Sweep

Sets the single sweep mode: after triggering, starts the number of sweeps that are defined by using the Statistic Count softkey. The measurement stops after the defined number of sweeps has been performed.

SCPI command:

INIT:CONT OFF, see INITiate<n>:CONTinuous on page 232

Continue Single Sweep

Repeats the number of sweeps set by using the Statistic Count softkey, without deleting the trace of the last measurement.

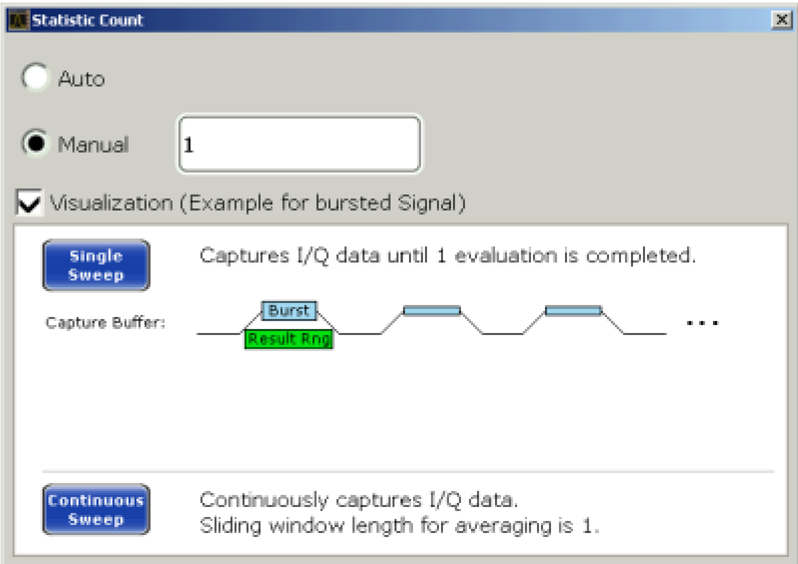
This is particularly of interest when using the trace configurations "Average" or "Max Hold" to take previously recorded measurements into account for averaging/maximum search.

SCPI command:

INITiate<n>:CONMeas on page 231

Statistics Count

Opens a dialog box to define sweep characteristics. The behavior depends on whether you have set the analyzer to single sweep mode or continuous sweep mode.



In single sweep mode, select

- "Auto" if you want to capture the I/Q data exactly once and then evaluate it
- "Manual" if you want capture data until a particular number of evaluations is finished. You can enter the number of evaluations you want to have in the corresponding input field.

In continuous sweep mode, select

- "Auto" if you want to continously capture I/Q data. The sliding window length for averaging is 10 (moving average).
- Manual if you want to continuously capture I/Q data and adjust the sliding window length for averaging to your needs (moving average). You can enter the length in the corresponding input field.

Activate "Visualization" to expand the dialog box by a pane that visualizes the behavior of the current settings.

SCPI command:
[SENSe<n>]:SWEep[:COUNt] on page 272

Show ResRange Number
Opens an input field that selects the result range you want to analyze.

By default, the analyzer shows the results over all result ranges that have been captured in the data capturing process and are in the analyzer's memory. By selecting a range number, you can analyze a specific result range, e.g. a particular burst.

The range depends on the number of result ranges you have captured previously.

A selection of the result range is possible in single sweep mode only.

For more information refer also to

- "Capture Length" on page 141
- "Result Length" on page 153
- "Statistics Count" on page 110

SCPI command:
[SENSe<n>]:DDEMod:SEARch:MBURst:CALC on page 260

4.3.2.6 Softkeys of the Trace Menu (R&S FSV-K70)

The TRACE key displays the "Trace" menu, which contains the following softkeys.

Context-sensitive menus for traces
Traces have context-sensitive menus. If you right-click on a trace in the display or a trace setting in the information channel bar (or touch it for about 1 second), a menu is displayed which corresponds to the softkey functions available for traces.

Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Selects the active trace (1, 2, 3, 4, 5, 6) and opens the "Trace Mode" submenu for the selected trace. The default setting is trace 1 in the overwrite mode, the other traces are switched off ("Blank" mode). Not all measurement functions support all 6 traces.

For details see chapter 4.3.4.1, "Trace Mode Overview", on page 179.

Tip: To configure several traces in one step, press the "Trace Wizard" softkey to open a trace configuration dialog. See also "Trace Wizard" on page 113.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 223

Clear Write ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

SCPI command:
`DISP:TRAC:MODE WRIT`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Max Hold ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
The maximum value is determined over several sweeps and displayed. The analyzer saves the sweep result in the trace memory only if the new value is greater than the previous one.

This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.

This mode is not available for statistics measurements.

SCPI command:
`DISP:TRAC:MODE MAXH`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Min Hold ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
The minimum value is determined from several measurements and displayed. The analyzer saves for each sweep the smallest of the previously stored/currently measured values in the trace memory.

This mode is useful e.g. for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed whereas a CW signal is recognized by its constant level.

This mode is not available for statistics measurements.

SCPI command:
`DISP:TRAC:MODE MINH`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Average ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
The average is formed over several sweeps. The "Sweep Count" determines the number of averaging procedures.

This mode is not available for statistics measurements.

SCPI command:
DISP:TRAC:MODE AVER, see DISPlay[:WINDow<window>]:TRACe<trace>:MODE on page 223

View ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
The current contents of the trace memory are frozen and displayed.

If a trace is frozen, the instrument settings, apart from level range and reference level (see below), can be changed without impact on the displayed trace. The fact that the trace and the current instrument setting do not correspond any more is indicated by the icon on the tab label.

If the level range or reference level is changed, the analyzer automatically adapts the measured data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

SCPI command:
DISP:TRAC:MODE VIEW, see DISPlay[:WINDow<window>]:TRACe<trace>:MODE on page 223

Blank ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Hides the selected trace.

SCPI command:
DISP:TRAC OFF, see DISPlay[:WINDow<window>]:TRACe<trace>:MODE on page 223

Evaluation (Meas/Ref) ← Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Defines whether the trace displays the evaluation of the measured signal or the reference signal (if "Meas & Ref Signal" is used as the signal source, see "Source" on page 163).

SCPI command:
CALCulate<screen>:TRACe<trace>[:VALue] on page 220

Trace Wizard
Opens the "Trace Wizard" dialog. For each trace you can define a "Trace Mode" and an "Evaluation" type. Alternatively, you can configure several traces in one step using the predefined settings.

Trace Mode ← Trace Wizard

Defines the type of display and the evaluation of the trace.

- Clear Write
- Max Hold
- Min Hold
- Average
- View
- Blank

For details see chapter 4.3.4.1, "Trace Mode Overview", on page 179

SCPI command:

`DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Evaluation ← Trace Wizard

Defines whether the trace displays the evaluation of the measured signal or the reference signal (if "Meas & Ref Signal" is used as the signal source, see "Source" on page 163).

SCPI command:

`CALCulate<screen>:FEED` on page 214

Preset All Traces ← Trace Wizard

Configures several traces to predefined display modes in one step:

Trace 1: "Clear Write"

Trace 2-6: Blank

For details see (chapter 4.3.4.1, "Trace Mode Overview", on page 179).

Select Max | Avg | Min ← Trace Wizard

Configures several traces to predefined display modes in one step:

Trace 1: "Max Hold"

Trace 2: "Average"

Trace 3: "Min Hold"

Trace 4-6: Blank

For details see (chapter 4.3.4.1, "Trace Mode Overview", on page 179).

Select Max | ClrWrite | Min ← Trace Wizard
Configures several traces to predefined display modes in one step:

Trace 1: "Max Hold"

Trace 2: "Clear Write"

Trace 3: "Min Hold"

Trace 4-6: Blank

For details see (chapter 4.3.4.1, "Trace Mode Overview", on page 179).

ASCII Trace Export
Opens the "ASCII Trace Export" dialog box and saves the active trace in ASCII format to the specified file and directory. Various options are available to configure the stored data.

- "Mode"
  Stores raw I/Q data or trace data
- "Header"
  Includes a header with scaling information etc.
- "Decimal Separator"
  Defines the separator for decimal values as point or comma

SCPI command:

`FORMat:DEXPort:DSEParator` on page 230
`FORMat:DEXPort:HEADer` on page 231
`FORMat:DEXPort:MODE` on page 231
`MMEMory:STORe<n>:TRACe` on page 239

4.3.2.7 Softkeys of the Trigger Menu (R&S FSV-K70)

The TRIG key opens the "I/Q Capture" tab of the "Frontend & I/Q Capture Settings" dialog box (see "Frontend and I/Q Capture Settings", on page 137) and displays the "Trigger" menu, which contains the following softkeys.

Free Run
The start of a sweep is not triggered. Once a measurement is completed, another is started immediately.

SCPI command:
`TRIG:SOUR IMM`, see `TRIGger<n>[:SEQuence]:SOURce` on page 278

External
Defines triggering via a TTL signal at the "EXT TRIG/GATE IN" input connector on the rear panel.

SCPI command:
`TRIG:SOUR EXT`, see `TRIGger<n>[:SEQuence]:SOURce` on page 278

IF Power/ Baseband Power
Defines triggering of the measurement using the second intermediate frequency.

For this purpose, the analyzer uses a level detector at the second intermediate frequency. Its threshold can be set in a range between -50 dBm and -10 dBm at the input mixer. The resulting trigger level at the RF input is calculated via the following formula:

"$mixerlevel_{min}$ + RFAtt – PreampGain ≤ Input Signal ≤ $mixerlevel_{max}$ + RFAtt – PreampGain"

The bandwidth at the intermediate frequency is 40 MHz. The analyzer is triggered as soon as the trigger threshold is exceeded within a 6 MHz range around the selected frequency (= start frequency in the frequency sweep).

For digital input via the Digital Baseband Interface (R&S FSV-B17), the baseband power ("BB Power") is used as the trigger source.

SCPI command:
`TRIG:SOUR IFP`, see `TRIGger<n>[:SEQuence]:SOURce` on page 278
`TRIG:SOUR BBP` for digital input

Trigger Level
Defines the trigger level as a numeric value.

SCPI command:
`TRIGger<n>[:SEQuence]:LEVel:IFPower` on page 276
For digital input via the Digital Baseband Interface, R&S FSV-B17:
`TRIGger<n>[:SEQuence]:LEVel:BBPower` on page 275

Trigger Polarity
Sets the polarity of the trigger source.

The sweep starts after a positive or negative edge of the trigger signal. The default setting is "Pos". The setting applies to all modes with the exception of the "Free Run" and "Time" mode.

"Pos" Level triggering: the sweep is stopped by the logic "0" signal and restarted by the logical "1" signal after the gate delay time has elapsed.

"Neg" Edge triggering: the sweep is continued on a "0" to "1" transition for the gate length duration after the gate delay time has elapsed.

SCPI command:

`TRIGger<n>[:SEQuence]:SLOPe` on page 278

Trigger Offset

Opens an edit dialog box to enter the time offset between the trigger signal and the start of the sweep.

The time may be entered in s or in symbols.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pre-trigger) Only possible for span = 0 (e.g. I/Q Analyzer mode) and gated trigger switched off Maximum allowed range limited by the sweep time: $pretrigger_{max}$ = sweep time When using digital baseband interface (R&S FSV-B17) with I/Q Analyzer mode, the maximum range is limited by the number of pretrigger samples. See the digital baseband interface(R&S FSV-B17) description in the base unit.

In the "External" or "IF Power" trigger mode, a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger delay (trigger offset) as well.

SCPI command:

`TRIGger<n>[:SEQuence]:HOLDoff[:TIME]` on page 277

Trigger Offset Unit

Toggles between symbols and seconds as the trigger offset unit.

4.3.2.8 Softkeys of the Meas Config Menu (R&S FSV-K70)

The "Meas Config" menu provides functions for measurement configuration.

Settings Overview
Displays the main settings overview that visualizes the data flow of the Vector Signal Analyzer and summarizes the current settings. In addition, the "Settings Overview" dialog box provides access to the individual settings dialog boxes and allows you to restore default values.

For details on configuring the measurement and a description of the individual dialog boxes, see chapter 4.3.3.1, "Settings Overview", on page 130.

Modulation/Signal Description
Opens the "Modulation/Signal Description" dialog box.

The signal description of the expected input signal determines the available configuration settings and the available burst or pattern settings. You can define a pattern to which the result range can be aligned (see "Pattern" on page 137).

A schematic preview of the current signal description is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

The "Modulation" tab contains modulation and TX filter settings. A live preview of the I/Q Constellation trace using the currently defined settings is displayed at the bottom of the dialog box to visualize the changes to the settings.

For details on the available settings see "Modulation", on page 132 and "Signal Description", on page 135.

Frontend
Displays the "Frontend" tab of the "Frontend & I/Q Capture Settings" dialog box.

A live preview of the signal with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

Note that this works only in continuous sweep mode.

For details on the available settings see "Frontend", on page 137

I/Q Capture
Displays the "I/Q Capture" tab of the "Frontend & I/Q Capture Settings" dialog box.

A live preview of the signal in the capture buffer with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

Note that this works only in continuous sweep mode.

For details on the available settings see "I/Q Capture", on page 140

Config Pattern
Displays the "Advanced Pattern Settings" dialog box (see "Advanced Settings" on page 148).

Burst/Pattern Search
Displays the "Burst/Pattern Search" dialog box.

The "Burst Search" tab contains the settings for burst searches.

A live preview of the capture buffer with the current settings is displayed in the preview area at the bottom of the dialog box. The green bar below the trace indicates the defined evaluation ranges (see "Evaluation Range", on page 154). The preview area is not editable directly.

The "Pattern Search" tab contains the settings for pattern searches.

For details on the available settings see "Burst Search", on page 144 and "Pattern Search", on page 146.

Range Settings

Displays the "Result Range" tab of the "Result Range/Evaluation Range" dialog box.

A preview of the result display with the current settings is displayed in the visualization area at the bottom of the dialog box.

For details on the available settings see "Result Range", on page 152 and "Evaluation Range", on page 154

Demod/ Meas Filter

Displays the "Demodulation & Measurement Filter" dialog box.

The "Demodulation" tab contains the settings for the demodulation.

The "Measurement Filter" tab contains the settings for the measurement filter.

A live preview of the I/Q constellation trace with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

For details on the available settings see "Measurement Filter", on page 160 and "Demodulation", on page 156.

Display Config

Opens the "Display Configuration" dialog box to configure the measurement results display. See "Display Configuration", on page 162.

4.3.2.9 Softkeys of the Marker Menu (R&S FSV-K70)

The MARKER key displays the "Marker" menu, which contains the following softkeys.

Marker 1/2/3/4

Selects the corresponding marker and activates it.

Marker 1 is always a normal marker. After Marker 2 to 4 have been switched on, they are delta markers that are referenced to Marker 1. These markers can be converted into markers with absolute value displays using the "Marker Norm/Delta" softkey. When Marker 1 is the active marker, pressing the "Marker Norm/Delta" softkey switches on an additional delta marker. Pressing the "Marker 1" to "Marker 4" softkey again switches the corresponding marker off.

SCPI command:

CALCulate<n>:MARKer<m>[:STATe] on page 208
CALCulate<n>:MARKer<m>:X on page 209
CALCulate<n>:MARKer<m>:Y on page 211
CALCulate<n>:DELTamarker<m>[:STATe] on page 189
CALCulate<n>:DELTamarker<m>:X on page 190
CALCulate<n>:DELTamarker<m>:Y on page 191

Marker Norm/Delta

Changes the active marker to a normal (norm) or delta marker (with respect to marker 1).

SCPI command:

CALCulate<n>:MARKer<m>[:STATe] on page 208
CALCulate<n>:DELTamarker<m>[:STATe] on page 189

Couple Screens (On/Off)

Markers in all diagrams with the same (time or symbols) x-axis have coupled x-values (except for capture buffer display), i.e. if you move the marker in one diagram, it is moved in all coupled diagrams.

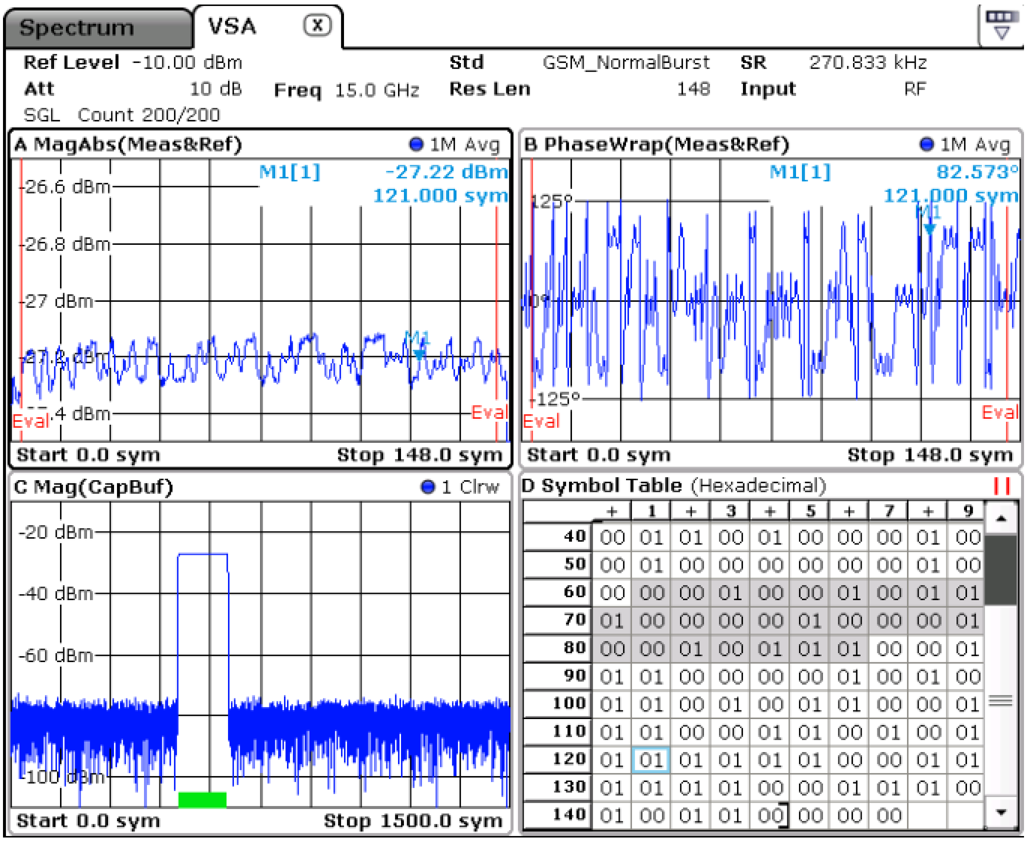


Fig. 4-77: Coupled markers in screens A, B and D

SCPI command:
`CALCulate<screen>:MARKer<marker>:LINK` on page 204

Link Mkr1 and Delta1
The delta marker 1 is linked to marker 1, so if the x-axis value of the marker 1 is changed, the delta marker 1 will follow on the same x-position. The link is off by default.

You can set the two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

SCPI command:
`CALCulate<n>:DELTamarker<m>:LINK` on page 186

Marker to Trace
Opens an edit dialog box to enter the number of the trace on which the marker is to be placed.

SCPI command:
`CALCulate<n>:MARKer<m>:TRACe` on page 209

All Marker Off
Switches all markers off. It also switches off all functions and displays that are associated with the markers/delta markers.

SCPI command:
`CALCulate<n>:MARKer<m>:AOFF` on page 192

4.3.2.10 Softkeys of the Marker To Menu (R&S FSV-K70)

The MARKER -> key displays the "Marker To" menu, which contains the following softkeys.

Select 1/2/3/4/Δ
Selects the normal marker or the delta marker and activates the marker. "Δ" stands for delta marker 1.

`CALCulate<n>:MARKer<m>[:STATe]` on page 208

`CALCulate<n>:MARKer<m>:X` on page 209

`CALCulate<n>:MARKer<m>:Y` on page 211

Select Mkr and Trace
Opens the "Select Marker and Trace" tab of the "Marker To Settings" dialog box.

Marker ← Select Mkr and Trace
Enables and defines the setting for the individual markers. The marker value is defined in the x-axis unit. The selected marker can be moved to a specific trace using the Move Marker to Trace function.

SCPI command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 208

Move Marker to Trace ← Select Mkr and Trace
Moves the marker selected under Marker to the trace selected here. The marker changes to the selected trace, but remains on the previous symbol.

SCPI command:
`CALCulate<n>:MARKer<m>:TRACe` on page 209

Search Settings
Opens the "Search Settings" tab of the "Marker To Settings" dialog box.

Search Direction ← Search Settings
Defines whether the absolute values are searched, or the values to the left (smaller) or to the right (greater).

SCPI command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 206
`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 205
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 206

Marker Real / Marker Imag ← Search Settings
Defines whether marker search functions are performed on the real or imaginary trace of the "Real/Imag" measurement.

SCPI command:
`CALCulate<screen>:MARKer<marker>:SEARch` on page 208

Search Limits ← Search Settings
If enabled, defines the limits of the search.

"Left Limit"	Lowest symbol number for which the search is performed.
"Right Limit"	Highest symbol number for which the search is performed.
"Use Zoom Limits"	Restricts the marker search to the zoomed area.

SCPI command:
`CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM` on page 211
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 210
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 210

Peak
Sets the active marker/delta marker to the highest maximum of the trace.

SCPI command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 206

Next Peak
Sets the active marker/delta marker to the next maximum of the selected trace.

SCPI command:
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 205
`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 187

Max |Peak|
Sets the active marker/delta marker to the largest absolute peak value (maximum or minimum) of the selected trace.

SCPI command:
`CALCulate<screen>:MARKer<marker>:MAXimum:APEak` on page 205

Min
Sets the active marker/delta marker to the minimum of the selected trace.

SCPI command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 207

Next Min
Sets the active marker/delta marker to the next minimum of the selected trace.

SCPI command:
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 207
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 188

4.3.2.11 Softkeys of the Input/Output menu (R&S FSV-K70)

The INPUT/OUTPUT key displays the "In-/Output" menu, which contains the following softkeys.

Signal Source
Opens a dialog box to select the signal source. For "Digital Baseband (I/Q)", the source can also be configured here.

Input Path ← Signal Source
Defines whether the "RF Radio Frequency" or the "Baseband Digital" input path is used for measurements. "Baseband Digital" is only available if option R&S FSV-B17 (Digital Baseband interface) is installed.

Note: Note that the input path defines the characteristics of the signal, which differ significantly between the RF input and digital input.

SCPI command:
`INPut:SELect` on page 238

Connected Device ← Signal Source
Displays the name of the device connected to the optional Digital Baseband interface (R&S FSV-B17) to provide Baseband Digital input. The device name cannot be changed here.

The device name is unknown.

SCPI command:
`INPut:DIQ:CDEVice` on page 234

Input Sample Rate ← Signal Source
Defines the sample rate of the digital I/Q signal source. This sample rate must correspond with the sample rate provided by the connected device, e.g. a generator.

SCPI command:
`INPut:DIQ:SRATe` on page 236

Full Scale Level ← Signal Source
The "Full Scale Level" defines the level that should correspond to an I/Q sample with the magnitude "1".

The level can be defined either in dBm or Volt.

SCPI command:
`INPut:DIQ:RANGe[:UPPer]` on page 236

Level Unit ← Signal Source
Defines the unit used for the full scale level.

SCPI command:
`INPut:DIQ:RANGe[:UPPer]:UNIT` on page 236

Adjust Reference Level to Full Scale Level ← Signal Source
If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

SCPI command:
`INPut:DIQ:RANGe:COUPling` on page 235

EXIQ
Opens a configuration dialog box for an optionally connected R&S EX-IQ-BOX and a submenu to access the main settings quickly.

If the optional R&S DigIConf software is installed, the submenu consists only of one key to access the software. **Note that R&S DigIConf requires a USB connection (not LAN!) from the analyzer to the R&S EX-IQ-BOX in addition to the Digital Baseband Interface connection. R&S DigIConf version 2.10 or higher is required.**

For typical applications of the R&S EX-IQ-BOX see also the description of the Digital Baseband Interface (R&S FSV-B17) in the base unit manual.

For details on configuration see the "R&S®Ex I/Q Box - External Signal Interface Module Manual".

For details on installation and operation of the R&S DigIConf software, see the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

TX Settings ← EXIQ
Opens the "EX-IQ-BOX Settings" dialog box to configure the analyzer for digital output to a connected device ("Transmitter" Type).

RX Settings ← EXIQ
Opens the "EX-IQ-BOX Settings" dialog box to configure the analyzer for digital input from a connected device ("Receiver" Type).

Send To ← EXIQ
The configuration settings defined in the dialog box are transferred to the R&S EX-IQ-BOX.

Firmware Update ← EXIQ
If a firmware update for the R&S EX-IQ-BOX is delivered with the analyzer firmware, this function is available. In this case, when you select the softkey, the firmware update is performed.

R&S Support ← EXIQ
Stores useful information for troubleshooting in case of errors.

This data is stored in the `C:\R_S\Instr\user\Support` directory on the instrument.

The `SupportSave.dfl` file contains the instrument settings and input data and can be loaded to the instrument again for inspection later. (Remember to set the sweep mode to "Single Sweep" beforehand, as "Continuous Sweep" would immediately overwrite the loaded input data.)

If you contact the Rohde&Schwarz support to get help for a certain problem, send these files to the support in order to identify and solve the problem faster.

DigIConf ← EXIQ
Starts the optional R&S DigIConf application. This softkey is only available if the optional software is installed.

To return to the analyzer application, press any key on the front panel. The application is displayed with the "EXIQ" menu, regardless of which key was pressed.

For details on the R&S DigIConf application, see the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Note: If you close the R&S DigIConf window using the "Close" icon, the window is minimized, not closed.

If you select the "File > Exit" menu item in the R&S DigIConf window, the application is closed. Note that in this case the settings are lost and the EX-IQ-BOX functionality is no longer available until you restart the application using the "DigIConf" softkey in the analyzer once again.

SCPI command:
Remote commands for the R&S DigIConf software always begin with `SOURce:EBOX`. Such commands are passed on from the analyzer 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.

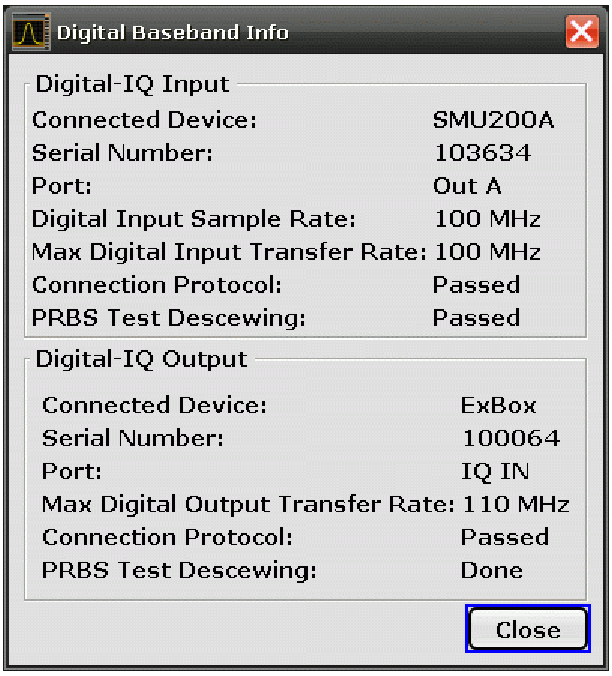
Input (AC/DC)
Toggles the RF input of the analyzer between AC and DC coupling.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

SCPI command:
`INPut:COUPling` on page 234

Digital Baseband Info
Displays a dialog box with information on the digital I/Q input and output connection via the optional Digital Baseband interface (R&S FSV-B17), if available. The information includes:

- Device identification
- Used port
- (Maximum) digital input/output sample rates and maximum digital input/output transfer rates
- Status of the connection protocol
- Status of the PRBS descewing test



For details see "Interface Status Information" in "Instrument Functions - Digital Baseband Interface (Option R&S FSV-B17)" in the description of the base unit.

SCPI command:

`INPut:DIQ:CDEVice` on page 234

4.3.2.12 Softkeys of the Save/Recall Menu (R&S FSV-K70)

The "Save/Recall" menu contains the same functions as for the base unit, except for the "Export" submenu:

Export

Opens a dialog box to configure exports of trace data.

ASCII Trace Export ← Export

Opens the "ASCII Trace Export" dialog box and saves the active trace in ASCII format to the specified file and directory. Various options are available to configure the stored data.

- "Mode"
  Stores raw I/Q data or trace data
- "Header"
  Includes a header with scaling information etc.
- "Decimal Separator"

Defines the separator for decimal values as point or comma

SCPI command:

FORMat:DEXPort:DSEParator on page 230
FORMat:DEXPort:HEADer on page 231
FORMat:DEXPort:MODE on page 231
MMEMory:STORe<n>:TRACe on page 239

R&S Support ← Export

Stores useful information for troubleshooting in case of errors.

This data is stored in the `C:\R_S\Instr\user\Support` directory on the instrument.

The `SupportSave.dfl` file contains the instrument settings and input data and can be loaded to the instrument again for inspection later. (Remember to set the sweep mode to "Single Sweep" beforehand, as "Continuous Sweep" would immediately overwrite the loaded input data.)

If you contact the Rohde&Schwarz support to get help for a certain problem, send these files to the support in order to identify and solve the problem faster.

4.3.2.13 Available Context Menus

For many objects on the screen, context-sensitive menues are available that provide helpful functions for the specific object, e.g. an edit dialog box for a specific setting. Thus, you don't have to navigate through various softkey levels or dialog boxes to quickly change a setting.

There are two ways to access the context menus:

- Right-click the object to display the menu temporarily and select the required function directly.
- Double-click the object to display a context-sensitive softkey menu that remains visible until you click a hardkey with its own menu.

Example:

For example, the context-sensitive menu for the symbol rate display in the information bar at the top of the screen provides a function to change the symbol rate directly. Alternatively, you could select "Home > Modulation" and then the "Symbol Rate" input field.

4.3.3 Configuring VSA measurements

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:

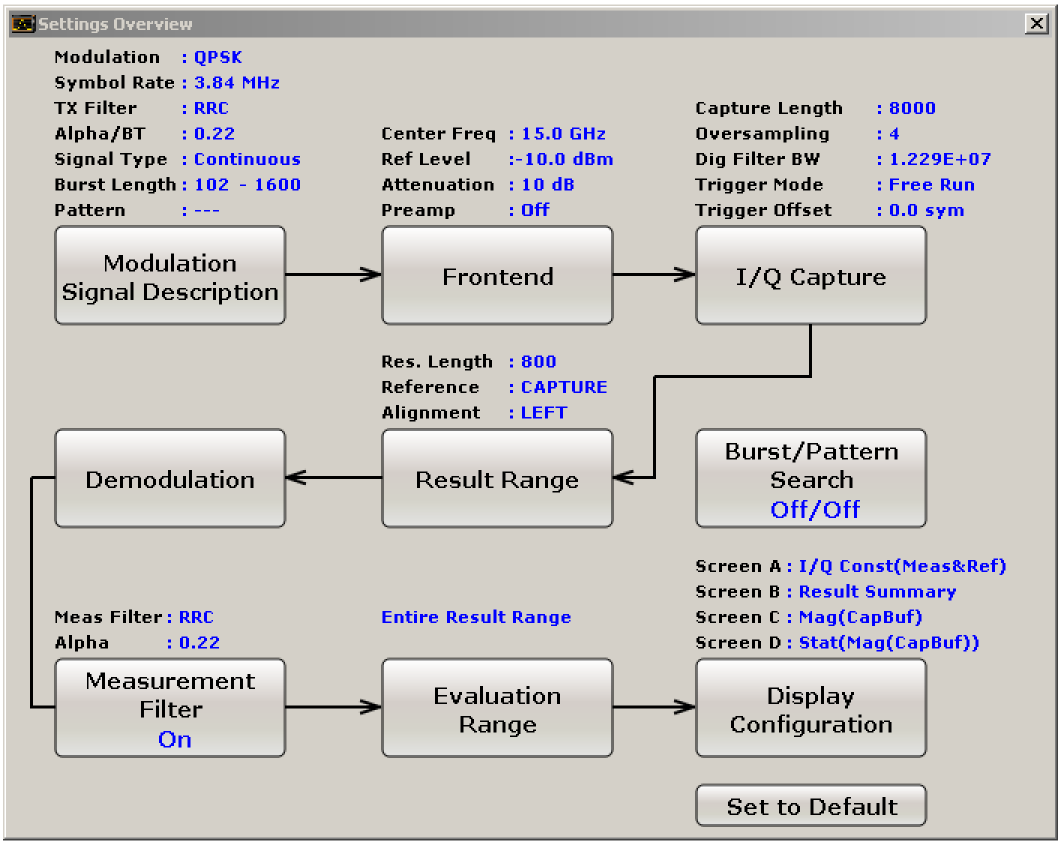
- Selecting an existing standard settings file and, if necessary, adapting the measurement settings to your specific requirements.
- Configuring the measurement settings and, if necessary, storing the settings in a file.

4.3.3.1 Settings Overview

An overview of the current and required settings is available using the "Settings Overview" softkey in the "VSA" menu (see "Settings Overview" on page 100).

The overview visualizes the data flow in the Vector Signal Analyzer, summarizes the current settings and provides a convenient way to configure all measurement settings. From the overview you can access the individual settings dialog boxes by clicking the required topic. For details on the displayed information, see the description of the individual dialog boxes below.

To reset the instrument to the default settings of the default standard, click "Set to Default".


Settings Overview
Modulation : QPSK
Symbol Rate : 3.84 MHz
TX Filter : RRC
Alpha/BT : 0.22
Signal Type : Continuous
Burst Length : 102 - 1600
Pattern : ---
Center Freq : 15.0 GHz
Ref Level : -10.0 dBm
Attenuation : 10 dB
Preamp : Off
Capture Length : 8000
Oversampling : 4
Dig Filter BW : 1.229E+07
Trigger Mode : Free Run
Trigger Offset : 0.0 sym
Modulation Signal Description
Frontend
I/Q Capture
Res. Length : 800
Reference : CAPTURE
Alignment : LEFT
Demodulation
Result Range
Burst/Pattern Search Off/Off
Screen A : I/Q Const(Meas&Ref)
Screen B : Result Summary
Screen C : Mag(CapBuf)
Screen D : Stat(Mag(CapBuf))
Meas Filter : RRC
Alpha : 0.22
Entire Result Range
Measurement Filter On
Evaluation Range
Display Configuration
Set to Default

Modulation and Signal Description Settings

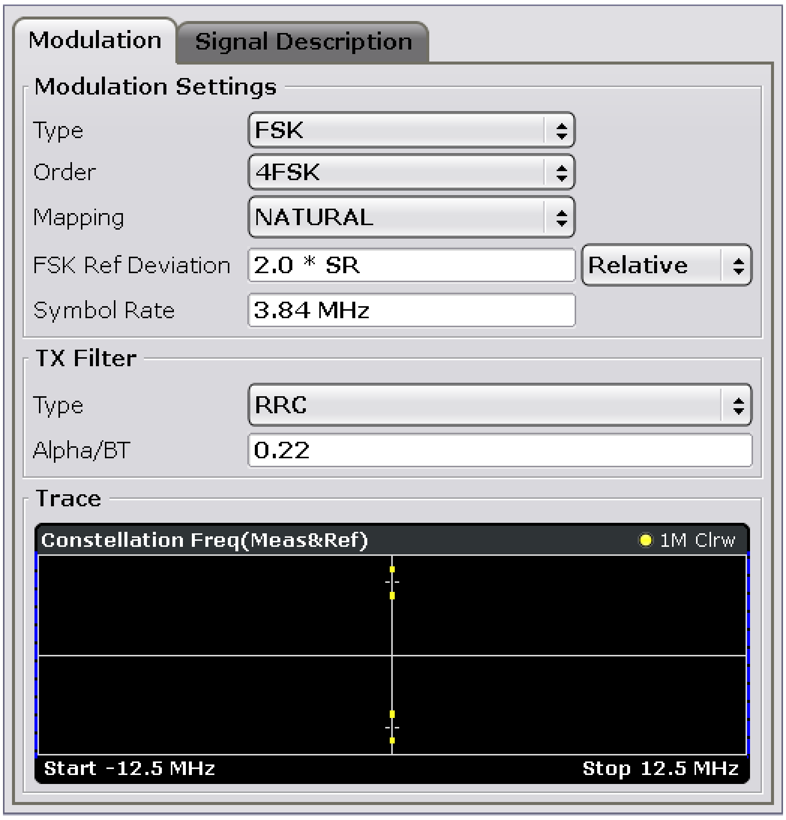
You describe the properties of the signal to be measured in the "Modulation and Signal Description Settings" dialog box. This dialog box is displayed when you select "Modulation / Signal Description" in the "Settings Overview".

The dialog box contains the following tabs:

- "Modulation", on page 132
- "Signal Description", on page 135

Modulation

The "Modulation" tab of the "Modulation & Signal Description" dialog box contains modulation and TX filter settings. A live preview of the I/Q Constellation trace using the currently defined settings is displayed at the bottom of the dialog box to visualize the changes to the settings. The preview area is not editable directly.



Modulation Type
Defines the modulation type of the vector signal. The following types are available:

- PSK
- MSK

- QAM
- FSK
- UserQAM

SCPI command:
[SENSe<n>]:DDEMod:FORMat on page 246

Modulation Order
Depending on the Modulation Type, various orders of modulation are available:

Type	Available orders
PSK	BPSK
	QPSK
	Offset QPSK
	DQPSK
	PI/4-DQPSK
	8PSK
	D8PSK
	3PI/8-8PSK
	PI/8-D8PSK
MSK	MSK
	DMSK
QAM	16QAM
	Pi/4-16QAM
	32QAM
	Pi/4-32QAM
	64QAM
	128QAM
	256QAM
FSK	2FSK
	4FSK
UserQAM	16ary
	32ary

SCPI command:
[SENSe<n>]:DDEMod:PSK:FORMat on page 254
[SENSe<n>]:DDEMod:QPSK:FORMat on page 256
[SENSe<n>]:DDEMod:MSK:FORMat on page 249
[SENSe<n>]:DDEMod:QAM:FORMat on page 255

FSK Ref Deviation

The FSK Reference Deviation sets the deviation to the reference frequency.

In case of 2FSK, it indicates the distance from the reference frequency to the positive / negative deviation frequency and in case of 4FSK, the distance to the outer positive/ negative deviation frequency.

Select "Relative" from the dropdown menu next to the input field to set the deviation as a multiple of the symbol rate (x*SR). If you want to set the deviation as an absolute value in Hz, select "Absolute" from the dropdown menu.

Note that this parameter is available only in combination with FSK modulated signals.

SCPI command:

`CALCulate<screen>:FSK:DEViation:REFerence[:VALue]` on page 216

`CALCulate<screen>:FSK:DEViation:REFerence:RELative` on page 216

Modulation Mapping

The available mapping types depend on the Modulation Type and Modulation Order.

For more information on the modulation mapping, refer to

- chapter 4.1.3, "Symbol Mapping", on page 21

SCPI command:

`[SENSe<n>]:DDEMod:MAPPing[:VALue]` on page 247

`[SENSe<n>]:DDEMod:MAPPing:CATalog` on page 247

Symbol Rate

The symbol rate also determines the I/Q bandwidth of the data recording and demodulation. You can change the default rate by entering a value in Hz. The value range is 25 Hz to 32 MHz (continuous) with the R&S FSV-B70 option, or 25 Hz to 11 MHz without the additional option.

Note: The maximum usable I/Q bandwidth for the R&S FSV 40 model 1307.9002K39 is 10 MHz. Thus, the maximum symbol rate is:

- For capture oversampling =4: symbol rate ≤ 3.125 MHz

SCPI command:

`[SENSe<n>]:DDEMod:SRATe` on page 267

TX Filter Type

Defines the type of transmit filter

- RC
  Raised cosine
- RRC
- Root raised cosine
- Gauss
  Gauss filter
- GMSK
  Gauss filter convolved with a rectangular filter; typically used for MSK
- Linearized GMSK
  Linearized Gauss filter, convolved with a rectangular filter; used as a transmit filter for GSM EDGE
- Half Sine

- APCO25 C4FM
  Filter for the APCO25 C4FM standard.
- APCO25 H-CPM
  Filter for the APCO25 H-CPM standard.
- APCO25 DQPSK
  Filter for the APCO25 DQPSK standard.
- APCO25 DQPSK Narrow
- APCO25 DQPSK Wide
- 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)
- None
  No filter

SCPI command:
`[SENSe<n>]:DDEMod:TFILter:NAME` on page 270

Alpha/BT

Defines the roll-off factor (Alpha) or the filter bandwidth (BT).

The roll-off factor and filter bandwidth for TX filter is available for RC, RRC, Gauss and GMSK filter.

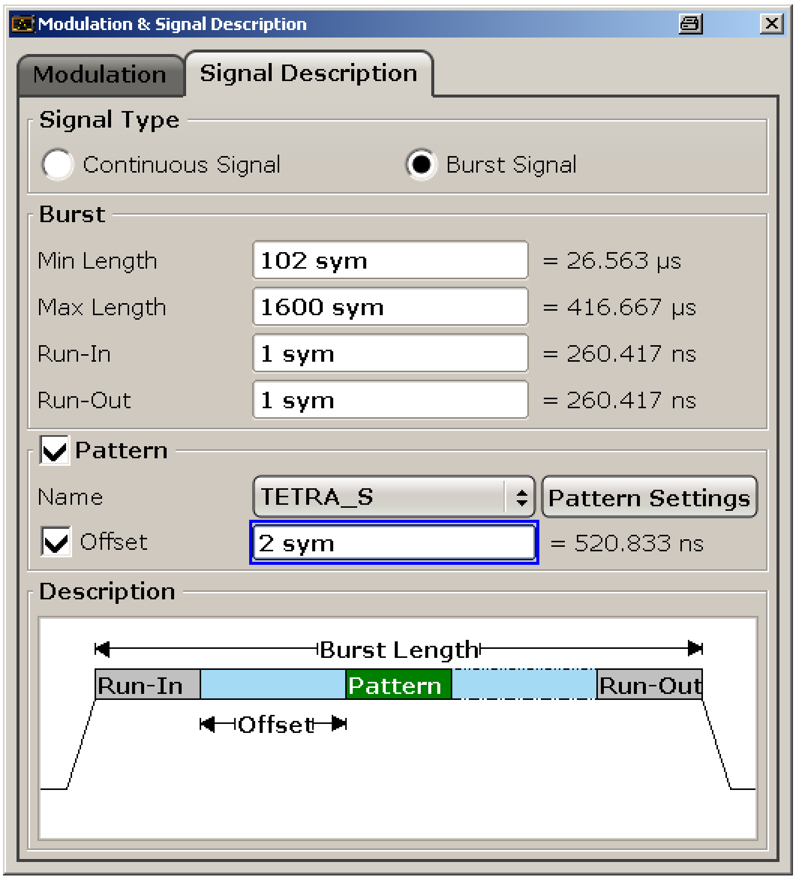
The roll-off factor and filter bandwidth for measurement filter is available for RRC filter.

SCPI command:
TX Filter: `[SENSe<n>]:DDEMod:FILTer:ALPHa` on page 245
Measurement filter: `[SENSe<n>]:DDEMod:MFILter:ALPHa` on page 247

Signal Description

The settings in the "Signal Description" tab of the "Modulation & Signal Description" dialog box 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.

A graphical preview of the current Signal Description configuration is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.



Continuous Signal / Burst Signal

Determines whether the signal is continuous or contains bursts. For bursts, further settings are available.

Parameter	Description
Min Length	Shortest expected burst length in symbols
Max Length	Longest expected burst length in symbols (≦15000)
Run-In	The number of symbols before the signal is assumed to have valid modulated symbols
Run-Out	The number of symbols before the falling edge that do not necessarily need to have a valid modulation

Note:

The burst excluding its Run-In/-Out areas is sometimes referrred to as the "useful part". The minimum length of the useful part (= Min Length - Run-In - Run-Out) must be ≧10.

The parameter Run-In/-Out can be used to influence the range over which the EVM is minimized. The (internal) synchronization range is the overlapping area of the result range and the burst excluding its Run-In/-Out areas. Hence, this parameter also allows for demodulation of bursts with mixed modulations, e.g. Bluetooth, because it can be used to explicitely exclude symbols from influencing the synchronization.

SCPI command:

`[SENSe<n>]:DDEMod:SIGNal[:VALue]` on page 267

Pattern

If enabled, the instrument expects the signal to contain a pattern.

Note: The pattern search itself must be enabled separately in the "Pattern Search Settings", see "Auto/On/Off" on page 147. By default, the pattern search is active if the signal description contains a pattern.

This function cannot be enabled if the signal description does not contain a pattern.

Select the pattern from the selection list. To change the pattern settings, press "Advanced Settings" on page 148. For details on working with pattern searches, see chapter 4.3.3.5, "Working with Pattern Searches", on page 174

Further pattern settings are located in the "Pattern Search", on page 146 dialog box (see "Burst and Pattern Search Settings", on page 144).

SCPI command:

`[SENSe<n>]:DDEMod:SIGNal:PATTern` on page 267

Pattern Settings

Displays the "Advanced Pattern Settings" dialog box (see "Advanced Settings" on page 148).

Offset

The offset of the pattern is defined with respect to the start of the useful part of the burst (see also the note in "Continuous Signal / Burst Signal" on page 136). If the position of the pattern within the burst is known, it is recommended that you define the offset. That will accelerate the pattern search and enhance the accuracy of the burst search.

SCPI command:

`[SENSe<n>]:DDEMod:STANdard:SYNC:OFFSet:STATe` on page 269

`[SENSe<n>]:DDEMod:STANdard:SYNC:OFFSet[:VALue]` on page 269

Frontend and I/Q Capture Settings

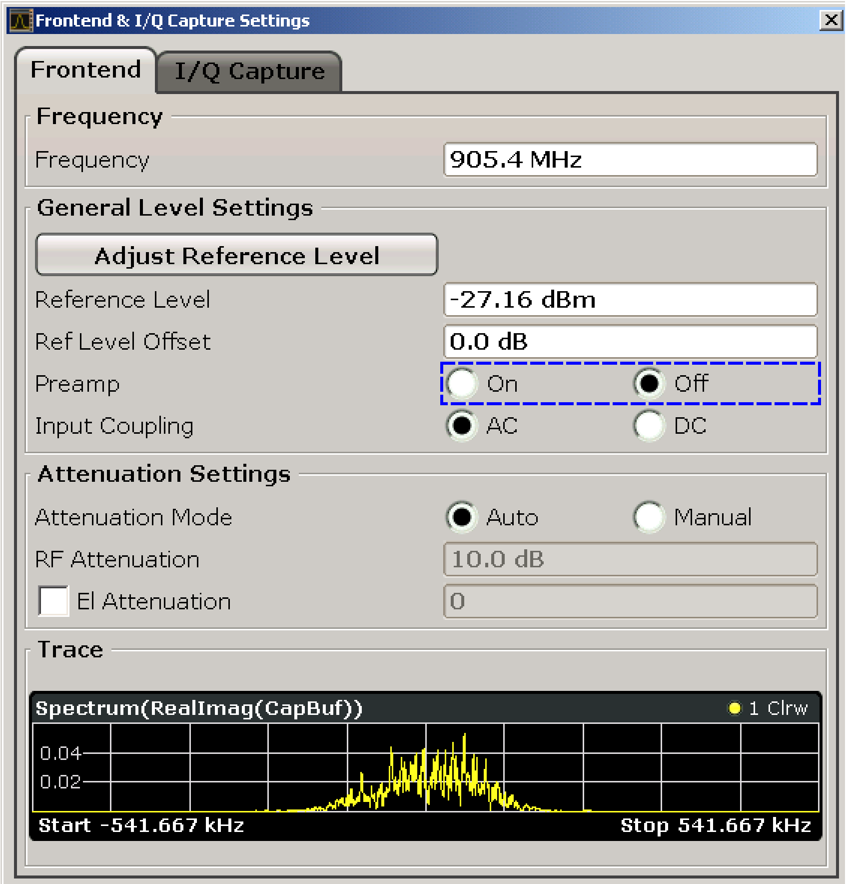
You configure the measurement of the actual input signal in the "Frontend and I/Q Capture Settings" dialog box. This dialog box contains the following tabs:

- "Frontend", on page 137
- "I/Q Capture", on page 140

Frontend

The "Frontend" tab contains the frontend settings of the instrument.

A live preview of the signal with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.



Frequency

Defines the center frequency. The allowed range of values for the center frequency depends on the frequency span.

span > 0: $span_{min}/2 \le f_{center} \le f_{max} - span_{min}/2$

span = 0: $0\ Hz \le f_{center} \le f_{max}$

f_{max} and $span_{min}$ are specified in the data sheet.

SCPI command:

`[SENSe:]FREQuency:CENTer` on page 271

Reference Level

Defines the reference level in dBm.

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IFOVL" status display.

To get an ideal reference level, use Auto Level function. For more information, see

- "Auto Level" on page 108

SCPI command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 228

Ref Level Offset

Defines the arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. Where necessary, the scaling of the y-axis is changed accordingly. The setting range is ±200 dB in 0.1 dB steps.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 228

Preamp On/Off (option RF Preamplifier, B22/B24)

Switches the preamplifier on or off.

If option R&S FSV-B22 is installed,the preamplifier is only active below 7 GHz.

If option R&S FSV-B24 is installed, the preamplifier is active for all frequencies.

This function is not available for I/Q Digital Baseband input (option R&S FSV-B17).

SCPI command:

`INPut:GAIN:STATe` on page 238

Input Coupling

Toggles the RF input of the analyzer between AC and DC coupling.

SCPI command:

`INPut:COUPling` on page 234

Attenuation Mode

Toggles the attunuation mode. In automatic mode, the RF attenuation is automatically set as a function of the selected reference level. This ensures that the optimum RF attenuation is always used. It is the default setting.

In manual mode, the specified RF attenuation is used irrespective of the reference level (see "RF Attenuation" on page 139).

SCPI command:

`INPut:ATTenuation:AUTO` on page 234

RF Attenuation

For Attenuation Mode = "Manual", this value defines the attenuation irrespective of the reference level. If electronic attenuation is enabled (option R&S FSV-B25 only; Attenuation Mode = "Auto"), this setting defines the mechanical attenuation.

The mechanical attenuation can be set in 10 dB steps.

The RF attenuation can be set in 5 dB steps (with option R&S FSV-B25: 1 dB steps). The range is specified in the data sheet. If the defined reference level cannot be set for the set RF attenuation, the reference level is adjusted accordingly.

Note: Values under 10 dB can only be entered via the numeric keypad or via remote control command in order to protect the input mixer against overload.

The RF attenuation defines the level at the input mixer according to the formula:

"$level_{mixer}$ = $level_{input}$ – RF attenuation"

The maximum mixer level allowed is -10 dBm. Mixer levels above this value may lead to incorrect measurement results, which are indicated by the "OVLD" status display.

SCPI command:

`INPut:ATTenuation` on page 233

El Attenuation ON/OFF

Enables and defines the electric attenuation. The attenuation can be varied in 1 dB steps from 0 to 30 dB. Other entries are rounded to the next lower integer value.

If the defined reference level cannot be set for the given RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is output.

SCPI command:

`INPut:EATT:STATe` on page 237

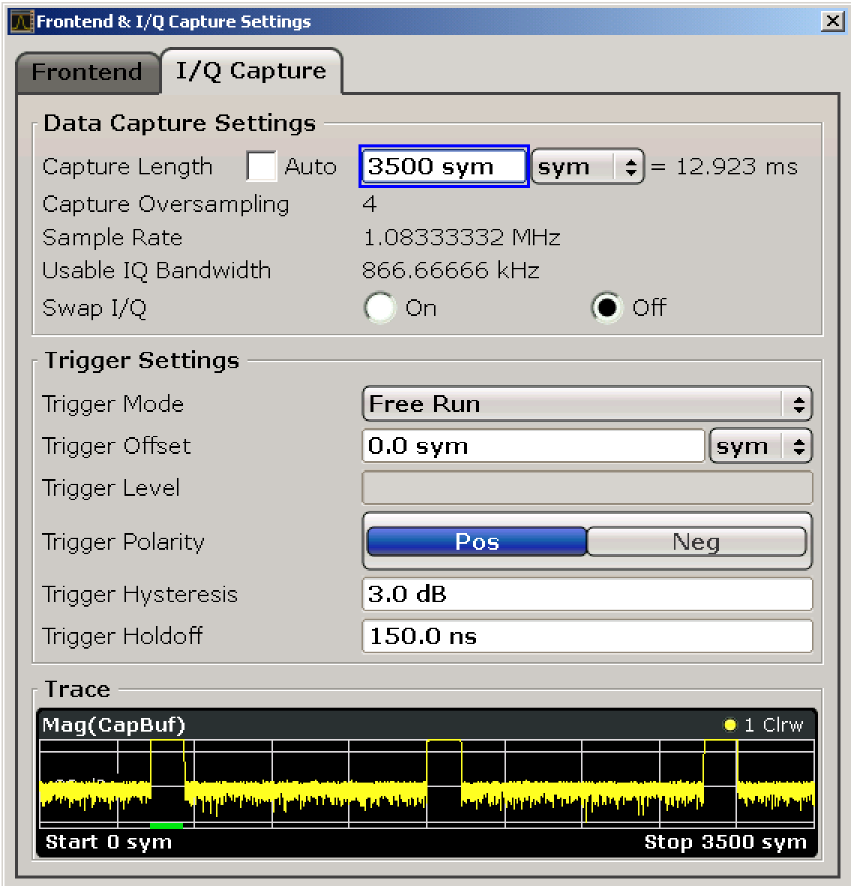
`INPut:EATT` on page 237

I/Q Capture

The "I/Q Capture" tab contains the settings for the measured I/Q data.

Note that the maximum usable I/Q bandwidth for the analyzer40 with the order number 1307.9002K39 is 10 MHz. Therefore the maximum symbol rate for this model is ≤3.125 MHz (capture oversampling = 4), ≤1.5625 MHz (capture oversampling = 8) and ≤0.78125 MHz (capture oversampling = 16).

A live preview of the signal in the capture buffer with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.



Capture Length Auto
Defines the Capture Length automatically according to the burst and pattern length settings and the statistics count (see "Signal Description", on page 135). Thus, a minimal Capture Length is used, which improves performance.

SCPI command:
`[SENSe<n>]:DDEMod:RLENgth:AUTO` on page 256

Capture Length
Defines the capture length in symbols or seconds, if not defined automatically (Capture Length).

The capture oversampling factor, the sample rate and the usable I/Q bandwidth are displayed for reference only.

SCPI command:
`[SENSe<n>]:DDEMod:RLENgth[:VALue]` on page 256

Capture Oversampling
Sets the oversampling rate.

By changing this parameter, it is possible to influence the I/Q bandwidth. The default value is 4. However, it may be necessary to increase it, especially when measuring FSK signals.

Note that a capture oversampling that does not suit the signal can cause inaccurate measurement results.

Take a look at the capture buffer with a Real/Imag result display and Spectrum transformation to make sure that the selected capture oversampling suits the signal.

SCPI command:
[SENSe<n>]:DDEMod:PRATe on page 251

Sample Rate
Shows the current sample rate.

Note that this is a read only field.

Usable I/Q Bandwidth
Shows the usable I/Q bandwidth.

Note that this is a read only field.

Swap I/Q
Swaps the I and Q values of the signal.

SCPI command:
[SENSe<n>]:DDEMod:SBANd on page 257

Trigger Mode
Defines the trigger mode.

"External" Defines triggering via a TTL signal at the "EXT TRIG/GATE IN" input connector on the rear panel.

"IF Power" Defines triggering of the measurement using the second intermediate frequency.
For this purpose, the analyzer uses a level detector at the second intermediate frequency. Its threshold can be set in a range between -50 dBm and -10 dBm at the input mixer. The resulting trigger level at the RF input is calculated via the following formula:
"$mixerlevel_{min}$ + RFAtt – PreampGain ≤ Input Signal ≤ $mixerlevel_{max}$ + RFAtt – PreampGain"
The bandwidth at the intermediate frequency is 40 MHz. The analyzer is triggered as soon as the trigger threshold is exceeded within a 6 MHz range around the selected frequency (= start frequency in the frequency sweep).

"Free Run" The start of a sweep is not triggered. Once a measurement is completed, another is started immediately.

SCPI command:
TRIGger<n>[:SEQuence]:SOURce on page 278
TRIGger<n>[:SEQuence]:LEVel:IFPower on page 276
For digital input: TRIGger<n>[:SEQuence]:LEVel:BBPower on page 275

Trigger Offset
Opens an edit dialog box to enter the time offset between the trigger signal and the start of the sweep.

The time may be entered in s or in symbols.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pre-trigger) Only possible for span = 0 (e.g. I/Q Analyzer mode) and gated trigger switched off Maximum allowed range limited by the sweep time: $pretrigger_{max}$ = sweep time When using digital baseband interface (R&S FSV-B17) with I/Q Analyzer mode, the maximum range is limited by the number of pretrigger samples. See the digital baseband interface(R&S FSV-B17) description in the base unit.

In the "External" or "IF Power" trigger mode, a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger delay (trigger offset) as well.

SCPI command:
`TRIGger<n>[:SEQuence]:HOLDoff[:TIME]` on page 277

Trigger Level
Defines the trigger level as a numeric value.

SCPI command:
`TRIGger<n>[:SEQuence]:LEVel:IFPower` on page 276
For digital input via the Digital Baseband Interface, R&S FSV-B17:
`TRIGger<n>[:SEQuence]:LEVel:BBPower` on page 275

Trigger Polarity
Sets the polarity of the trigger source.

The sweep starts after a positive or negative edge of the trigger signal. The default setting is "Pos". The setting applies to all modes with the exception of the "Free Run" and "Time" mode.

"Pos" Level triggering: the sweep is stopped by the logic "0" signal and restarted by the logical "1" signal after the gate delay time has elapsed.

"Neg" Edge triggering: the sweep is continued on a "0" to "1" transition for the gate length duration after the gate delay time has elapsed.

SCPI command:
`TRIGger<n>[:SEQuence]:SLOPe` on page 278

Trigger Hysteresis
Defines the value for the trigger hysteresis. The hysteresis in dB is the value the input signal must stay below the IF power trigger level in order to allow a trigger to start the measurement. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

This softkey is only available if IF Power is the selected trigger source.

SCPI command:
`TRIGger<n>[:SEQuence]:IFPower:HYSTeresis` on page 277

Trigger Holdoff
Defines the value for the trigger holdoff. The holdoff value in s is the time which must pass before triggering, in case another trigger event happens.

This softkey is only available if "IFPower" or "BBPower" is the selected trigger source.

SCPI command:
`TRIGger<n>[:SEQuence]:IFPower:HOLDoff` on page 276
For digital input via the Digital Baseband Interface, R&S FSV-B17:
`TRIGger<n>[:SEQuence]:BBPower:HOLDoff` on page 276

Burst and Pattern Search Settings

You configure burst and pattern searches in the "Burst & Pattern Settings" dialog. This dialog box contains the following tabs:

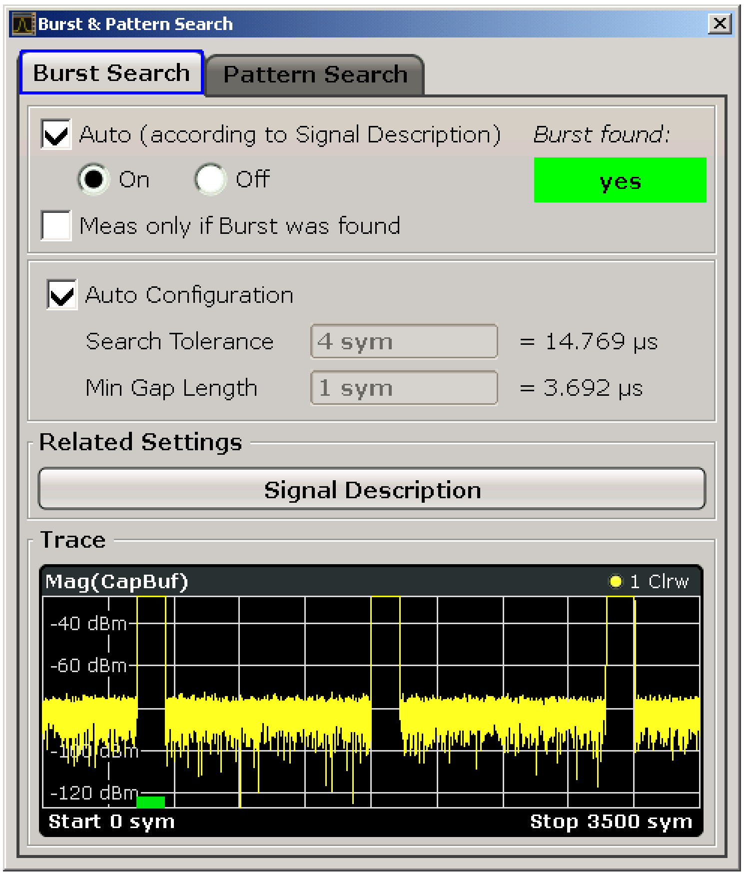
- Burst Search
- Pattern Search

Burst Search

The "Burst Search" tab contains the settings for burst searches. In addition, it contains a link to the "Signal Description" settings (see "Signal Description", on page 135).

A live preview of the capture buffer with the current settings is displayed in the preview area at the bottom of the dialog box. The green bar below the trace indicates the defined evaluation range (see "Evaluation Range", on page 154). The preview area is not editable directly.

The "Burst Search" tab is also displayed when you select the "Burst Search" softkey in the "Meas Config" menu (see "Burst/Pattern Search" on page 118).



Auto/On/Off

Enables or disables burst searches. If "Auto" is selected, burst search is enabled only if "Bursted Signal" is selected in the "Signal Description" tab of the "Modulation & Signal Description" dialog box (see "Continuous Signal / Burst Signal" on page 136).

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:BURSt:AUTO` on page 257

Meas only if burst was found

If enabled, measurement results are only displayed (and are only averaged) if a valid burst has been found. For measurements of burst signals that are averaged over several sweeps, this option should be enabled so that erroneous measurements do not affect the result of averaging.

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:BURSt:MODE` on page 259

Auto Configuration

Configures the burst search automatically. If enabled, the Search Tolerance and Min Gap Length settings are not available.

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:BURSt:CONFigure:AUTO` on page 257

Search Tolerance ← Auto Configuration
Defines the number of symbols that may differ from the burst length without influencing the burst detection. A search tolerance of 5, for example, with a minimum and maximum burst length of 100, will detect bursts that are 95 to 100 symbols long.

Note that due to the fact that the VSA does not have knowledge of the ramp length, there is an uncertainty in the burst search algorithm. Thus, setting this parameter to "0" will result in a failed burst search for most signals.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:BURSt:TOLerance` on page 260

Min Gap Length ← Auto Configuration
Represents the minimum distance (in symbols) between adjacent bursts. The default value is 1 symbol in order to make sure that the burst search finds bursts that are very close to each other. However, in case the capture buffer does not contain bursts that are narrowly Modulation Orderd, it is recommended to increase the value. This makes the burst search faster and also more robust for highly distorted signals.

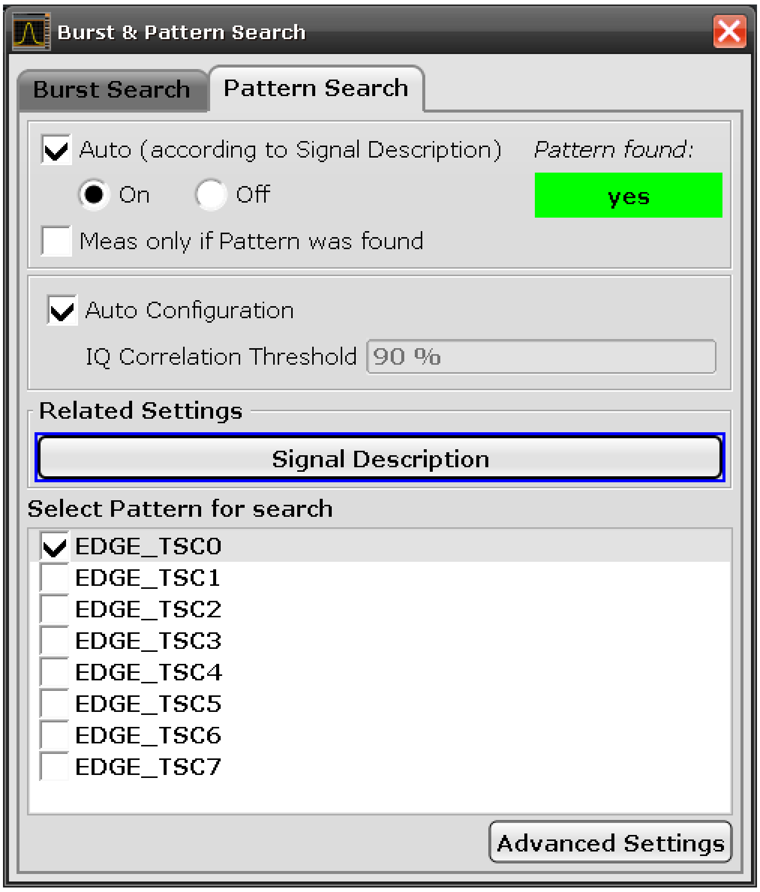
Note that this parameter only influences the robustness of the burst search. It should not be used to explicitly exclude certain bursts from the measurement. For example, setting the minimum gap length to 100 symbols does not ensure that the burst search does not find bursts that are more narrowly Modulation Orderd.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:BURSt:GLENgth[:MINimum]` on page 258

Pattern Search

The "Pattern Search" tab contains the settings for pattern searches. In addition, it contains a link to the "Signal Description" settings (see "Signal Description", on page 135).

For details on pattern searches, see chapter 4.3.3.5, "Working with Pattern Searches", on page 174.



Auto/On/Off

Enables or disables pattern searches. If "Auto" is selected, pattern search is enabled automatically if "Pattern" is selected in the "Signal Description" tab of the "Modulation & Signal Description" dialog box (see "Pattern" on page 137).

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:SYNC:MODE` on page 264

`[SENSe<n>]:DDEMod:SEARch:SYNC:AUTO` on page 261

Meas only if a pattern was found

If enabled, measurement results are only displayed (and averaged) if a valid pattern has been found. For measurements of signals with patterns that are averaged over several sweeps, this option should be enabled so that erroneous measurements do not affect the result of averaging.

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:SYNC:MODE` on page 264

Auto Configuration

Configures the pattern search automatically. If enabled, the I/Q Correlation Threshold setting is not available.

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:PATTern:CONFigure:AUTO` on page 261

I/Q Correlation Threshold ← Auto Configuration

The I/Q correlation threshold decides whether a match is accepted or not during a pattern search (see also chapter 4.3.3.5, "Working with Pattern Searches", on page 174). If the parameter is set to 100%, only I/Q patterns that match totally with the input signal are found. This is only the case for infinite SNR.

The default value is 90%. As long as the pattern is found, there is no need to change this parameter. However, if the pattern is very short (approximately < 10 symbols) or if the signal is highly distorted, tuning this parameter helps the pattern search to succeed.

SCPI command:

[SENSe<n>]:DDEMod:SEARch:SYNC:IQCThreshold on page 264

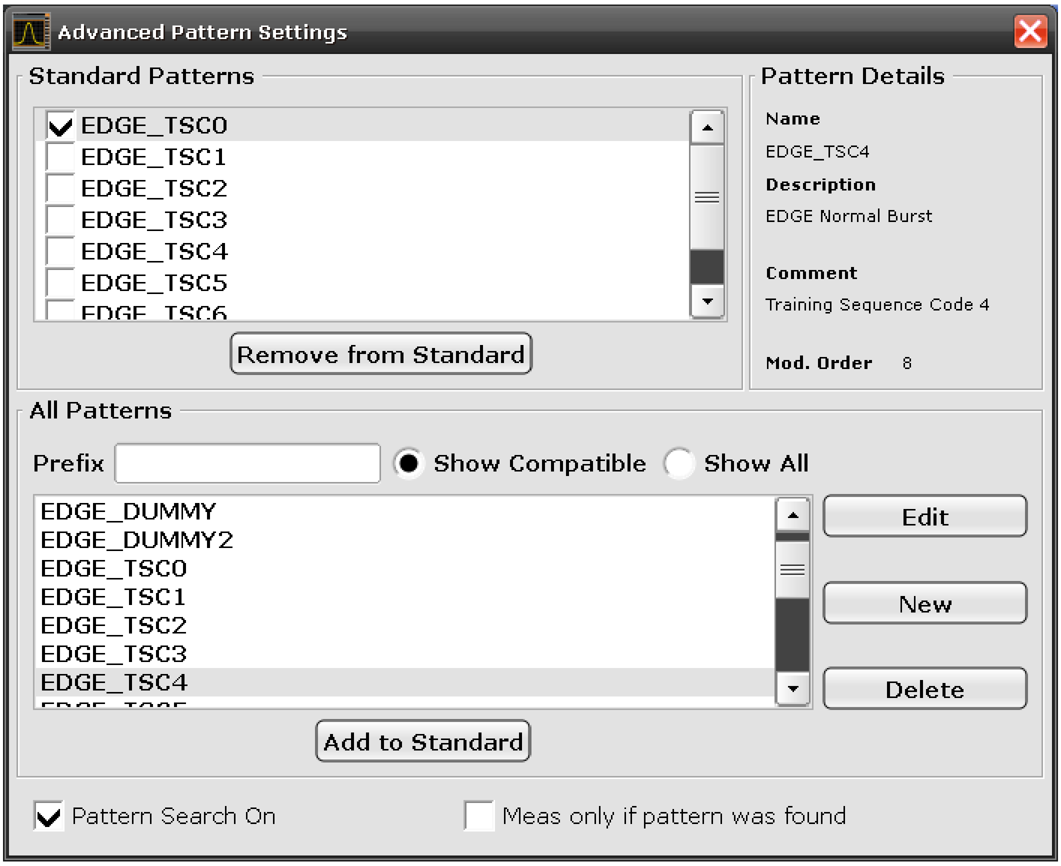
Select Pattern for Search

Determines which of the patterns that are assigned to the current standard is to be searched for. Only one pattern can be selected at a time. However, to check for several patterns in the same captured signal, select the single sweep mode (Statistic Count = 0 or 1) and change the pattern. The measurement is updated.

SCPI command:

[SENSe<n>]:DDEMod:SEARch:SYNC:SELect on page 266

Advanced Settings



The "Advanced Pattern Settings" dialog box lists the patterns assigned to the currently selected standard. You can add existing patterns to the standard, remove patterns already assigned to the standard, edit existing or define new patterns. For details on managing standard patterns, see chapter 4.3.3.6, "Managing patterns", on page 176.

Note: Pattern details. Pattern details for the currently focussed pattern are displayed at the upper right-hand side of the dialog box. You can refer to these details, for example, when you want to add a new pattern to the standard and want to make sure you have selected the correct one.

Prefix ← Advanced Settings
Shows only patterns that contain the specified prefix.

Show Compatible ← Advanced Settings
Shows only patterns that are compatible to the selected modulation mode.

Show All ← Advanced Settings
Shows all patterns, regardless of the selected standard.

Pattern Search On ← Advanced Settings
If enabled, the instrument can adapt its result range to the selected pattern.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:STATe` on page 266

Meas only if a pattern was found ← Advanced Settings
If enabled, measurement results are only displayed (and averaged) if a valid pattern has been found. For measurements of signals with patterns that are averaged over several sweeps, this option should be enabled so that erroneous measurements do not affect the result of averaging.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:MODE` on page 264

Add to Standard ← Advanced Settings
Adds the selected patterns to the list of available patterns ("Standard Patterns").

For details see "To add a predefined pattern to a standard" on page 176.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:PATTern:ADD` on page 265

Remove from Standard ← Advanced Settings
Removes the assignment of the selected patterns to the standard. The patterns are removed from the "Standard Patterns" list, but not deleted.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:PATTern:REMove` on page 265

Edit ← Advanced Settings
Opens the "Edit Pattern" dialog box to edit the pattern definition. See "Pattern Definition", on page 150.

For details on defining a pattern, see example "Defining a pattern" on page 178.

SCPI command:

[SENSe<n>]:DDEMod:SEARch:SYNC:NAME on page 264
[SENSe<n>]:DDEMod:SEARch:SYNC:COMMent on page 262
[SENSe<n>]:DDEMod:SEARch:SYNC:DATA on page 263
[SENSe<n>]:DDEMod:SEARch:SYNC:TEXT on page 266

New ← Advanced Settings

Opens the "Pattern" dialog box to create a new pattern definition. See "Pattern Definition", on page 150.

For details on defining a pattern, see example "Defining a pattern" on page 178.

SCPI command:

[SENSe<n>]:DDEMod:SEARch:SYNC:NAME on page 264
[SENSe<n>]:DDEMod:SEARch:SYNC:COMMent on page 262
[SENSe<n>]:DDEMod:SEARch:SYNC:DATA on page 263
[SENSe<n>]:DDEMod:SEARch:SYNC:TEXT on page 266

Delete ← Advanced Settings

Deletes the selected patterns. Any existing assignments to other standards are removed.

SCPI command:

[SENSe<n>]:DDEMod:SEARch:SYNC:DELete on page 263

Pattern Definition

The settings in the "Pattern" dialog box define the pattern.

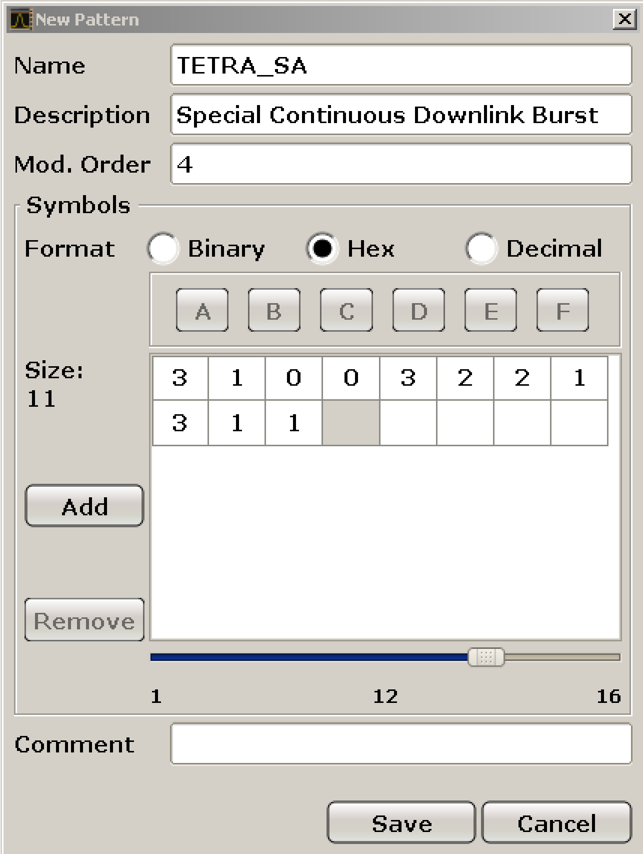


Fig. 4-78: Pattern definition

For details on defining a pattern, see example "Defining a pattern" on page 178.

Name
Pattern name that will be displayed in selection list

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:NAME` on page 264

Description
Optional description of the pattern which is displayed in the pattern details

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:TEXT` on page 266

Mod. order
The order of modulation, e.g. 8 for an 8-PSK.

SCPI command:
`[SENSe<n>]:DDEMod:SEARch:SYNC:NSTate` on page 265

Symbol format
Hexadecimal, decimal or binary format

Symbols

Pattern definition, consisting of one or more symbols

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:SYNC:DATA` on page 263

Comment

Optional comment for the pattern, displayed in the pattern details (kept for compatibility with FSQ)

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:SYNC:COMMent` on page 262

Result Range and Evaluation Range Settings

You configure the result range and evaluation range settings in the "Result Range Alignment and Evaluation Range" dialog box. This dialog box contains the following tabs:

- "Result Range", on page 152
- "Evaluation Range", on page 154

Result Range

The "Result Range" tab contains the settings for the result range. The result range determines which part of the capture buffer, burst or pattern is displayed. For more information, see chapter 4.3.3.2, "Defining the Result Range", on page 168 .

A preview of the result display with the current settings is displayed in the visualization area at the bottom of the dialog box.

The "Result Range" tab is also displayed when you select the "Range Settings" softkey in the "Meas Config" menu (see "Range Settings" on page 119).

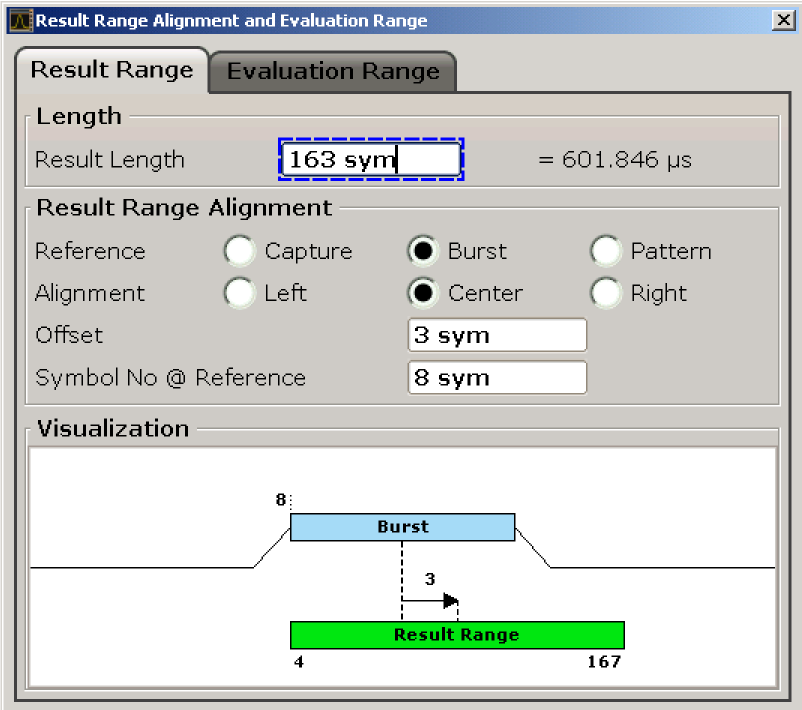


Fig. 4-79: Result Range Alignment

Result Length

Defines the number of symbols that are to be demodulated. All traces over time are displayed over the result range. For example, if you have a burst of 100 symbols and you define the result length as 200 symobls, you can examine the burst ramps in detail (by selecting the alignment "Burst - Center").

SCPI command:

`[SENSe<n>]:DDEMod:TIME` on page 270

Reference

Defines the reference for the result range alignment.

The result of the current setting is displayed in the visualization area of the dialog box.

"Capture"	the capture buffer
"Burst"	the detected burst
"Pattern"	the detected pattern

SCPI command:

`CALCulate<screen>:TRACe<trace>:ADJust[:VALue]` on page 220

Alignment

Defines the type of alignment of the result range to the reference source. The result of the current setting is displayed in the visualization area of the dialog box.

SCPI command:

`CALCulate<screen>:TRACe<trace>:ADJust:ALIGnment[:DEFault]`
on page 220

Offset
Defines the offset of the result range to the alignment reference. The result of the current setting is displayed in the visualization area of the dialog box.

Note: Note the following restrictions to this parameter:
- An offset < 0 is not possible if you align the result range to the left border of the capture buffer.
- An offset that moves the pattern outside the result range is not allowed. For example, if you align the result to the left border of the pattern, only offsets ≦ 0 are allowed. Otherwise, you would never be able to find the pattern within the result range.

SCPI command:
`CALCulate<screen>:TRACe<trace>:ADJust:ALIGnment:OFFSet` on page 219

Symbol No @ Reference
Defines the number of the symbol which marks the beginning of the alignment reference source.

In effect, this setting defines an offset of the x-axis (in addition to the one defined for the Signal Description, see "Offset" on page 137).

For example, if you align the result to the center of the pattern and set the "Symbol No @ Reference" to "0", you can easily find the pattern start in the EVM measurement simply by moving a marker to the symbol number "0".

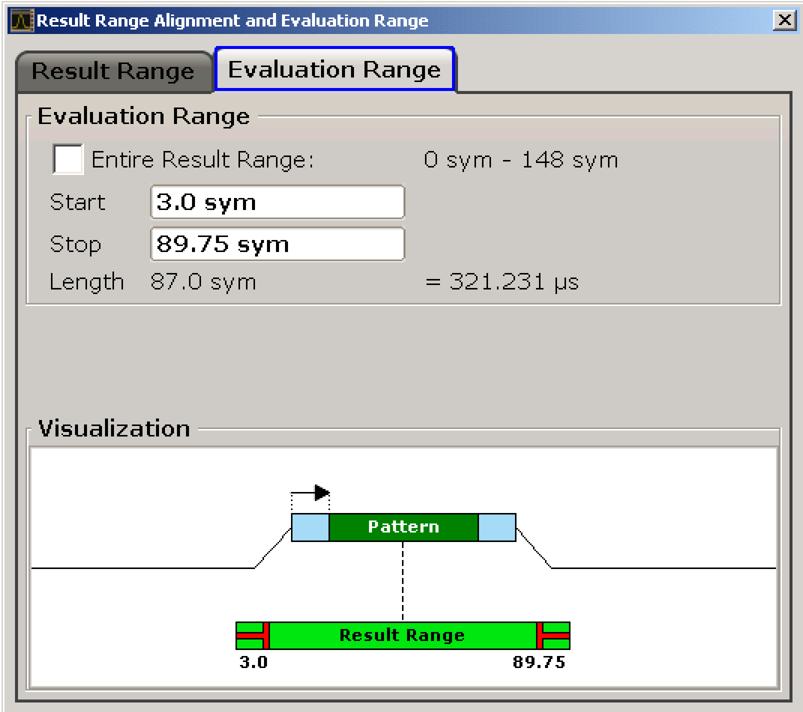
Note: If you define an offset of the pattern with respect to the useful part of the burst in the signal description (see "Offset" on page 137) and align the result to the pattern, the Symbol No @ Reference refers to the first symbol of the useful part of the burst, not the first symbol of the pattern.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:VOFFset`
on page 226

Evaluation Range

In the "Evaluation Range" tab you define which range of the result is to be evaluated - either the entire result range or only a specified part of it. The calculated length of the specified range is indicated beneath the entries. The selected evaluation range is displayed in the visualization area.

A preview of the result display with the current settings is displayed in the visualization area at the bottom of the dialog box.



Entire Result Range

If enabled, the entire result range is evaluated.

SCPI command:

CALCulate<screen>:ELIN<startstop>:STATe on page 213

Start

Defines the symbol in the result range at which evaluation is started. The start symbol itself is included in the evaluation range.

Note: Note that the start value is defined with respect to the x-axis including an optional offset defined via the Symbol No @ Reference parameter.

SCPI command:

CALCulate<screen>:ELIN<startstop>[:VALue] on page 213

Stop

Defines the symbol in the result range at which evaluation is stopped. The stop symbol itself is included in the evaluation range.

Note: Note that the stop value is defined with respect to the x-axis including an optional offset defined via the Symbol No @ Reference parameter.

SCPI command:

CALCulate<screen>:ELIN<startstop>[:VALue] on page 213

Demodulation and Measurement Filter Settings

You configure the demodulation and measurement filter settings in the "Demodulation & Measurement Filter" dialog box. This dialog box contains the following tabs:

- "Demodulation", on page 156

- "Measurement Filter", on page 160

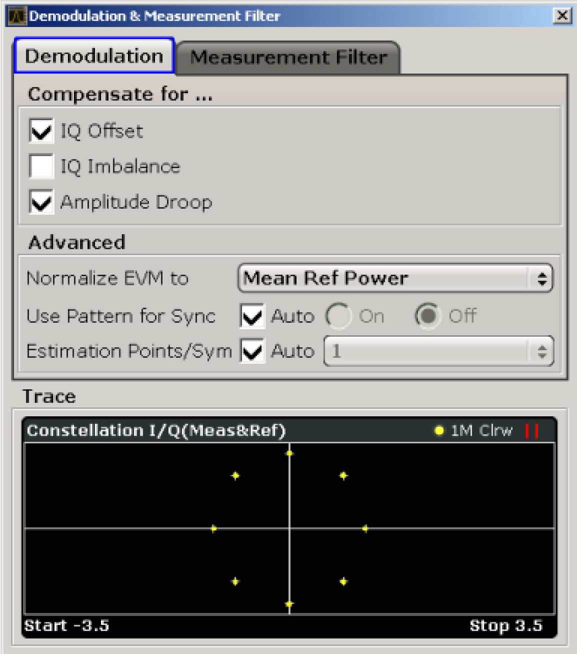
Demodulation

The "Demodulation" tab contains the settings for the demodulation.

A live preview of the trace with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

Depending on the modulation scheme you have selected, the dialog has different content.

Demodulation dialog for PSK, QAM and MSK modulated signals
This is what the dialog box looks like for PSK, QAM and MSK modulation types.



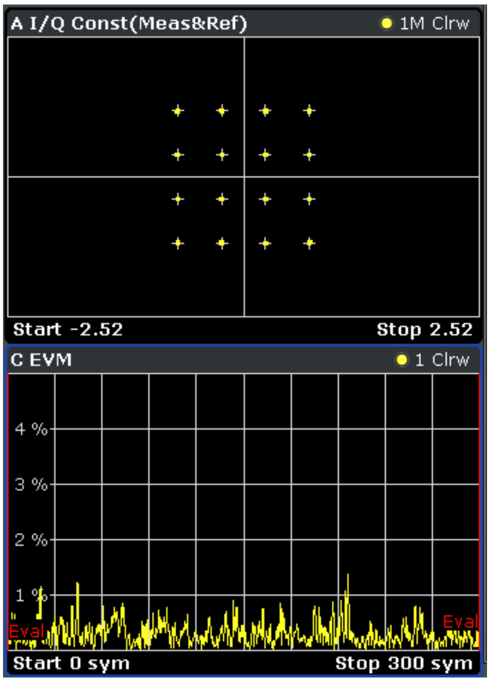
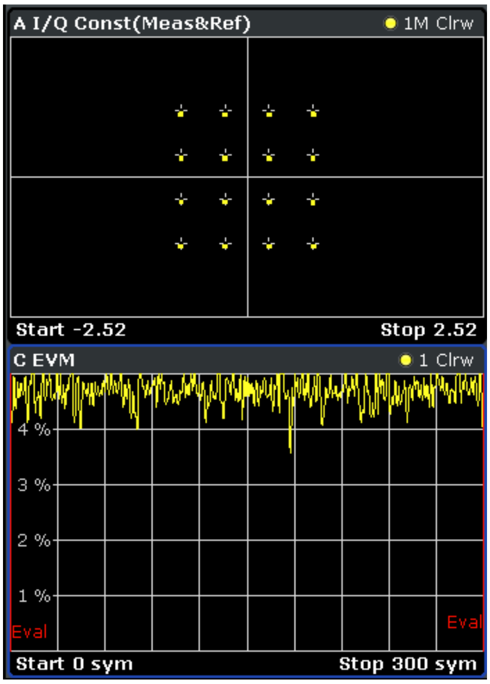
Compensate for... ← Demodulation dialog for PSK, QAM and MSK modulated signals
If enabled, compensation for various effects is taken into consideration during demodulation.

Note: Note that compensation for all the listed distortions can result in lower EVM values.

- "I/Q Offset"
- "I/Q Imbalance"
- "Amplitude Droop"

Example:

The following figures compare the results for a compensated I/Q offset of 2.5% and a non-compensated offset.

I/Q Offset compensated for	I/Q Offset NOT compensated for
	

SCPI command:

[SENSe<n>]:DDEMod:NORMalize:ADRoop on page 249
[SENSe<n>]:DDEMod:NORMalize:IQIMbalance on page 250
[SENSe<n>]:DDEMod:NORMalize:IQOFfset on page 250

Normalize EVM to ← Demodulation dialog for PSK, QAM and MSK modulated signals

Normalizes the EVM to the specified power value.

This setting is not available for MSK modulation.

- **Max Ref Power**
  Maximum power of the reference signal at the symbol instants.
- **Mean Ref Power**
  mean power of the reference signal at the symbol instants.
- **Mean Constellation Power**
  Mean expected power of the measurement signal at the symbol instants
- **Max Constellation Power**
  The maximum expected power of the measurement signal at the symbol instants

SCPI command:

[SENSe<n>]:DDEMod:ECALc[:MODE] on page 244

Offset EVM ← Demodulation dialog for PSK, QAM and MSK modulated signals

The offset EVM has an effect when you measure Offset QPSK modulated signals.

Unlike QPSK modulation, the Q component of Offset QPSK modulation is delayed by half a symbol period against the I component in the time domain. The symbol time instants of the I and the Q component therefore do not coincide.

The offset EVM controls the calculation of all results that are based on the error vector. It affects the EVM, Real/Imag and Vector I/Q result displays as well as the EVM results in the Result Summary (EVM and MER).

You can select the way the analyzer calculates the error vector results.

If "Offset EVM" is inactive, the analyzer 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.

If "Offset EVM" is active however, the analyzer 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.

Use Pattern For Sync ← Demodulation dialog for PSK, QAM and MSK modulated signals

It is possible to not only check whether the pattern is part of the signal, but to also use the pattern for synchronization, in order to obtain the correct reference signal. Depending on the signal, making use of the pattern for synchronization speeds up your measurement considerably and makes it more robust against high carrier frequency offsets. However, in case the parameter is set to true, it should be made sure that the pattern is suitable for synchronization, e.g. a pattern that was made for synchronization purpose like in GSM. In case the pattern is short or the pattern does not have good synchronization properties, e.g. a pattern that consists of only one symbol that is repeated, this parameter should be set to false.

SCPI command:

`[SENSe<n>]:DDEMod:SEARch:PATTern:SYNC:AUTO` on page 261

`[SENSe<n>]:DDEMod:SEARch:PATTern:SYNC[:STATe]` on page 261

Estimation Points/Sym ← Demodulation dialog for PSK, QAM and MSK modulated signals

The estimation points per symbol affect and control synchronization of the signal. You can set the estimation points manually or let the analyzer decide which estimation points to use.

If you decide to set the estimation points manually, you can set the estimation points to 1 or 2 per symbol or the value of the capture oversampling per symbol. Setting the estimation points to "1" means that the estimation algorithm takes only the symbol time instants into account, while setting the estimation points to "Capture Oversampling" means that all sample time instants are weighted equally.

If you select the automatic routine, the analyzer uses 2 estimation points per symbol for Offset QPSK modulation and 1 estimation point per symbol for other PSK and QAM modulated signals. For MSK and FSK modulated signals the estimation points correspond to the capture oversampling.

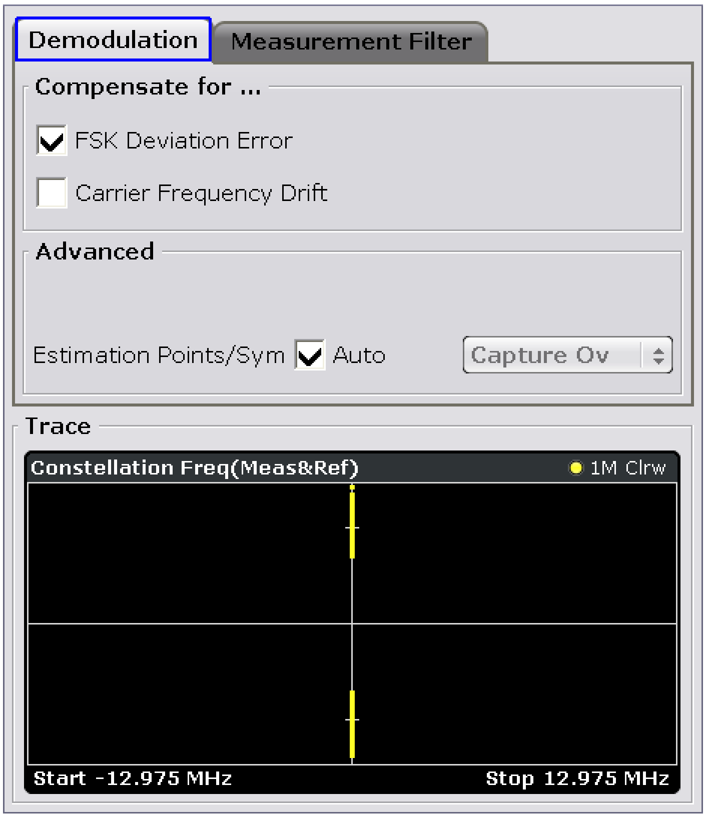
SCPI command:

`[SENSe<n>]:DDEMod:EPRate:AUTO` on page 244

`[SENSe<n>]:DDEMod:EPRate[:VALue]` on page 245

Demodulation dialog for FSK modulated signals

This is what the dialog box looks like for FSK modulation.



Compensate for... ← Demodulation dialog for FSK modulated signals

Estimation Points/Sym ← Demodulation dialog for FSK modulated signals

The estimation points per symbol affect and control synchronization of the signal. You can set the estimation points manually or let the analyzer decide which estimation points to use.

If you decide to set the estimation points manually, you can set the estimation points to 1 per symbol, 2 per symbol or the value of the capture oversampling per symbol. Setting the estimation points to "1" means that the estimation algorithm takes only the symbol time instants into account, while setting the estimation points to "Capture Oversampling" means that all sample time instants are weighted equally.

If you select the automatic routine, the analyzer uses 2 estimation points per symbol for Offset QPSK modulation and 1 estimation point per symbol for other PSK and QAM modulated signals. For MSK and FSK modulated signals the estimation points correspond to the capture oversampling.

SCPI command:

`[SENSe<n>]:DDEMod:NORMalize:CFDRift` on page 249

`[SENSe<n>]:DDEMod:NORMalize:FDERror` on page 250

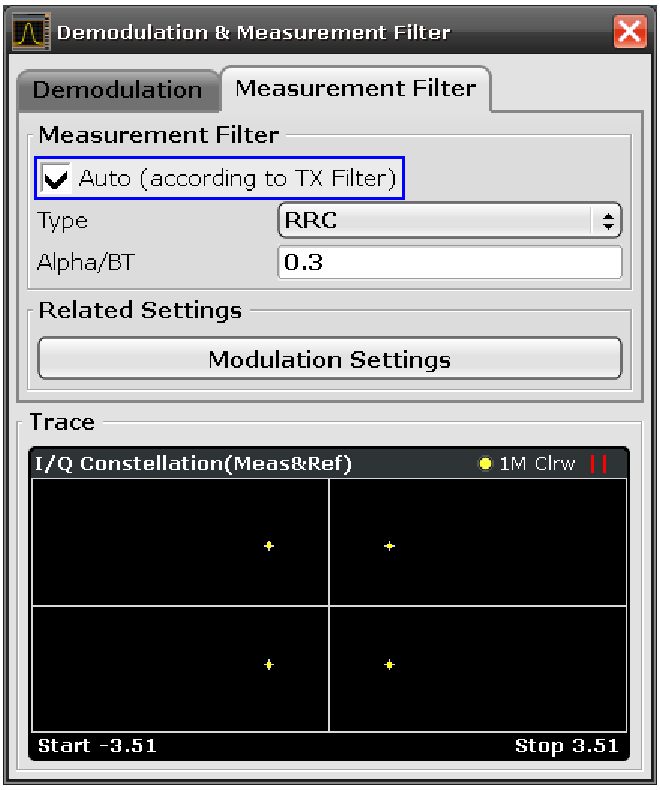
Measurement Filter

The "Measurement Filter" tab contains the settings for the measurement filter. In addition, a link to the "Modulation Settings" tab of the "Modulation and Signal Description Settings" dialog box is provided (see "Modulation", on page 132).

A live preview of the trace with the current settings is displayed in the preview area at the bottom of the dialog box. The preview area is not editable directly.

For details on measurement filters see chapter 4.1.2.4, "Measurement Filters", on page 19.

The "Measurement Filter" tab is also displayed when you select the "Demod/ Meas Filter" softkey in the "Meas Config" menu (see "Demod/ Meas Filter" on page 119).



Auto
The measurement filter is defined automatically depending on the TX filter specified in the "Modulation" tab of the "Modulation & Signal Description" dialog box (see "TX Filter Type" on page 134).

SCPI command:
[SENSe<n>]:DDEMod:MFILter:AUTO on page 248

Type
Defines the measurement filter type, if the Auto setting is not enabled. The following filter types are available:

Root Raised Cosine Filter. The roll-off parameter "Alpha" is set according to the TX Filter if the "Auto (according to TX Filter)" option is enabled (see "Auto" on page 161). Otherwise it must be set manually.

If the TX filter is also a Root Raised Cosine filter with the same roll-off parameter, the resulting system is inter-symbol interference free.

"RRC"	Root Raised Cosine Filter. The roll-off parameter "Alpha" is set according to the TX Filter if the "Auto (according to TX Filter)" option is enabled (see "Auto" on page 161). Otherwise it must be set manually. If the TX filter is also a Root Raised Cosine filter with the same roll-off parameter, the resulting system is inter-symbol interference free.
"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.
"APCO25 C4FM"	Measurement filter required for the "APCO25 C4FM" standard.
"APCO25 H-CPM"	Measurement filter required for the "APCO25 H-CPM" standard.
"APCO25 C4FM"	Measurement filter required for the "APCO25 DQPSK" standard.
"APCO25 C4FM"	Measurement filter required for the "APCO25 DQPSK Narrow" standard.
"APCO25 C4FM"	Measurement filter required for the "APCO25 DQPSK Wide" standard.
"CDMA2000 1x Forward"	Measurement filter required for measurements on "CDMA2000 1x" forward link signals.
"CDMA2000 1x Reverse"	Measurement filter required for measurements on "CDMA2000 1x" reverse link signals.
"NONE"	No measurement filter is used.

SCPI command:
[SENSe<n>]:DDEMod:MFILter[:STATe] on page 248
[SENSe<n>]:DDEMod:MFILter:NAME on page 248

Alpha/BT
Defines the roll-off factor (Alpha) or the filter bandwidth (BT).

The roll-off factor and filter bandwidth for TX filter is available for RC, RRC, Gauss and GMSK filter.

The roll-off factor and filter bandwidth for measurement filter is available for RRC filter.

SCPI command:
TX Filter: `[SENSe<n>]:DDEMod:FILTer:ALPHa` on page 245
Measurement filter: `[SENSe<n>]:DDEMod:MFILter:ALPHa` on page 247

Display Configuration

You configure the display for the results in the "Display Configuration" dialog box. This dialog box contains the following tabs:

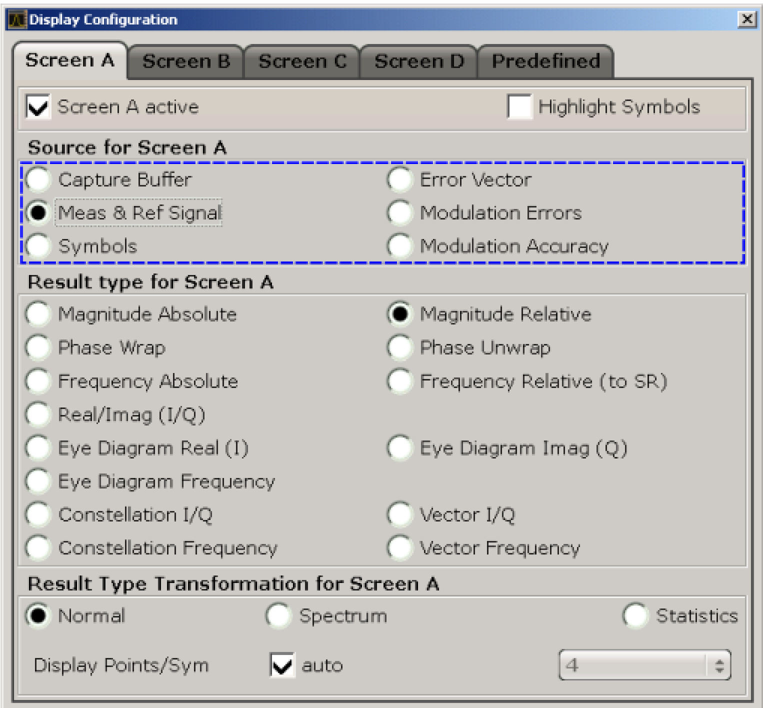
- "Screen A-D": a separate tab for each of the four available screens
- "Predefined": for predefined display configurations

For more information, see chapter 4.3.1, "Measurement Result Display", on page 73.

The "Display Configuration" tab is also displayed when you select the MEAS key.

Screen A-D

For each of the four available screens you can configure what is to be displayed.



Screen X active
If enabled, the screen the tab corresponds to is displayed. If fewer than 4 screens are enabled, the remaining screens are enlarged to make best use of the available display.

SCPI command:
`DISPlay[:WINDow<window>]:STATe` on page 223

Highlight Symbols
If enabled, the symbol instants are highlighted as squares in the screen for measured and reference signals in time (normal) display, as well as error displays.

Not all measurements support this function.

SCPI command:
`DISPlay[:WINDow<window>]:TRACe<trace>:SYMBol` on page 224

Source
You can choose which signal source is to be displayed from the following options:

- "Capture Buffer"
- "Measurement & Reference Signal"
- "Symbols"
- "Error Vector"
- "Modulation Errors"
- "Modulation Accuracy"

SCPI command:
`CALCulate<screen>:FEED` on page 214

Result Type
Defines how the signal source is evaluated and which result is displayed. The available result types depend on the selected source type.

For more information, see chapter 4.3.1.1, "Result types", on page 74.

Table 4-28: Available result types depending on source type

Source Type	Result Type
Capture Buffer	Magnitude Absolute
	Real/Imag (I/Q)
	Vector I/Q
Meas & Ref Signal	Magnitude Absolute
	Magnitude Relative
	Phase Wrap
	Phase Unwrap
	Frequency Absolute
	Frequency Relative
	Real/Imag (I/Q)
	Eye Diagram Real (I)
	Eye Diagram Imag (Q)

Source Type	Result Type
	Eye Diagram Frequency
	I/Q Constellation
	I/Q Vector
	Constellation Frequency
	Vector Frequency
Symbols	Binary
	Octal
	Decimal
	Hexadecimal
Error Vector	EVM
	Real/Imag (I/Q)
	I/Q Vector
Modulation Errors	Magnitude Error
	Phase Error
	Frequency Error Absolute
	Frequency Error Relative
Modulation Accuracy	Result Summary

SCPI command:
`CALCulate<screen>:FORMat` on page 215

Result Type Transformation
The result type transformation parameters set the evaluation method of the measurement results.

●

These settings are not available for the following source types (see "Source" on page 163):

- Symbols
- Modulation Accuracy

For more information, see chapter 4.3.1, "Measurement Result Display", on page 73.

"Normal" X-axis displays time values.

"Spectrum" X-axis displays frequency values.

"Statistics" X-axis displays former y-values. Y-axis displays statistical information:

- Trace 1: the probability of occurrence of a certain value is plotted against the value
- Trace 2: the cumulated probability of occurance is plotted against the value.

SCPI command:
`CALCulate<screen>:DDEM:SPECtrum[:STATe]` on page 212
`CALCulate<screen>:STATistics:CCDF[:STATe]` on page 217

Display Points/Sym
Sets the number of display points that are displayed per symbol. The number of display points have an effect on the detail of the trace. The more points per symbol, the more detailed the trace. If the number of display points per symbol is higher than the capture oversampling rate, the excessive points are interpolated.

For the Result Summary, the display points control which samples are considered for the Peak and RMS values and the Power result.

You can set the display points manually from the dropdown menu. The available values differ depending on the source type.

In case of automatic selection, the number of display points is the capture oversampling rate that you have set.

For the Result Summary, the number of display points corresponds to estimation points per symbol. By default, the estimation points are 1 for QAM and PSK modulated signals and the capture oversampling rate for MSK and FSK modulated signals).

If you set the display points automatically, the analyzer uses the capture oversampling rate

If "Auto" is enabled, the Capture Oversampling value is used.

Alternatively, select the number of points to be displayed per symbol manually. If more points per symbol are selected than the given "Capture Oversampling" rate, the additional points are interpolated for the display. The more points are displayed per symbol, the more detailed the trace becomes.

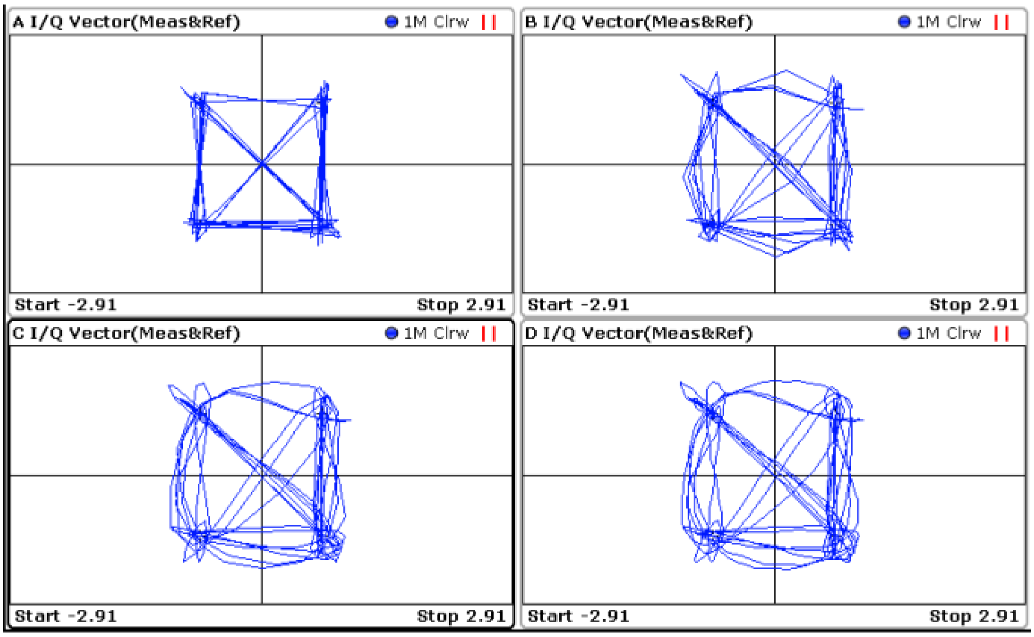


Fig. 4-80: Result display with different numbers of points per symbol: Screen A = 1; Screen B = 2; Screen C = 4; Screen D = 16;

SCPI command:
`DISPlay[:WINDow<window>]:PRATe:AUTO` on page 222

Capture Oversampling

Defines how many points per symbol are captured. This setting is only available for the source type "Capture Signal". You can select a capture oversampling size of 4, 8 or 16.

For statistics measurements, you can define the sample basis for the calculation.

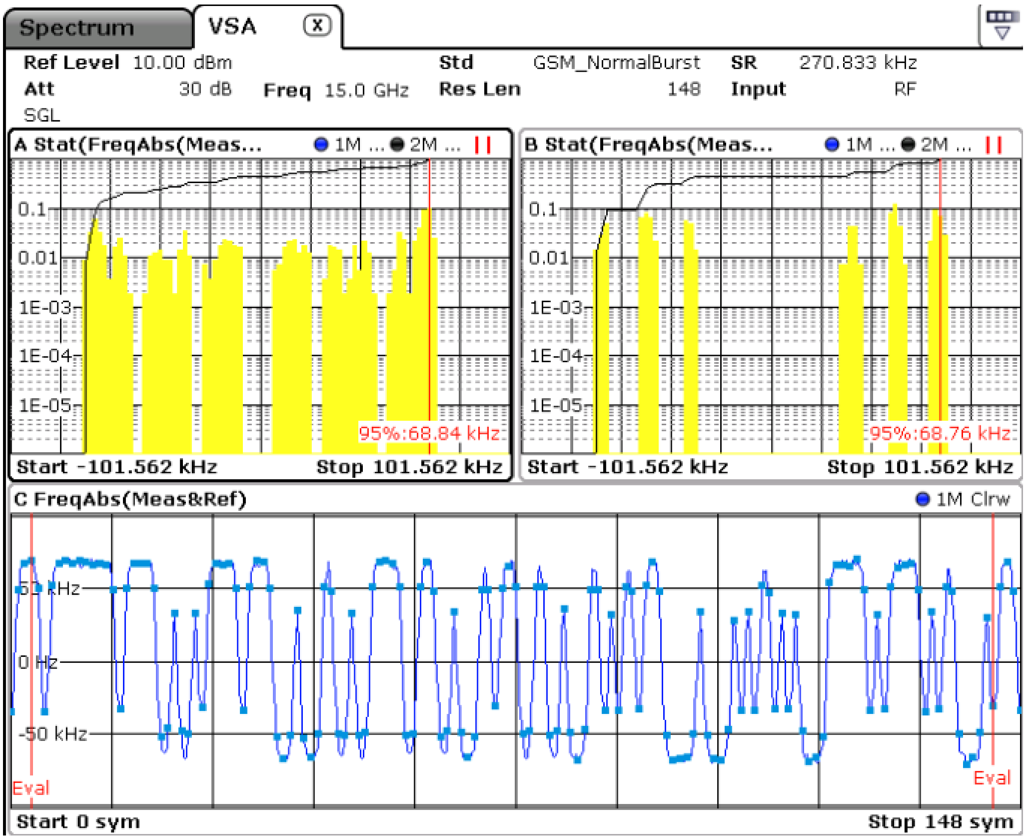


Fig. 4-81: Statistics measurement: Screen C: measured signal (symbols highlighted); Screen A: statistics for all trace points; Screen B: statistics for symbol instants only

"Symbols only" Statistics are calculated for symbol instants only
See screen B in figure 4-81.

"Infinite" Statistics are calculated for all trace points (symbol instants and intermediate times)
See screen A in figure 4-81.

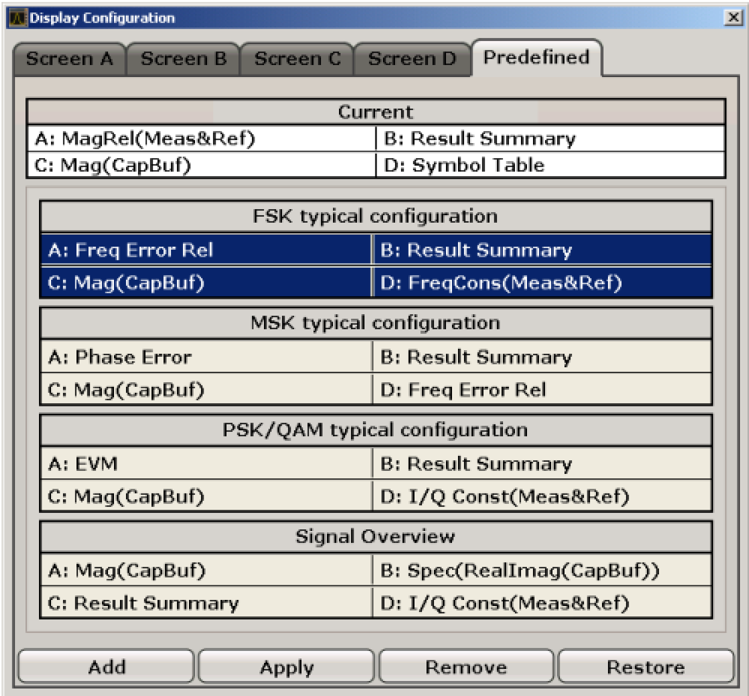
"auto" currently not used

SCPI command:

`CALCulate<screen>:STATistics:MODE` on page 217

Predefined

You can store and load predefined screen configurations. All available configurations are displayed in the "Predefined" tab. The current screen configuration is indicated under "Current" at the top of the list.



Add

Opens an edit dialog box to enter a name for the current screen configuration. The configuration is then stored and added to the list.

Apply

Applies the currently selected configuration from the list to the current display.

Remove

Removes the currently selected configuration from the list.

Restore

Restores the default Display Configuration. Existing settings with the default names are replaced.

4.3.3.2 Defining the Result Range

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

You configure the result range and evaluation range settings in the "Result Range and Evaluation Range" dialog box in the "Settings Overview" (see also "Result Range and Evaluation Range Settings", on page 152).

1. Define the "Result Length", i.e. the number of symbols from the result that are to be analyzed (see "Result Length" on page 153.

2. Define the "Reference" for the result range, i.e. the source to which the result will be aligned (see "Reference" on page 153). The reference can be the captured data, a detected burst or a detected pattern.
3. 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 (see "Alignment" on page 153).
4. Optionally, define an offset of the result range to the reference source, e.g. to ignore the first few symbols of the captured data (see "Offset" on page 154).
5. Optionally, define the label of the symbol which marks the beginning of the reference source to change the scaling of the x-axis (see "Symbol No @ Reference" on page 154). This offset is added to the one defined for the signal description, see "Offset" on page 137).

Example: Defining the result range

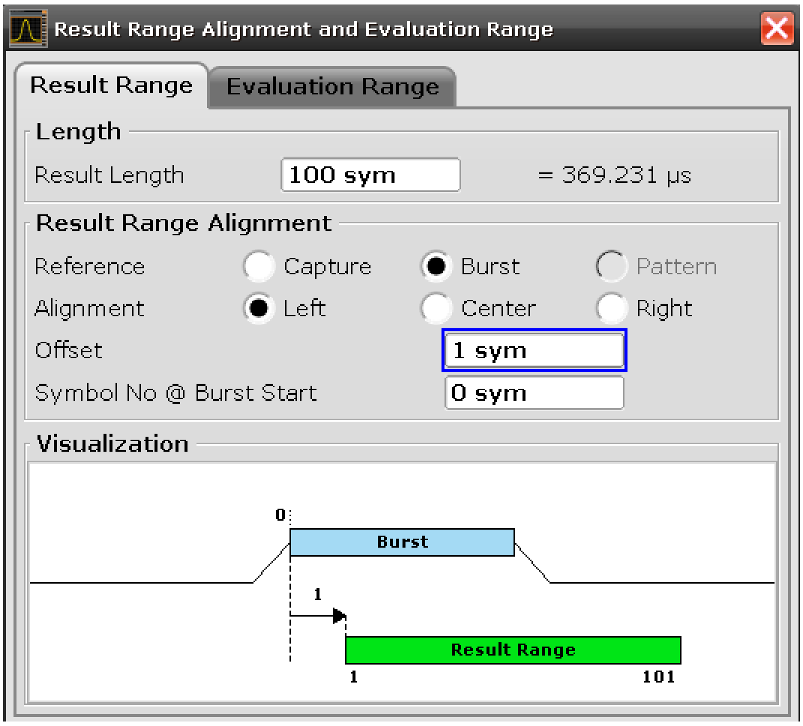


Fig. 4-82: Example: Defining the Result Range

In figure 4-82, the burst will be displayed on the left side of the diagram, starting at the second burst symbol, which has the symbol number 1 (the burst starts at symbol number 0, the first symbol to be displayed is the second burst symbol due to the offset: 0+1=1).

Defining an Evaluation Range

By default, the entire result range is used for evaluation. If necessary, you can define an evaluation range that differs from the result range. The used evaluation range is then indicated in the result display. For details see "Evaluation Range", on page 154.

4.3.3.3 Changing 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. Scaling functions are located in the "Ranges" submenu of the "Amplitude" menu (see chapter 4.3.2.3, "Softkeys of the Amplitude Menu (R&S FSV-K70) ", on page 102).

Scaling 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 screen.
2. Select "AMPT > Ranges > Y-Axis Reference Value" (see "Y-Axis Reference Value" on page 103).
3. Enter a reference value for the y-axis in the current unit.
4. Select "AMPT > Ranges > Y-Axis Reference Position" (see "Y-Axis Reference Position" on page 104).
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 > Ranges > Y-Axis Range" (see "Y-Axis Range" on page 103).

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%*.

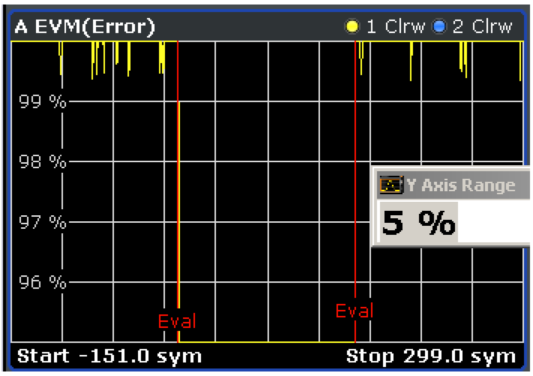


Fig. 4-83: Defining the y-axis scaling using a reference point

To define the scaling automatically

1. Focus the result screen.
2. Select "AMPT > Ranges > Y-Axis Autorange" (see chapter 4.3.2.3, "Softkeys of the Amplitude Menu (R&S FSV-K70) ", on page 102).

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

Scaling 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, be 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 screen.
2. Select "AMPT > Ranges > X-Axis Quantize" (see "X-Axis Quantize" on page 104).
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 screen.
2. Select "AMPT > Ranges > X-Axis Reference Value" (see "X-Axis Reference Value" on page 104).
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 %*.

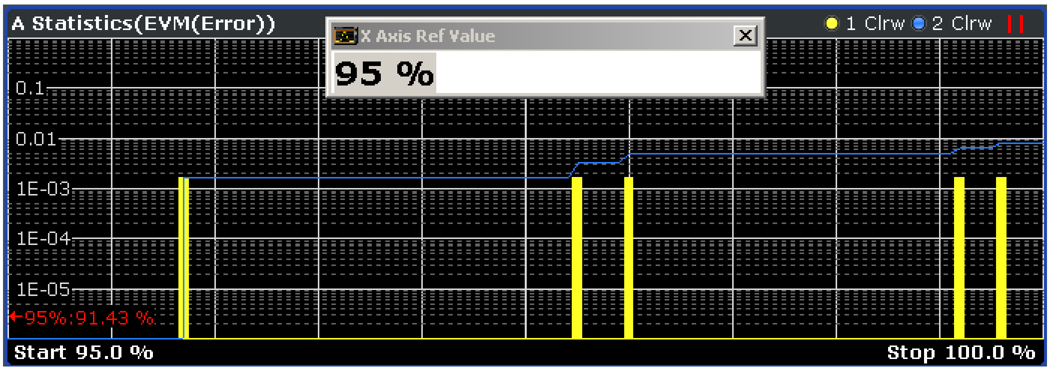


Fig. 4-84: Defining the x-axis scaling using a reference point

To define the x-axis range manually

1. Focus the result screen.
2. Select "AMPT > Ranges > X-Axis Range" (see "X-Axis Range" on page 104).
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 screen.
2. Select "AMPT > Ranges > Adjust Settings" (see "Adjust Settings" on page 105).

   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. The y-axis scaling is defined via the "y-Unit %/Abs" softkey (see "y-Unit %/Abs" on page 105). If the y-axis has logarithmic scale, the distance between max and min value must be at least one decade.

1. Focus the result screen.
2. Select "AMPT > Ranges > Y-Axis Min Value" (see "y-Axis Min Value" on page 105).
3. Enter the lower limit in the current unit.
4. Select "AMPT > Ranges > Y-Axis Max Value" (see "y-Axis Max Value" on page 105).

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.

To restore the default scaling settings

1. Focus the result screen.
2. Select "AMPT > Ranges > Default Settings" (see "Default Settings" on page 105).

   The x- and y-axis scalings are reset to their default values.

4.3.3.4 Managing standard settings files

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.

To load predefined settings files

1. In the "VSA > Digital Standards" menu, select "Load Standard".
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 "Select" 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

This task can also be performed by remote control (see `[SENSe<n>]:DDEMod:STANdard:SAVE` on page 268).

1. Configure the measurement as required. See Settings Overview for help.
2. In the "VSA > Digital Standards" menu, select "Save As Standard".
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, click the "New Folder" softkey 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 "Digital 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.
2. Press the "Select" button.
3. Confirm the message to avoid unintentionally deleting a standard.
   The standard file is removed from the folder.

To restore standard files

► In the "VSA > Digital Standards" menu, select "Restore Standard Files".

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

To restore default standard settings

If you change predefined standard settings for a specific measurement, you may want to return to the default settings later.

This task can also be performed by remote control (see `[SENSe<n>]:DDEMod:STANdard:PREset[:VALue]` on page 268).

► In the "VSA > Digital Standards" menu, select "Standard Defaults".

The instrument is reset to the default settings of the standard last used.

4.3.3.5 Working with Pattern Searches

Patterns provide a fixed sequence of symbols at a defined point in time in the symbol stream. They are used in many digital mobile radio systems to evaluate the channel impulse response and to facilitate a demodulation in the receiver.

The pattern search is performed on the I/Q capture buffer. The R&S FSV-K70 takes the symbol numbers of the pattern, modulates the pattern according to the Tx filter and the modulation and, subsequently, searches the I/Q capture buffer for this I/Q pattern. The K70 option can then adapt its result range to this pattern.

Predefined Patterns

Common standards usually have predefined pattern lists with standard specific patterns. Patterns required for the current measurement can be selected from this list. This list can be extended by patterns that are already available in the instrument. Newly created patterns can also be added to the list.

Pattern Settings

To configure a pattern search

Configuring a pattern search requires the following steps:

1. Selecting a pattern
   This may require further subtasks:
   a) Changing the display for the list of patterns
   b) Adding a pattern to a standard
   c) Creating a new pattern
   d) Editing a pattern
2. Enabling pattern search (if "Auto" mode is disabled)
3. Optionally, defining the offset of the pattern with respect to the useful part of the burst. The specified number of symbols in the signal are ignored during the pattern search.

To add a pattern to the signal description

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Select the "Pattern" option.

To select a predefined pattern for a search

This task can also be performed by remote control, see `[SENSe<n>]:DDEMod:SEARch:SYNC:CATalog` on page 262 and `[SENSe<n>]:DDEMod:SEARch:SYNC:SELect` on page 266.

Depending on whether a dialog box is already displayed, there are different ways to select a pattern:

1. If the "Settings Overview" dialog box is displayed, select "Signal Description".
   From the "Name" selection list, select a pattern that is assigned to the currently defined standard.
2. If the "Burst & Pattern Settings" dialog box is displayed, select the "Pattern Search" tab and select the pattern from the list of assigned patterns.
3. If the "Advanced Pattern Settings" dialog box is displayed, select the required pattern from the "Standard Patterns" list.
4. Otherwise, from the "VSA" menu, select "Signal Description".
   From the "Name" selection list, select a pattern that is assigned to the currently defined standard.

   If the pattern you require is not available, see "To add a predefined pattern to a standard" on page 176.

To enable a pattern search

This task can also be performed by remote control, see `[SENSe<n>]:DDEMod:SEARch:SYNC:STATe` on page 266.

1. If the "Advanced Pattern Settings" dialog box is already displayed, select the "Pattern Search On" option.
   Otherwise, in the "VSA > Settings Overview" dialog box, select "Pattern Search".
2. Select "On" to enable the search globally, or "Auto" to enable a search if a pattern is part of the signal description (see "To add a pattern to the signal description" on page 175).

   The selected pattern is used for a pattern search.
3. Optionally, select the "Meas only if a pattern was found" option. In this case, measurement results are only displayed if a valid pattern has been found. See also "Meas only if a pattern was found" on page 147.

To define an offset for the pattern search

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Select the "Offset" option and enter the number of symbols to be used as an offset.

4.3.3.6 Managing patterns

The available patterns and those assigned to the current standard are listed in the "Pattern Settings" dialog box. In addition, details for the currently focussed pattern are displayed in the upper right-hand part of the dialog box. To show the details for a specific pattern, simply click on it.

To add a predefined pattern to a standard

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Press "Pattern Settings".
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 176.
4. Press "Add to Standard".

   The selected pattern is inserted in the list of "Standard Patterns".

To change the display for the list of patterns

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Press "Pattern Settings".
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 create a new pattern

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Press "Pattern Settings".
3. Press "New Pattern".

   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 (order of modulation)
Symbol format	Hexadecimal or decimal format
Symbols	Pattern definition, consisting of one or more symbols
Comment	Optional comment for the pattern, displayed in the pattern details (kept for compatibility with FSQ)

   To define the pattern, proceed as follows:
   a) If necessary, add a new symbol field by pressing "Add".
   b) Select the symbol field you want to define.
   c) Enter a value using the keyboard. Depending on the "Modulation Order", the value can be in the range 0 to n-1, where n is the "Modulation Order", e.g. 8 for 8-PSK.
   d) 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".

Example: Defining a pattern

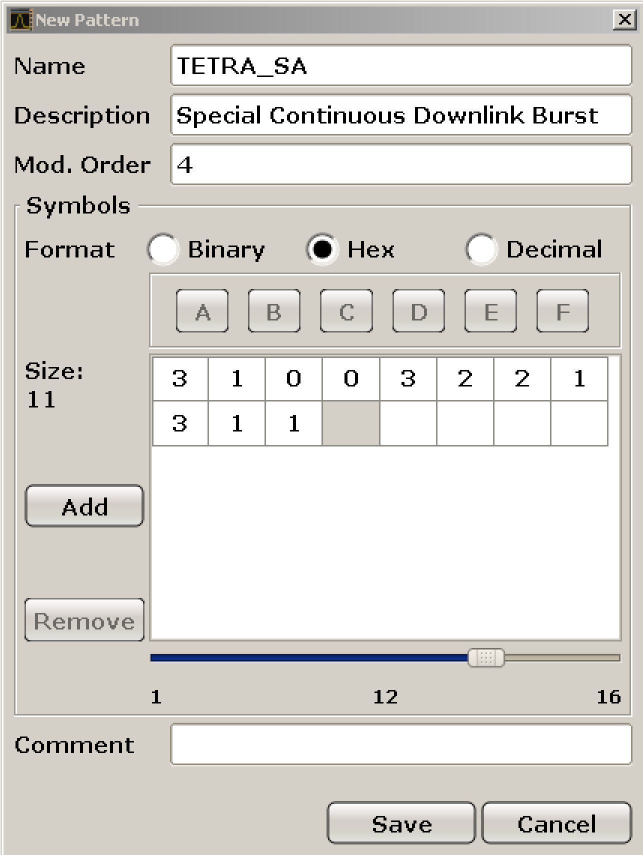


Fig. 4-85: Pattern definition

This task can also be performed by remote control.

Example:

SENS:DDEM:SEAR:SYNC:NAME 'TETRA_SA', see [SENSe<n>]:DDEMod:SEARch:SYNC:NAME on page 264

SENS:DDEM:SEAR:SYNC:NST 4, see [SENSe<n>]:DDEMod:SEARch:SYNC:NSTate on page 265

SENS:DDEM:SEAR:SYNC:DATA '000300010000000000003000200020001000300010001', see [SENSe<n>]:DDEMod:SEARch:SYNC:DATA on page 263

SENS:DDEM:SEAR:SYNC:COMM '' , see [SENSe<n>]:DDEMod:SEARch:SYNC:COMMent on page 262

SENS:DDEM:SEAR:SYNC:TEXT 'Special Continuous Downlink Burst', see [SENSe<n>]:DDEMod:SEARch:SYNC:TEXT on page 266

To edit a predefined pattern

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".

2. Press "Pattern Settings".
3. Select the pattern from the list of "All Patterns".
4. Press "Edit Pattern".
5. Change the settings as required as described in "To create a new pattern" on page 177.

To delete a predefined pattern

1. In the "VSA > Settings Overview" dialog box, select "Signal Description".
2. Press "Pattern Settings".
3. Select the pattern from the list of "All Patterns".
4. Press "Delete Pattern".

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

To remove a predefined pattern from a standard

1. In the "VSA > Settings Overview" menu, select "Signal Description".
2. Press "Pattern Settings".
3. Select the pattern from the list of "Standard Patterns".
4. Press "Remove from Standard".

   The pattern is deleted and removed from the list of "Standard Patterns", but is still available for assignment from the list of "All Patterns".

4.3.4 Further Information

4.3.4.1 Trace Mode Overview

The traces can be activated individually for a measurement or frozen after completion of a measurement. Traces that are not activated are hidden. Each time the trace mode is changed, the selected trace memory is cleared.

The analyzer offers 6 different trace modes:

Clear Write

Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

SCPI command:

`DISP:TRAC:MODE WRIT`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Max Hold

The maximum value is determined over several sweeps and displayed. The analyzer saves the sweep result in the trace memory only if the new value is greater than the previous one.

This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.

This mode is not available for statistics measurements.

SCPI command:

`DISP:TRAC:MODE MAXH`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Min Hold

The minimum value is determined from several measurements and displayed. The analyzer saves for each sweep the smallest of the previously stored/currently measured values in the trace memory.

This mode is useful e.g. for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed whereas a CW signal is recognized by its constant level.

This mode is not available for statistics measurements.

SCPI command:

`DISP:TRAC:MODE MINH`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Average

The average is formed over several sweeps. The "Sweep Count" determines the number of averaging procedures.

This mode is not available for statistics measurements.

SCPI command:

`DISP:TRAC:MODE AVER`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

View

The current contents of the trace memory are frozen and displayed.

If a trace is frozen, the instrument settings, apart from level range and reference level (see below), can be changed without impact on the displayed trace. The fact that the trace and the current instrument setting do not correspond any more is indicated by the icon on the tab label.

If the level range or reference level is changed, the analyzer automatically adapts the measured data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

SCPI command:

`DISP:TRAC:MODE VIEW`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

Blank

Hides the selected trace.

SCPI command:

`DISP:TRAC OFF`, see `DISPlay[:WINDow<window>]:TRACe<trace>:MODE` on page 223

4.3.4.2 ASCII File Export Format

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 measurement) which are also separated by a semicolon.

File contents: header and data section	Description
Type;FSV;	Instrument model
Version;1.50;	Firmware version
Date;01.Apr 2010;	Date of data set storage
Screen;A;	Instrument mode
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
Ref value y axis;-10.00;dBm;	Y axis reference value
Ref value position;100;%;	Y axis reference position
Trace;1;	Trace number
Meas;Result;	Result type
Meas Signal;Magnitude;	Result display
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: header and data section	Description
Values;592;	Number of results
<values>	List of results

4.4 Remote Control Commands - R&S FSV-K70

This chapter lists and describes all remote control commands specific to this software application.

For further information on analyzer or basic settings commands, refer to the corresponding subsystem in the base unit description.

4.4.1 Notation

In the following sections, all commands implemented in the instrument are first listed and then described in detail, arranged according to the command subsystems. The notation is adapted to the SCPI standard. The SCPI conformity information is included in the individual description of the commands.

Individual Description

The individual description contains the complete notation of the command. An example for each command, the *RST value and the SCPI information are included as well.

The options and operating modes for which a command can be used are indicated by the following abbreviations:

Abbreviation	Description
A	signal analysis
A-F	signal analysis – span > 0 only (frequency mode)
A-T	signal analysis – zero span only (time mode)
ADEMOD	analog demodulation (option R&S FSV-K7)
BT	Bluetooth (option R&S FSV-K8)
CDMA	CDMA 2000 base station measurements (option R&S FSV-K82)
EVDO	1xEV-DO base station analysis (option R&S FSV-K84)
GSM	GSM/Edge measurements (option R&S FSV-K10)
IQ	IQ Analyzer mode
OFDM	WiMAX IEEE 802.16 OFDM measurements (option R&S FSV-K93)
OFDMA/WiBro	WiMAX IEEE 802.16e OFDMA/WiBro measurements (option R&S FSV-K93)
NF	Noise Figure measurements (R&S FSV-K30)
PHN	Phase Noise measurements (R&S FSV-K40)
PSM	Power Sensor measurements (option R&S FSV-K9)
SFM	Stereo FM measurements (optionR&S FSV-K7S)
SPECM	Spectogram mode (option R&S FSV-K14)
TDS	TD-SCDMA base station / UE measurements (option R&S FSV-K76/K77)
VSA	Vector Signal Analysis (option R&S FSV-K70)
WCDMA	3GPP Base Station measurements (option R&S FSV-K72), 3GPP UE measurements (option R&S FSV-K73)
WLAN	WLAN TX measurements (option R&S FSV-K91)

The signal analysis (spectrum) mode is implemented in the basic unit. For the other modes, the corresponding options are required.

Upper/Lower Case Notation

Upper/lower case letters are used to mark the long or short form of the key words of a command in the description (see chapter 5 "Remote Control – Basics"). The instrument itself does not distinguish between upper and lower case letters.

Special Characters

|	A selection of key words with an identical effect exists for several commands. These keywords are indicated in the same line; they are separated by a vertical stroke. Only one of these keywords needs to be included in the header of the command. The effect of the command is independent of which of the keywords is used.

Example:

`SENSe:FREQuency:CW|:FIXed`

The two following commands with identical meaning can be created. They set the frequency of the fixed frequency signal to 1 kHz:

`SENSe:FREQuency:CW 1E3`

`SENSe:FREQuency:FIXed 1E3`

A vertical stroke in parameter indications marks alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.

Example: Selection of the parameters for the command

`[SENSe<1…4>:]AVERage<1…4>:TYPE VIDeo | LINear`

[]	Key words in square brackets can be omitted when composing the header. The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards. Parameters in square brackets can be incorporated optionally in the command or omitted as well.

{}	Parameters in braces can be incorporated optionally in the command, either not at all, once or several times.

Description of Parameters

Due to the standardization, the parameter section of SCPI commands consists always of the same syntactical elements. SCPI has therefore specified a series of definitions, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<…>) and is briefly explained in the following (see also chapter 5 "Remote Control – Basics", section "Parameters").

<Boolean>

This keyword refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword OFF or by the numeric value 0, the "on" state is indicated by ON or any numeric value other than zero. Parameter queries are always returned the numeric value 0 or 1.

<numeric_value> <num>

These keywords mark parameters which may be entered as numeric values or be set using specific keywords (character data). The following keywords given below are permitted:

- MAXimum: This keyword sets the parameter to the largest possible value.
- MINimum: This keyword sets the parameter to the smallest possible value.

- DEFault: This keyword is used to reset the parameter to its default value.
- UP: This keyword increments the parameter value.
- DOWN: This keyword decrements the parameter value.

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

Example:

SENSe:FREQuency:CENTer? MAXimum

Returns the maximum possible numeric value of the center frequency as result.

<arbitrary block program data>

This keyword is provided for commands the parameters of which consist of a binary data block.

4.4.2 CALCulate subsystem

4.4.2.1 CALCulate:DELTamarker subsystem

CALCulate<n>:DELTamarker<m>:AOFF

This command switches off all active delta markers in the window specified by the suffix <n>.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number
Example:	`CALC:DELT:AOFF` Switches off all delta markers.
Mode:	A, ADEMOD, CDMA, EVDO, PHN, TDS, VSA, WCDMA

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker 1 to marker 1. If you change the horizontal position of the marker, so does the delta marker.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	1 irrelevant

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`CALC:DELT:LINK ON`
Mode:	A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM VSA

CALCulate<screen>:DELTamarker<marker>:MAXimum:APEak

This command positions the active marker or deltamarker on the largest absolute peak value (maximum or minimum) of the selected trace.

Suffix:

<screen>	1..4
<marker>	1..4
Usage:	Event
Mode:	VSA

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command positions the delta marker to the next smaller maximum value to the left of the current value (i.e. descending X values) in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number

Example: `CALC:DELT:MAX:LEFT`
Sets delta marker 1 to the next smaller maximum value to the left of the current value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command positions the delta marker to the next smaller maximum value on the measured curve in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT2:MAX:NEXT`
Sets delta marker 2 to the next smaller maximum value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

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

This command positions the delta marker to the current maximum value on the measured curve in the window specified by the suffix <n>. If necessary, the corresponding delta marker is activated first.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT3:MAX`
Sets delta marker 3 to the maximum value of the associated trace.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command positions the delta marker to the next smaller maximum value to the right of the current value (i.e. ascending X values) in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT:MAX:RIGH`
Sets delta marker 1 to the next smaller maximum value to the right of the current value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command positions the delta marker to the next higher minimum value to the left of the current value (i.e. descending X values) in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT:MIN:LEFT`
Sets delta marker 1 to the next higher minimum to the left of the current value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command positions the delta marker to the next higher minimum value of the measured curve in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT2:MIN:NEXT`
Sets delta marker 2 to the next higher minimum value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM

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

This command positions the delta marker to the current minimum value on the measured curve in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT3:MIN`
Sets delta marker 3 to the minimum value of the associated trace.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command positions the delta marker to the next higher minimum value to the right of the current value (i.e. ascending X values) in the window specified by the suffix <n>. The corresponding delta marker is activated first, if necessary.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT:MIN:RIGH`
Sets delta marker 1 to the next higher minimum value to the right of the current value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

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

This command defines the marker specified by the suffix <m> as a delta marker for the window specified by the suffix <n>. If the corresponding marker was not already active, it is activated and positioned on the maximum of the measurement curve.

If no suffix is given for DELTamarker, delta marker 1 is selected automatically.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT1 ON`
Switches marker 1 to delta marker mode.

Mode: All

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

This command assigns the selected delta marker to the indicated trace in the window specified by the suffix <n>. The selected trace must be active, i.e. its state must be different from "BLANK".

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number

Parameters:

<TraceNumber>	**1 to 6** Selects trace 1 through 6.
Example:	`CALC:DELT3:TRAC 2` Assigns delta marker 3 to trace 2.
Mode:	A, ADEMOD, CDMA, EVDO, PHN, TDS, WCDMA, SPECM, RT, VSA

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

This command positions the selected delta marker to the indicated value in the window specified by the suffix <n>. The input is in absolute values.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number

Parameters:

<Position>	Depends on the measurement and scale of the horizontal axis
Example:	`CALC:DELT:X?` Outputs the absolute frequency/time of delta marker 1.
Mode:	A, ADEMOD, CDMA, EVDO, PHN, TDS, WCDMA, VSA

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.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number
Usage:	Query only
Mode:	VSA

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

This command queries the x-value of the selected delta marker relative to marker 1 or to the reference position (for `CALC:DELT:FUNC:FIX:STAT ON`) in the window specified by the suffix <n>. The command activates the corresponding delta marker, if necessary.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA

CALCulate<n>:DELTamarker<m>:Y

This command queries the measured value of the selected delta marker in the specified window. The corresponding delta marker is activated, if necessary. The output is always a relative value referred to marker 1 or to the reference position (reference fixed active).

To obtain a correct query result, a complete sweep with synchronization to the sweep end must be performed between the activation of the delta marker and the query of the y value. This is only possible in single sweep mode.

Depending on the unit defined with `CALC:NIT:POW` or on the activated measuring functions, the query result is output in the units below:

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

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

Mode: A, ADEMOD, BT, CDMA, EVDO, PHN, TDS, WCDMA, VSA

4.4.2.2 CALCulate:MARKer subsystem

CALCulate<n>:MARKer<m>:AOFF

This command switches off all active markers, delta markers, and marker measurement functions in the specified window.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	depends on mode irrelevant
Example:	`CALC:MARK:AOFF` Switches off all markers.
Mode:	all

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:ADRoop <type>
CALCulate<screen>:MARKer<marker>: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 "Result Summary", on page 85).

Suffix:

<screen>	1..4
<marker>	1..4

Parameters:

<type>

PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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: PEAK

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:ALL?

This command queries all results of the result summary as shown on the screen.

Suffix:

<screen>	1..4 screen number
<marker>	irrelevant

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>: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 .

Suffix:

<screen>	1..4
<marker>	irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>: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 .

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FDERror? <type>

This command queries the results of the FSK deviation error of FSK modulated signals.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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.

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK: CFDRift? <type>

This command queries the results of the carrier frequency drift for FSK modulated signals.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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.

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK: DERRor? <type>

This command queries the results of the frequency error of FSK modulated signals.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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.

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:MDEViation? <type>

This command queries the results of the measurement deviation of FSK modulated signals.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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.

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:FSK:RDEViation? <type>

This command queries the results of the reference deviation of FSK modulated signals.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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.

Usage: Query only

Mode: VSA

**CALCulate<screen>:MARKer<marker>: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 .

Suffix:

<screen>	1..4
<marker>	irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

**CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:
IQIMbalance?** <type>

This command queries the results of the I/Q imbalance error measurement of digital demodulation.

Suffix:

<screen>	1..4
<marker>	irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MERRor? <type>

This command queries the results of the magnitude error measurement of digital demodulation.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:MPOWer? <type>

This command queries the results of the power measurement of digital demodulation.

Suffix:

<screen> 1..4

<marker> irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:OOFFset <type>
CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:OOFFset? <type>

This command queries the results of the I/Q offset measurement performed for digital demodulation.

Suffix:

<screen> 1..4

<marker> 1..4

Parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:PERRor?
<type>

This command queries the results of the phase error measurement performed for digital demodulation.

Suffix:

<screen>	1..4
<marker>	irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:QERRor?
<type>

This command queries the results of the Quadratur error measurement performed for digital demodulation.

Suffix:

<screen>	1..4
<marker>	irrelevant

Query parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Usage: Query only

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:RHO <type>
CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:RHO? <type>

This command queries the results of the Rho factor measurement performed for digital demodulation.

Suffix:

<screen> 1..4

<marker> 1..4

Parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Mode: VSA

CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:SNR <type>
CALCulate<screen>:MARKer<marker>:FUNCtion:DDEMod:STATistic:SNR?
<type>

This command queries the results of the SNR error measurement performed for digital demodulation.

Suffix:

<screen> 1..4

<marker> 1..4

Parameters:

<type> PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEAk | RPEak | PAVG | PSDev | PPCTl

<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

Mode: VSA

CALCulate<screen>:MARKer<marker>:LINK <MarkerCoupling>

With this command markers between several screens can be coupled, i.e. use the same stimulus. All screens can be linked with an X-axis scaled in symbols or time, except those showing the capture buffer. If several capture buffer measurements are visible, their markers are coupled, too.

Suffix:

<screen> 1..4

<marker> irrelevant

Setting parameters:

<MarkerCoupling>	ON | OFF	
	*RST:	OFF
Mode:	VSA	

CALCulate<screen>:MARKer<marker>:MAXimum:APEak

This command positions the active marker or deltamarker on the largest absolute peak value (maximum or minimum) of the selected trace.

Suffix:

<screen>	1..4
<marker>	1..4
Usage:	Event
Mode:	VSA

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command positions the marker to the next smaller maximum value to the left of the current value (i.e. in descending X values) on the trace in the window specified by the suffix <n>.

If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number
Example:	`CALC:MARK2:MAX:LEFT` Positions marker 2 to the next lower maximum value to the left of the current value.
Mode:	A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command positions the marker to the next smaller maximum value of the corresponding trace in the window specified by the suffix <n>.

If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number
Example:	`CALC:MARK2:MAX:NEXT` Positions marker 2 to the next lower maximum value.
Mode:	A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command positions the marker to the next smaller maximum value to the right of the current value (i.e. in ascending X values) on the corresponding trace in the window specified by the suffix <n>.

If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number
Example:	`CALC:MARK2:MAX:RIGH` Positions marker 2 to the next lower maximum value to the right of the current value.
Mode:	A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM

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

This command positions the marker to the current maximum value of the corresponding trace in the specified window. The corresponding marker is activated first or switched to the marker mode.

If no maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	depends on mode marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.
Example:	`CALC:MARK2:MAX` Positions marker 2 to the maximum value of the trace.
Mode:	A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM, NF

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command positions the marker to the next higher minimum value to the left of the current value (i.e. in descending X direction) on the corresponding trace in the window specified by the suffix <n>.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number

Example: `CALC:MARK2:MIN`
Positions marker 2 to the minimum value of the trace.
`CALC:MARK2:MIN:LEFT`
Positions marker 2 to the next higher minimum value to the left of the current value.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, SPECM, VSA

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command positions the marker to the next higher minimum value of the corresponding trace in the window specified by the suffix <n>.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:MARK2:MIN`
Positions marker 2 to the minimum value of the trace.
`CALC:MARK2:MIN:NEXT`
Positions marker 2 to the next higher maximum value.

Mode: A, ADEMOD, CDMA, EVDO, SPECM, TDS, VSA, WCDMA

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

This command positions the marker to the current minimum value of the corresponding trace in the specified window. The corresponding marker is activated first or switched to marker mode, if necessary.

If no minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> depends on mode
marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.

Example: `CALC:MARK2:MIN`
Positions marker 2 to the minimum value of the trace.

Mode: A, ADEMOD, CDMA, EVDO, TDS, WCDMA, VSA, SPECM, NF

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command positions the marker to the next higher minimum value to the right of the current value (i.e. in ascending X direction) on the corresponding trace in the window specified by the suffix <n>.

If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is produced.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Example: `CALC:MARK2:MIN`
Positions marker 2 to the minimum value of the trace.
`CALC:MARK2:MIN:RIGH`
Positions marker 2 to the next higher minimum value to the right of the current value.

Mode: A, ADEMOD, CDMA, EVDO, SPECM, TDS, VSA, WCDMA

CALCulate<screen>:MARKer<marker>:SEARch <MarkRealImag>

This command specifies whether the marker search works on the real or the imag trace.

Suffix:

<screen> 1..4

<marker> 1..4
irrelevant

Setting parameters:

<MarkRealImag> REAL | IMAG

*RST: REAL

Example: `CALC4:MARK:SEAR IMAG`

Mode: VSA

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

This command activates a marker in the specified window. If no indication is made, marker 1 is selected automatically. If activate, the marker is switched to normal mode.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> depends on mode
marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3 or switches to marker mode.

Mode: all

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

This command assigns the selected marker to the indicated measurement curve in the specified window. The corresponding trace must be active, i.e. its status must not be "BLANK".

If necessary, the corresponding marker is switched on prior to the assignment.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	depends on mode marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.

Parameters:

<Trace>	**1 to 6** Selects trace 1 through 6.
Example:	`CALC:MARK3:TRAC 2` Assigns marker 3 to trace 2.
Mode:	all

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

This command positions the selected marker to the indicated x-value in the window specified by the suffix <n>.

If marker 2, 3 or 4 is selected and used as delta marker, it is switched to marker mode.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker number

Parameters:

<Position>	0 to MAX (frequency | sweep time | level)
Example:	`CALC:MARK2:X 10.7MHz` Positions marker 2 to frequency 10.7 MHz.
Mode:	ALL

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

This command switches between a limited (ON) and unlimited (OFF) search range.

If the power measurement in zero span is active, this command limits the evaluation range on the trace.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	marker

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`CALC:MARK:X:SLIM ON` Switches on search limitation.
Mode:	all

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <Limit>

This command sets the left limit of the search range for markers and delta markers in the window specified by the suffix <n>. Depending on the span setting of the x-axis the indicated value defines a frequency (span > 0) or time (span = 0).

If the power measurement in zero span is active, this command limits the evaluation range to the trace.

Note: The function is only available if the search limit for marker and delta marker is switched on (see `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 209).

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	irrelevant

Parameters:

<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.

Mode:	all

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <Limit>

This command sets the right limit of the search range for markers and delta markers in the window specified by the suffix <n>. Depending on the span setting of the x-axis the indicated value defines a frequency (span > 0) or time (span = 0).

If the power measurement in zero span is active, this command limits the evaluation range to the trace.

Note: The function is only available if the search limit for marker and delta marker is switched on (`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 209).

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<m>	irrelevant

Parameters:
<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.

Mode: all

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM <State>

This command sets the limits of the search range for markers and delta markers to the zoom area in the window specified by the suffix <n>.

Note: The function is only available if the search limit for marker and delta marker is switched on (see `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 209).

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:
<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Mode: all

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

This command queries the measured value of the selected marker in the window specified by the suffix <n>. The corresponding marker is activated before or switched to marker mode, if necessary.

To obtain a correct query result, a complete sweep with synchronization to the sweep end must be performed after the change of a parameter and before the query of the Y value. This is only possible in single sweep mode.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Return values:
<Result> The measured value of the selected marker is returned.
In I/Q Analyzer mode, if the result display configuration "Real/Imag (I/Q)" is selected, this query returns the Real (Q) value of the marker first, then the Imag (I) value.

Example:
`INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.
In I/Q Analyzer mode, for "Real/Imag (I/Q)", for example:
`1.852719887E-011,0`

Usage: Query only

Mode: ALL

4.4.2.3 Other CALCulate commands

CALCulate<screen>:DDEM:SPECtrum[:STATe] <AddEvaluation>

This command switches the result display 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<screen>:FORMat on page 215).

Suffix:

<screen>	1..4

Setting parameters:

<AddEvaluation>	ON | OFF *RST: Off

Example:
CALC:FEED 'XTIM:DDEM:MEAS'
Selects the measurement signal for display.
CALC:FORM PHAS
Selects the phase as the result parameter.
CALC:DDEM:SPEC:STAT ON
Selects spectral display of the phase.

Mode: VSA

CALCulate<screen>: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:

<screen>	1..4
<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<screen>:ELIN<startstop>[:VALue] on page 213).

OFF
The complete result area is evaluated.

*RST: OFF

Mode: VSA

CALCulate<screen>:ELIN<startstop>[:VALue] <LeftDisp>

Defines the start and stop values for the evaluation range (see CALCulate<screen>:ELIN<startstop>:STATe on page 213).

Suffix:

<screen> 1..4

<startstop> 1..2
1: start value, 2: stop value

Setting parameters:

<LeftDisp>
Range: 0 to 1000000
*RST: 0
Default unit: SYM

Mode: VSA

CALCulate<screen>:FEED <Feed>

Selects the signal source to be displayed.

Suffix:

<screen> 1..4

Setting parameters:

<Feed> 'XTIM:DDEM:MEAS' | 'XTIM:DDEM:REF' | 'XTIM:DDEM:ERR:MPH' | 'XTIM:DDEM:ERR:VECT' | 'XTIM:DDEM:ERR:SYMB' | 'XTIM:DDEM:MACC' | 'TCAP'

'XTIM:DDEM:MEAS'
Measured signal

'XTIM:DDEM:REF'
Reference signal

'XTIM:DDEM:ERR:MPH'
Error signal

'XTIM:DDEM:ERR:VECT'
Error vector

'XTIM:DDEM:ERR:SYMB'
Symbol table

'XTIM:DDEM:MACC'
Modulation accuracy

'TCAP'
Capture Buffer

Example: Switch to EVM:
```
CALC:FEED 'XTIM:DDEM:ERR:VECT'
CALC:FORM MAGN
```
Switch to Meas Signal, Frequency Relative
```
CALC:FEED 'XTIM:DDEM:MEAS'
CALC:FORM FREQ
DISP:WIND1:TRAC1:Y:SCAL:MODE REL
```

Mode: VSA

CALCulate<screen>:FORMat <Format>

This command defines the result type of the traces. Which parameters are available depends on the setting for `CALC:FEED` (see `CALCulate<screen>:FEED` on page 214).

Table 4-29: Available result types depending on source type

Source Type	Result Type	Parameter
Capture Signal	Magnitude Absolute	MAGNitude
	Real/Imag (I/Q)	RIMag
	Vector I/Q	COMP
Meas & Ref Signal	Magnitude Absolute	MAGNitude
	Magnitude Relative	MAGNitude
	Phase Wrap	PHASe
	Phase Unwrap	UPHase
	Frequency Absolute	FREQuency
	Frequency Relative	FREQuency
	Real/Imag (I/Q)	RIMag
	Eye Diagram Real (I)	IEYE
	Eye Diagram Imag (Q)	QEYE
	Eye Diagram Frequency	FEYE
	I/Q Constellation	CONS
	I/Q Vector	COMP
	Constellation Frequency	CONF
	Vector Frequency	COVF
Symbols	Binary	-
	Octal	-
	Decimal	-
	Hexadecimal	-
Error Vector	EVM	MAGNitude
	Real/Imag (I/Q)	RIMag
	I/Q Constellation	CONS
	I/Q Vector	COMP
Modulation Errors	Magnitude Error	MAGNitude
	Phase Error	PHASe
	Frequency Error Absolute	FREQuency

Source Type	Result Type	Parameter
	Frequency Error Relative	FREQuency
Modulation Accuracy	-	-

Whether the result type shows absolute or relative values is defined using the `DISP:WIND:TRAC:Y:MODE` command (see `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 227).

Suffix:
<screen> 1..4

Setting parameters:
<Format> MAGNitude | PHASe | UPHase | RIMag | FREQuency | COMP | CONS | IEYE | QEYE | FEYE | CONF | COVF

Mode: VSA

CALCulate<screen>:FSK:DEViation:COMPensation <RefDevCompensation>

This command selects the method for calculating the frequency error for FSK modulation.

Suffix:
<screen> 1..4

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

Mode: VSA

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

This command sets the relative reference value of the frequency deviation for FSK modulation. The reference is in relation to the symbol rate.

Suffix:
<screen> 1..4

Setting parameters:
<FSKRefDev>
Range: 0.1 to 15
*RST: 1
Default unit: NONE

Mode: VSA

CALCulate<screen>:FSK:DEViation:REFerence[:VALue] <FSKRefDevAbsResult>

This command sets the absolute reference value of the frequency deviation for FSK modulation.

Suffix:
<screen> 1..4

Setting parameters:

<FSKRefDevAbsResult>

Range: The range depends on the symbol rate and has to be between 0.1 to 15 times the symbol rate.
*RST: 100e3
Default unit: Hz

Mode: VSA

CALCulate<screen>:STATistics:CCDF[:STATe] <AddEvaluation>

This command switches the calculation of the statistical distribution of magnitude, phase or frequency values on or off.

Suffix:

<screen> 1..4

Setting parameters:

<AddEvaluation> ON | OFF

*RST: OFF

Example: `CALC:STAT:CCDF ON`
Switches the statistic measurements on.

Mode: VSA

CALCulate<screen>:STATistics:MODE <StatisticMode>

This command defines whether only the symbol points or all points are considered for the statistical calculations.

Suffix:

<screen> 1..4

Setting parameters:

<StatisticMode> SONLy | INFinite

SONLy
Symbol points only

INFinite
All points are used

*RST: SONLy

Example: `CALC1:STAT:MODE SONL`

Mode: VSA

CALCulate<screen>:STATistics:PRESet

This command sets both axis of the statistics measurement to measurement dependent default values.

Suffix:

<screen> 1..4

Example: `CALC:STAT:PRES`

Usage: Event

Mode: VSA

CALCulate<screen>:STATistics:SCALe:AUTO <AutoMode>

Sets the x-axis of the statistics measurement depending on the measured values.

Suffix:

<screen> 1..4

Setting parameters:

<AutoMode> ONCE

Example: `CALC3:STAT:SCAL:AUTO ONCE`

Usage: Setting only

Mode: VSA

CALCulate<screen>:STATistics:SCALe:X:BCOunt <StatisticsNofColumns>

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

Suffix:

<screen> 1..4

Setting parameters:

<StatisticsNofColumns>

Range: 2 to 1024
*RST: 101
Default unit: NONE

Example: `CALC:STAT:SCAL:X:BCO 10`
Sets the number of columns to 10.

Mode: VSA

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

This command defines the lower limit for the y-axis of the diagram in statistical measurements. Since probabilities are specified on the y-axis, the entered numeric values are dimensionless.

Suffix:

<n> selects the screen

Parameters:

<Value> 1E-9 to 0.1

*RST: 1E-6

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

Mode: A, CDMA, EVDO, TDS, VSA, WCDMA

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

This command defines the scaling type of the y-axis.

Suffix:

<n> selects the screen

Parameters:

<Unit> PCT | ABS

*RST: ABS

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

Mode: A, CDMA, EVDO, TDS, WCDMA, VSA

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

This command defines the upper limit for the y-axis of the diagram in statistical measurements. Since probabilities are specified on the y-axis, the entered numeric values are dimensionless.

Suffix:

<n> irrelevant

Parameters:

<Value> 1E-8 to 1.0

*RST: 1.0

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

Mode: A, CDMA, EVDO, TDS, WCDMA, VSA

CALCulate<screen>:TRACe<trace>: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:

<screen> 1..4

<trace> 1..6

Setting parameters:

<FitOffset>

Range: -8000 to 8000
*RST: 0
Default unit: SYM

Example: `CALC:TRAC:ADJ:ALIG:OFF 5`
The display range is shifted by 5 symbols towards the right.

Mode: VSA

CALCulate<screen>:TRACe<trace>:ADJust:ALIGnment[:DEFault] <Alignment>

This command defines where the relevant event (reference point) is to appear in the result range.

Suffix:

<screen>	1..4
<trace>	1..6 irrelevant

Setting parameters:

<Alignment> LEFT | CENTer | RIGHt

LEFT
The reference point is displayed at the left edge of the result range.

CENTer
The reference point is displayed in the middle of the result range.

RIGHt
The reference point is displayed at the right edge of the result range.

*RST: LEFT

Example: `CALC:TRAC:ADJ:ALIG LEFT`
The reference point is displayed at the left edge.

Mode: VSA

CALCulate<screen>:TRACe<trace>:ADJust[:VALue] <Reference>

This command defines the reference point for the display.

Suffix:

<screen>	1..4
<trace>	1..6 irrelevant

Setting parameters:

<Reference> TRIGger | BURSt | PATTern

TRIGger
The reference point is the start of the capture buffer.

BURSt
The reference point is the burst.

PATTern
The instrument selects the reference point and the alignment.

*RST: TRIGger

Example: `:CALC:TRAC:ADJ BURS`
Defines the reference point as the burst.

Mode: VSA

CALCulate<screen>:TRACe<trace>[:VALue] <TrRefType>

This commands selects the meas or the ref signal for a trace.

Suffix:

<screen> 1..4

<trace> 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.

Example: `CALC2:TRAC5 MEAS`
Sets the measurement signal for trace 5.

Usage: SCPI conform

Mode: VSA

CALCulate<screen>:UNIT:ANGLe <Unit>

This command selects the default unit for angles.

Suffix:

<screen> 1..4

Setting parameters:

<Unit> DEG | RAD

*RST: RAD

Example: `CALC:UNIT:ANGLe DEG`
Selects degrees as the default unit.

Mode: VSA

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

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

Suffix:

<screen> 1..4

Setting parameters:

<Unit> S | SYM

*RST: SYM

Example: `CALC:X:UNIT:TIME S`
Sets the unit to seconds.

Mode: VSA

4.4.3 DISPlay subsystem

DISPlay[:WINDow<window>]:PRATe:AUTO <DisplayPPSMode>

This command turns auto mode of points per symbol on or off. If "Auto" is enabled, most measurements use the current "Capture Oversampling". Alternatively, select the number of points to be displayed per symbol manually (see `DISPlay[:WINDow<window>]:PRATe[:VALue]` on page 222).

Suffix:

<window> 1..4

Setting parameters:

<DisplayPPSMode> AUTO | MANual

*RST: AUTO

Example: `DISP:WIND2:PRAT:AUTO?`

Queries the points per symbol mode.

Mode: VSA

DISPlay[:WINDow<window>]:PRATe[:VALue] <DisplayPPS>

This command determines the number of points to be displayed per symbol if manual mode is selected (see `DISPlay[:WINDow<window>]:PRATe:AUTO` on page 222).

Suffix:

<window> 1..4

Setting parameters:

<DisplayPPS> 1, 2, 4, 8 or 16

*RST: 4

Example: `DDEM:PRAT 8`

Sets 8 points per symbol.

Mode: VSA

DISPlay[:WINDow<window>]:STATe <Active>

Activates/deactivates the window specified by the suffix <1...4>.

Suffix:

<window>	1..4

Setting parameters:

<Active>	ON | OFF *RST: ON
Example:	`DISP:WIND1:STAT ON` Activates window 1.
Mode:	VSA

DISPlay[:WINDow<window>]:TRACe<trace>:MODE

This command defines the type of display and the evaluation of the traces in the window specified by the suffix <n>. WRITE corresponds to the Clr/Write mode of manual operation. The trace is switched off (= BLANK in manual operation) with `DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 223.

The number of measurements for AVERage, MAXHold and MINHold is defined with `[SENSe<n>]:SWEep[:COUNt]` on page 272. It should be noted that synchronization to the end of the indicated number of measurements is only possible in single sweep mode.

Suffix:

<window>	1..4
<trace>	irrelevant

Parameters:

<Mode>	WRITe | VIEW | AVERage | MAXHold | MINHold | BLANk *RST: WRITe for TRACe1, STATe OFF for TRACe2/3/4/5/6 For details on trace modes refer to chapter 4.3.4.1, "Trace Mode Overview", on page 179.

Example:	`INIT:CONT OFF`
	Switching to single sweep mode.
	`SWE:COUN 16`
	Sets the number of measurements to 16.
	`DISP:TRAC3:MODE MAXH`
	Switches on the calculation of the maximum peak for trace 3.
	`INIT;*WAI`
	Starts the measurement and waits for the end of the 16 sweeps.

Mode:	VSA

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command switches on or off the display of the corresponding trace in the window specified by the suffix <n>. The other measurements are not aborted but continue running in the background.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<t> trace

Parameters:

<State> ON | OFF

*RST: ON for TRACe1, OFF for TRACe2 to 6

Example: `DISP:TRAC3 ON`

Mode: all

DISPlay[:WINDow<window>]:TRACe<trace>:SYMBol

This command defines the display of the decision instants (time when the signals occurred) on the trace.

Suffix:

<window> 1..4

<trace> 1..6

Parameters:

Example: `DISP:WIND1:TRAC:SYMB ON`
Defines that the decision instants are displayed in the form of dots.

Mode: VSA

DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:PDIVision <PDiv>

This command defines the scaling of the X axis.

Setting the scale of the horizontal axis is possible only for statistical result displays. All other result displays support the query only.

Suffix:

<window> 1..4

<trace> irrelevant

Setting parameters:

<PDiv> numeric value

Example: `DISP:TRAC:X:PDIV 20`
Sets the scaling of the Y axis to 20 DIV.

Mode: VSA

DISPlay[:WINDow<window>]:TRACe<trace>: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.

Suffix:

<window>	1..4
<trace>	irrelevant

Setting parameters:

<RPos>	<numeric_value>
Example:	`DISP:TRAC:X:RPOS 30 PCT` The reference value is shifted by 30% towards the left.
Mode:	VSA

DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:RVALue <RVal>

This command defines the reference value for the X axis of the measurement diagram.

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

Suffix:

<window>	1..4
<trace>	1..6

Setting parameters:

<RVal>	Reference value for the X axis
Example:	`DISP:TRAC:X:RVAL 20` Sets the reference value to 20.
Mode:	VSA

DISPlay[:WINDow<window>]:TRACe<trace>: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: In the "Result Range Alignment And Evaluation Range" dialog (or using the `CALC:TRAC:ALIG` commands), the burst on the screen is shifted; the x-axis thus no longer begins on the left at 0 symbols but at a selectable value.

Suffix:

<window>	1..4
<trace>	1..6

Example:	`CALC:TRAC:ADJ BURS`
	Defines the burst as the reference for the screen display.
	`CALC:TRAC:ADJ:ALIG CENT`
	Position the burst at the center of the screen.
	`DISP:TRAC:X:STAR?`
	Queries the start value of the X axis.

Usage:	Query only
Mode:	VSA

DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:VOFFset <VOffset>

This command adds an offset to the symbols shown in the result display.

The offset is available for all result displays except the capture buffer.

Suffix:

<window>	1..4
<trace>	1..6

Setting parameters:

<VOffset>

Range: -100000 to 100000
*RST: 0
Default unit: NONE

Example: `DISP:TRAC:X:VOFF 20`
Adds an offset of 20 to the number of symbols.

Mode: VSA

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

This command defines the display range of the y-axis (level axis) with logarithmic scaling (`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 229) in the window specified by the suffix <n>.

For linear scaling, the display range is fixed and cannot be modified.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<t> irrelevant

Parameters:

<Range> 10 dB to 200 dB or value in Hz

*RST: 100dB

Example: `DISP:TRAC:Y 110dB`

Mode: all

DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe]:AUTO[:VALue]

This command automatically scales the vertical axis of the specified screen.

Suffix:

<window>	1..4
<trace>	1..6

Example: `DISP:WIND2:TRAC:Y:SCAL:AUTO`
Auto scaling for screen B

Usage: Event

Mode: VSA

DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe]:AUTO:ALL

This command automatically scales the vertical axis of all screens.

Suffix:

<window>	1..4
<trace>	1..6

Example: `DISP:WIND2:TRAC:Y:SCAL:AUTO:ALL`

Usage: Event

Mode: VSA

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command defines the scale type of the y-axis (absolute or relative) in the window specified by the suffix <n>.

When `SYSTem:DISPlay:UPDate` is set to OFF, this command has no immediate effect on the screen (see `SYSTem:DISPlay:UPDate` on page 273).

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<t> irrelevant

Parameters:

<Mode> ABSolute | RELative

*RST: ABS

Example: `DISP:TRAC:Y:MODE REL`

Mode: all

DISPlay[:WINDow<window>]:TRACe<trace>:Y[:SCALe][:PDIVision] <Range>

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

Suffix:

<window> 1..4

<trace> 1..6
irrelevant

Setting parameters:

<Range>

Range: 1 to 1000000
*RST: 100
Default unit: NONE

Example: `DISP:TRAC1:Y:PDIV 2 dB`

Mode: VSA

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

This command sets the reference level.

With the reference level offset <> 0, the indicated value range of the reference level is modified by the offset.

Suffix:

<n>	irrelevant.
<t>	irrelevant

Parameters:

<Value>	<numeric_value>, range specified in data sheet *RST: -10dBm
Example:	`DISP:TRAC:Y:RLEV -60dBm`
Mode:	A, ADEMOD, BT, CDMA, EVDO, TDS, VSA, WCDMA

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

This command sets the reference level offset.

Suffix:

<n>	irrelevant.
<t>	irrelevant

Parameters:

<Value>	-200dB to 200dB *RST: 0dB
Example:	`DISP:TRAC:Y:RLEV:OFFS -10dB`
Mode:	ALL

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

This remote command defines the position of the reference value on the Y axis (1 – 100 %) in the window specified by the suffix <n>.

When using a tracking generator (only with option R&S FSV-B9 or -B10, requires active normalization), and in Bluetooth mode (option R&S FSV-K8) this command defines the position of the reference value for all windows.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<t>	irrelevant

Parameters:

<Position>	0 to 100PCT *RST: 100 PCT = "Spectrum" mode, AF spectrum display; 50 PCT = Tracking Generator mode or time display
Example:	`DISP:TRAC:Y:RPOS 50PCT`
Mode:	A, BT, CDMA, EVDO, TDS, WCDMA, ADEMOD, VSA

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

This command selects the scaling for the level display range in the window specified by the suffix <n>.

Suffix:

<n>	window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.
<t>	irrelevant

Parameters:

<ScalingType> LOGarithmic | LINear | LDB

LOGarithmic
Selects logarithmic scaling.

LINear
Selects linear scaling in %.

LDB
Selects linear scaling in dB.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`

Mode: A, ADEMOD, BT, VSA

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command activates and deactivates the zoom mode in the window specified by the suffix <n>. When activated, the display of the measurement results is enlarged in the area specified by `DISPlay[:WINDow<n>]:ZOOM:AREA` on page 229.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP:ZOOM ON`
Activates the zoom mode.

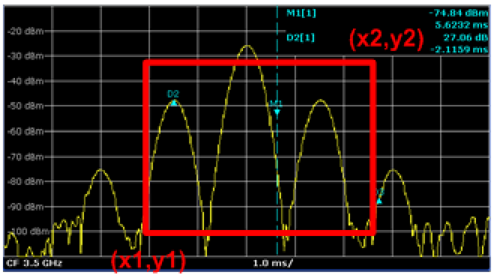
Mode: A, ADEMOD, VSA

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>, <y1>, <x2>, <y2>

This command defines the area for which the display is enlarged in the specified window in zoom mode.

The query returns the currently defined coordinates as x1,y1,x2,y2.

(100,100)



(0,0)

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

Parameters:

<x1>, <y1>, <x2>, <y2> percentage values between 0 and 100

The area is defined via the coordinates of the lower left (x1, y1) and top right (x2,y2) corners of a rectangle, where x and y are percentages of the complete diagram. (0,0) defines the lower left corner of the diagram area, (100,100) defines the top right corner.

Example: `DISP:ZOOM ON`

Activates the zoom mode.

`DISP:ZOOM:AREA 5,30,20,100`

Enlarges the display of the measurement results in the area defined by the coordinates (5,30) and (20,100).

Mode: A, ADEMOD, VSA

4.4.4 FORMat subsystem

FORMat:DEXPort:DSEParator <Separator>

This command defines which decimal separator (decimal point or comma) is to be used for outputting measurement data to the file in ASCII format. Different languages of evaluation programs (e.g. MS-Excel) can thus be supported.

The suffix <1…4> is irrelevant, the separator is defined globally for all windows.

Parameters:

<Separator> POINt | COMMA

*RST: (factory setting is POINt; *RST does not affect setting)

Example: `FORM:DEXP:DSEP POIN`

Sets the decimal point as separator.

Mode: all

FORMat:DEXPort:HEADer <Header>

This command defines if an extended file header (including start frequency, sweep time, detector, etc.) is created or not. A short header with the instrument model, the version and the date is always transferred.

Setting parameters:

<Header> ON | OFF

*RST: OFF

Example: `FORM:DEXP:HEAD OFF`
Only a short file header is transferred.

Mode: VSA

FORMat:DEXPort:MODE <Mode>

This command defines whether raw I/Q data or trace data is transferred.

Setting parameters:

<Mode> RAW | TRACe

*RST: TRACe

Example: `FORM:DEXP:MODE RAW`
Raw measurement data is transferred.

Mode: VSA

4.4.5 INITiate Subsystem

INITiate<n>:CONMeas

This command continues a stopped measurement at the current position in single sweep mode. The function is useful especially for trace functions MAXHold, MINHold and AVERage, if the previous results are not to be cleared with sweep count > 0 or average count > 0 on restarting the measurement (INIT:IMMediate resets the previous results on restarting the measurement).

The single sweep mode is automatically switched on. Synchronization to the end of the indicated number of measurements can then be performed with the commands *OPC, *OPC? or *WAI. In the continuous sweep mode, synchronization to the sweep end is not possible since the overall measurement "never" ends.

Suffix:

<n> irrelevant

Example:

`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 sequences) and waits for the end.

Mode: A, ADEMOD, CDMA, EVDO, VSA, WCDMA, TDS

INITiate<n>:CONTinuous <State>

This command determines whether the trigger system is continuously initiated (continuous) or performs single measurements (single).

In the **"Spectrum" mode**, this setting refers to the sweep sequence (switching between continuous/single sweep).

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: ON

Example:

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

Mode: all

INITiate<n>[:IMMediate]

The command initiates a new measurement sequence.

With sweep count > 0 or average count > 0, this means a restart of the indicated number of measurements. With trace functions MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

In single sweep mode, synchronization to the end of the indicated number of measurements can be achieved with the command *OPC, *OPC? or *WAI. In continuous-sweep mode, synchronization to the sweep end is not possible since the overall measurement never ends.

Suffix:

<n> irrelevant

Example:

```
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.

Mode: all

4.4.6 INPut Subsystem

INPut:ATTenuation <Value>

This command programs the input attenuator. To protect the input mixer against damage from overloads, the setting 0 dB can be obtained by entering numerals, not by using the DOWN command.

The attenuation can be set in 5 dB steps (with option R&S FSV-B25: 1 dB steps). If the defined reference level cannot be set for the set RF attenuation, the reference level is adjusted accordingly.

In the default state with "Spectrum" mode, the attenuation set on the step attenuator is coupled to the reference level of the instrument. If the attenuation is programmed directly, the coupling to the reference level is switched off.

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

Parameters:

<Value> <numeric_value> in dB; range specified in data sheet

*RST: 10 dB (AUTO is set to ON)

Example:

```
INP:ATT 30dB
```
Sets the attenuation on the attenuator to 30 dB and switches off the coupling to the reference level.

Mode: all

INPut:ATTenuation:AUTO <State>

This command automatically couples the input attenuation to the reference level (state ON) or switches the input attenuation to manual entry (state OFF).

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

Parameters:

<State> ON | OFF

*RST: ON

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

Mode: All

INPut:COUPling <CouplingType>

Toggles the RF input of the analyzer between AC and DC coupling.

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

Parameters:

<CouplingType> AC | DC

*RST: AC

Example: `INP:COUP:DC`

Mode: A, ADEMOD, BTS, CDMA, EVDO, TDS, VSA, WCDMA

INPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital baseband input from the optional Digital Baseband interface (option R&S FSV-B17).

For details see the section "Interface Status Information" for the Digital Baseband Interface (R&S FSV-B17) in the description of the base unit.

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 sampling 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

<Placeholder> for future use; currently "0"

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

Mode: IQ, VSA, EVDO, CDMA, WCDMA, GSM, ADEMOD, TDS

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the fullscale level changes.

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

For details see the Digital Baseband Interface (R&S FSV-B17) description of the base unit.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:DIQ:RANG:COUP OFF`

Mode: IQ, VSA, EVDO, CDMA, WCDMA, GSM, ADEMOD, TDS

INPut:DIQ:RANGe[:UPPer] <Level>

Defines the level that should correspond to an I/Q sample with the magnitude "1".

It can be defined either in dBm or Volt (see "Full Scale Level" on page 125).

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

For details see the Digital Baseband Interface (R&S FSV-B17) description of the base unit.

Parameters:

<Level> <numeric value>

Range: 70.711 nV to 7.071 V
*RST: 1 V

Example: `INP:DIQ:RANG 1V`

Mode: A, IQ, NF, TDS, VSA, CDMA, EVDO, WCDMA, ADEMOD, GSM, OFDM, OFDMA/WiBro, WLAN

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

Defines the unit of the full scale level (see "Level Unit" on page 125). The availability of units depends on the measurement application you are using.

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

For details see the Digital Baseband Interface (R&S FSV-B17) description of the base unit.

Parameters:

<Level> V | dBm | dBpW | W | dBmV | dBuV | dBuA | A

*RST: Volt

Example: `INP:DIQ:RANG:UNIT A`

Mode: IQ, VSA, EVDO, CDMA, WCDMA, GSM, ADEMOD, TDS

INPut:DIQ:SRATe <SampleRate>

This command specifies the sample rate of the digital baseband IQ input signal (see "Input Sample Rate" on page 125).

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

For details see the Digital Baseband Interface (R&S FSV-B17) description of the base unit.

Parameters:

<SampleRate>

Range: 1 Hz to 10 GHz
*RST: 32 MHz

Example: INP:DIQ:SRAT 200 MHz

Mode: A, IQ, NF, TDS, VSA, CDMA, EVDO, WCDMA, ADEMOD, GSM, OFDM, OFDMA/WiBro, WLAN

INPut:EATT <Attenuation>

Requires option R&S FSV-B25.

Switches the electronic attenuator on (if not already active) and allows the attenuation of the electronic attenuator to be set.

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

The attenuation can be varied in 1 dB steps from 0 to 25 dB. Other entries are rounded to the next lower integer value.

If the defined reference level cannot be set for the given RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is output.

Parameters:

<Attenuation> 0...25

*RST: 0 dB (OFF)

Example: `INP1:EATT 10 dB`

Mode: all

INPut:EATT:AUTO <State>

Switches the automatic behaviour of the electronic attenuator on or off. If activated, electronic attenuation is used to reduce the operation of the mechanical attenuation whenever possible.

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

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP1:EATT:AUTO OFF`

Mode: all

INPut:EATT:STATe <State>

Switches the electronic attenuator on or off.

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

Parameters:

<State> ON | OFF

*RST: OFF

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

Mode: all

INPut:GAIN:STATe <State>

This command switches the preamplifier on or off (only for option RF Preamplifier, R&S FSV-B22/B24).

With option R&S FSV-B22, the preamplifier only has an effect below 7 GHz.

With option R&S FSV-B24, the amplifier applies to the entire frequency range.

This command is not available when using Digital Baseband Interface (R&S FSV-B17).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 20 dB preamplification.

Mode: A, ADEMOD, BT, CDMA, EVDO, NF, PHN, WCDMA, GSM, VSA, TDS

INPut:SELect <Source>

This command selects the signal source for measurements.

Parameters:

<Source> RF | DIQ

RF
Radio Frequency ("RF INPUT" connector)

DIQ
Baseband Digital (IQ) (only available with Digital Baseband Interface, option R&S FSV-B17)

*RST: RF

Example: INP:SEL RF

Mode: A, IQ, NF, TDS, VSA, CDMA, EVDO, WCDMA, ADEMOD, GSM, OFDM, OFDMA/WiBro, WLAN

4.4.7 INSTrument Subsystem

INSTrument:SELect <Mode>

This command switches the instrument to VSA mode.

Parameters:

<Mode> **DDEM**
VSA mode

Example: `INST:SEL DDEM`

Mode: VSA

INSTrument:NSELect <Mode>

This command switches the instrument to VSA mode.

Parameters:

<Mode> **2**
VSA mode

Example: `INST:NSEL 2`

Mode: VSA

4.4.8 MMEMory Subsystem

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command stores the selected trace in the specified window in a file with ASCII format. The file format is described in chapter 4.3.4.2, "ASCII File Export Format", on page 181

The decimal separator (decimal point or comma) for floating-point numerals contained in the file is defined with the `FORMat:DEXPort:DSEParator` command (see `FORMat:DEXPort:DSEParator` on page 230).

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

Parameters:

<Trace> 1 to 6

selected measurement trace

<FileName> DOS file name
The file name includes indication of the path and the drive name.
Indication of the path complies with DOS conventions.

Example: `MMEM:STOR:TRAC 3,'TEST.ASC'`
Stores trace 3 in the file TEST.ASC.

Mode: all

MMEMory:SELect:ITEM:VIQData <Mode>

If enabled, the captured I/Q data is included in the save set when instrument data is stored (single sweep mode only).

Parameters:

<Mode> ON | OFF

Mode: VSA

4.4.9 OUTPut Subsystem

OUTPut:DIQ <State>

If enabled, the captured IQ data is output to the Digital Baseband interface in a continuous stream. This function requires the LVDS interface option (R&S FSV-B17).

Digital input and digital output cannot be used simultaneously.

Parameters:

<State>	**ON | OFF** *RST: OFF
Example:	`OUTP:DIQ ON`
Mode:	ADEMOD, IQ, VSA

OUTPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital baseband output to the optional Digital Baseband interface (option R&S FSV-B17).

For details see the Digital Baseband Interface description for the base unit.

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
<NotUsed>	to be ignored
<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

<NotUsed> to be ignored

<Placeholder> for future use; currently "0"

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

Mode: IQ, VSA

4.4.10 SENSe subsystem

[SENSe:]ADJust:CONFigure:LEVel:DURation <Duration>

Defines the duration of the level measurement used to determine the optimal reference level automatically (for `SENS:ADJ:LEV ON`).

Parameters:

<Duration> <numeric value> in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:LEV:DUR:5`

Mode: A, ADEMOD, CDMA, EVDO, TDS, VSA, WCDMA

[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

Defines whether the duration of the level measurement used to determine the optimal reference level (for `SENS:ADJ:LEV`) is determined automatically or if the value defined via `[SENSe:]ADJust:CONFigure:LEVel:DURation` is used.

Parameters:

<Mode> AUTO | MANual

*RST: AUTO

Example: `ADJ:CONF:LEV:DUR:MODE MAN`
Specifies manual definition of the measurement duration.
`ADJ:CONF:LEV:DUR:5`
Specifies the duration manually.

Mode: A, CDMA, EVDO, TDS, VSA, WCDMA

[SENSe<n>]:ADJust:LEVel

This command initiates automatic setting of the RF attenuation to the level of the applied signal.

Note: The following command must be synchronized to the end of the autorange process using *WAI, *OPC oder *OPC?, because otherwise the autorange process will be stopped.

Suffix:

<n> 1..2
irrelevant

Example: `ADJ:LEV`
Adjusts the reference level to the current measurement.

Usage: Event

Mode: VSA

[SENSe<n>]:DDEMod:ECALc:OFFSet <EVMOffsetState>

The command activates and deactivates an offset for the calculation of the EVM for OQPSK modulated signals.

Suffix:

<n> 1..2

Setting parameters:

<EVMOffsetState> ON | OFF

*RST: ON

Mode: VSA

[SENSe<n>]:DDEMod:ECALc[:MODE] <EvmCalc>

This command defines the calculation formula for EVM.

Suffix:

<n> 1..2

Setting parameters:

<EvmCalc> SIGNal | SYMBol | MECPower | MACPower

SIGNal
Calculation normalized to the average power within the measurement range.

SYMBol
Calculation normalized to the maximum power at symbol times.

MACPower
Calculation normalized to maximum constellation power.

MECPower
Calculation normalized to mean constellation power.

*RST: SIGNal

Example: `DDEM:ECAL SIGN`
EVM is normalized to the average power.

Mode: VSA

[SENSe<n>]:DDEMod:EPRate:AUTO <LinkMode>

This command activates and deactivates automatic estimation oversampling for the modulation accuracy table.

Suffix:

<n> irrelevant

Setting parameters:

<LinkMode> ON | OFF

*RST: ON

Mode: VSA

[SENSe<n>]:DDEMod:EPRate[:VALue] <EstimationOverSampling>

This command determines the number of estimation points per symbol for the modulation accuracy table.

Suffix:

<n> irrelevant

Setting parameters:

<EstimationOverSampling>

*RST: 1

Mode: VSA

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

This command restores the factory settings of standards or patterns for the R&S FSV-K70 option.

Suffix:

<n> 1..2

Setting parameters:

<Factory> ALL | STANdard | PATTern

ALL
Restores both standards and patterns.

*RST: ALL

Usage: Setting only

Mode: VSA

[SENSe<n>]:DDEMod:FILTer:ALPHa <MeasFilterAlphaBT>

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

Suffix:

<n> 1..2

Setting parameters:

<MeasFilterAlphaBT>

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

Example: `DDEM:FILT:ALPH 0.5`
Sets ALPHA/BT to 0.5

Mode: VSA

[SENSe<n>]: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 TX filter.

Suffix:

<n> irrelevant

Setting parameters:

<MeasFilterState> ON | OFF

ON

`[SENSe<n>]:DDEMod:MFILter:AUTO` is activated.

OFF

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

*RST: ON

Example: `DDEM:FILT OFF`

The input signal is not filtered.

Mode: VSA

[SENSe<n>]:DDEMod:FORMat <Group>

This command selects the digital demodulation mode.

Suffix:

<n> irrelevant

Setting parameters:

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

QPSK

Quad Phase Shift Key

PSK

Phase Shift Key

MSK

Minimum Shift Key

QAM

Quadrature Amplitude Modulation

*RST: PSK

Example: `SENS:DDEM:FORM QAM`

Selects QAM modulation.

Mode: VSA

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

This command defines the demodulation of the FSK modulation scheme.

Suffix:

<n> irrelevant

Setting parameters:

<FSKNstate> 2 | 4

2
2FSK

4
4FSK

*RST: 2

Mode: VSA

[SENSe<n>]: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.

Suffix:

<n> 1..2

Return values:

<Result> <mapping_1>,<mapping_2>, ... ,<mapping_n>

Example: `DDEM:MAPP:CAT?`
Queries the list of mappings.

Usage: Query only

Mode: VSA

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

This command selects the mapping designated by <mapping_name> for the digital demodulation. The mapping describes the assignment of constellation points to symbols.

Suffix:

<n> 1..2

Setting parameters:

<Mapping> <string>

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

Mode: VSA

[SENSe<n>]:DDEMod:MFILter:ALPHa <MeasFilterAlphaBT>

This command sets the alpha value of the measurement filter.

Suffix:

<n> 1..2

Setting parameters:

<MeasFilterAlphaBT>

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

Example: `SENS:DDEM:MFIL:ALPH 0.8`
Sets alpha to 0.8

Mode: VSA

[SENSe<n>]:DDEMod:MFILter:AUTO <MeasFilterAuto>

If this command is set to "ON", the measurement filter is defined automatically depending on the TX filter.

Suffix:
<n> 1..2

Setting parameters:
<MeasFilterAuto> ON | OFF

*RST: ON

Example: `SENS:DDEM:MFIL:AUTO ON`

Mode: VSA

[SENSe<n>]:DDEMod:MFILter:NAME <Name>

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

For more information on available measurement filters, refer to "Measurement Filter", on page 160

Suffix:
<n> 1..2

Setting parameters:
<Name>

Example: `SENS:DDEM:MFIL:NAME 'RRC'`
Selects the RRC measurement filter.

Mode: VSA

[SENSe<n>]:DDEMod:MFILter[:STATe] <MeasFilterState>

Use this command to switch the measurement filter off. To switch a measurement filter on, use the `[SENSe<n>]:DDEMod:MFILter:NAME` command.

Suffix:
<n> irrelevant

Setting parameters:
<MeasFilterState> ON | OFF

OFF
Switches the measurement filter off.

ON
Switches the measurement filter specified by `[SENSe<n>]:DDEMod:MFILter:NAME` on. However, this command is not necessary, as the `[SENSe<n>]:DDEMod:MFILter:NAME` command automatically switches the selected filter on.

*RST: ON

Example: `SENS:DDEM:MFIL:STAT OFF`
Deactivates the measurement filter.

Mode: VSA

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

This command defines the specific demodulation mode for MSK.

Suffix:
<n> 1..2

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

TYPE1 | NORMal
MSK

TYPE2 | DIFFerential
DMSK

*RST: QPSK

Example: `DDEM:FORM MSK`
Switches MSK demodulation on.
`DDEM:MSK:FORM TYPE2`
Switches DMSK demodulation on.

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize:ADRoop <CompAmptDroop>

This command switches the compensation of the amplitude droop on or off.

Suffix:
<n> 1..2

Setting parameters:
<CompAmptDroop> ON | OFF

*RST: ON

Example: `DDEM:NORM:ADR ON`
Switches the compensation on.

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize:CFDRift <CarrierFreqDrift>

This command activates or deactivates compensation of the carrier frequency drift.

Suffix:
<n> irrelevant

Setting parameters:
<CarrierFreqDrift> ON | OFF

*RST: OFF

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize:FDERror <RefDevCompensation>

This command selects the method for calculating the frequency error if you are using FSK modulation.

Suffix:

<n> 1..2

Setting parameters:

<RefDevCompensation> ON | OFF

ON
Scales the reference signal to the current deviation of the measurement signal

OFF
Uses the nominal deviation you have set for the reference signal

*RST: ON

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize:IQIMbalance <CompIQImbalance>

This command switches the compensation of the IQ imbalance on or off.

Suffix:

<n> 1..2

Setting parameters:

<CompIQImbalance> ON | OFF

*RST: OFF

Example: `DDEM:NORM:IQIM OFF`
Switches the compensation off.

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize:IQOFfset <CompIQOffset>

This command switches the compensation of the IQ offset on or off.

Suffix:

<n> 1..2

Setting parameters:

<CompIQOffset> ON | OFF

*RST: ON

Example: `DDEM:NORM:IQOF OFF`
Switches the compensation off.

Mode: VSA

[SENSe<n>]:DDEMod:NORMalize[:VALue] <Normalize>

This command switches the compensation of the I/Q offset and the compensation of amplitude droop on or off. When queried, the command returns 1 if both are ON and 0 if both are off. Otherwise, an error is returned.

The command is kept because of compatibility to the R&S FSQ and won't be supported in later versions. Instead, use the new command (`[SENSe<n>]:DDEMod:NORMalize:IQOFfset` on page 250)

Suffix:

<n> 1..2

Setting parameters:

<Normalize> ON | OFF

*RST: ON

Example: `SENS:DDEM:NORM ON`
Turn on IQ offset compensation and amplitude droop compensation

Mode: VSA

[SENSe<n>]:DDEMod:PRATe <CaptOverSampling>

This command determines the number of captured points per symbol.

Suffix:

<n> 1..2

Setting parameters:

<CaptOverSampling>

*RST: 4

Example: `DDEM:PRAT 8`
Sets 8 points per symbol.

Mode: VSA

[SENSe<n>]:DDEMod:PRESet:CALC

This command selects the Signal Overview from the predefined tab of the display overview dialog box.

Suffix:

<n> 1..2

Example: `SENS:DDEM:PRES:CALC`
Resets the screen display to the presetting.

Usage: Event

Mode: VSA

[SENSe<n>]:DDEMod:PRESet:RLEVel

This command initiates automatic setting of the RF attenuation and IF gain to the level of the applied signal.

Note: The following command must be synchronized to the end of the autorange process using *WAI, *OPC or *OPC?, because otherwise the autorange process will be stopped.

Suffix:

<n> 1..2
Irrelevant.

Example: `SENS:DDEM:PRES:RLEV;*WAI`
Performs automatic level setting

Usage: Event

Mode: VSA

[SENSe<n>]: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.

Suffix:

<n> 1..2

Setting parameters:

<Standard> 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. For predefined standards, the following short forms can be used:
3G_WCDMA_FWD = 3G_WCDMA
3G_WCDMA_REV = 3G_WCDMA
APCO25_C4FM
APCO25_CQPSK
Bluetooth_DH1
Bluetooth_DH3
Bluetooth_DH5
CDMA2K_1X_FWD = F1CD
CDMA2K_1X_REV = R1CD
DECT_P32_FixedPart = DECT_FP
DECT_P32_PortablePart
DVB_S2_16APSK
DVB_S2_32APSK
DVB_S2_8PSK
DVB_S2_QPSK
EDGE_NB = EDGE_8PSK
EDGE_NormalBurst = EDGE_8PSK
EDGE_16QAM
EDGE_32QAM
F1CD = CDMA2K_1X_FWD
GSM_AB = GSM_AccessBurst
GSM_FB = GSM_FrequencyBurst
GSM = GSM_NormalBurst
GSM_AB = GSM_AccessBurst
GSM_FB = GSM_FrequencyBurst
GSM_NB = GSM_NormalBurst
GSM_SB = GSM_SynchronisationBurst
TETRA_NCDOWN = TETRA_ContinousDownlink
TETRA_NDDOWN = TETRA_DiscontinuousDownlink
ZIGBEE_BPSK_868M_300K
ZIGBEE_BPSK_915M_600K
ZIGBEE_OQPSK_2450M_1M

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.

Mode: VSA

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

Together with DDEMod:PSK:NST, this command defines the demodulation order for PSK (see also [SENSe<n>]:DDEMod:PSK:NSTate on page 254). Depending on the demodulation format and state, the following orders are available:

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

Suffix:

<n> 1..2

Setting parameters:

<Name> NORMal | DIFFerential | N3Pi8 | PI8D8PSK

*RST: QPSK

Example:

```
DDEM:FORM PSK
```

Switches PSK demodulation on.

```
DDEMod:PSK:NST 8
DDEM:PSK:FORM DIFF
```

Switches D8PSK demodulation on.

Mode: VSA

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

Together with DDEMod:PSK:FORMat, this command defines the demodulation order for PSK (see also [SENSe<n>]:DDEMod:PSK:FORMat on page 254). Depending on the demodulation format and state, the following orders are available:

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

Suffix:

<n> 1..2

Setting parameters:

<PSKNstate>

*RST: 2

Example: `DDEM:FORM PSK`
Switches PSK demodulation on.
`DDEMod:PSK:NST 8`
`DDEM:PSK:FORM DIFF`
Switches D8PSK demodulation on.

Mode: VSA

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

This command defines the specific demodulation mode for QAM.

The current firmware release of the R&S FSV-K70 does not support Differential QAM.

Suffix:
<n> 1..2

Setting parameters:
<Name> NORMal | DIFFerential | NPI4 | MNPI4

*RST: QPSK

Example: `DDEM:FORM QAM`
Switches QAM demodulation on.
`DDEM:QAM:FORM NPI4`
Switches Pi/4-16QAM demodulation on.

Mode: VSA

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

This command defines the demodulation order for QAM.

NSTate	Order
16	16QAM
16	Pi/4-16QAM
32	32QAM
32	Pi/4-32QAM
64	64QAM
128	128QAM
256	256QAM

Suffix:
<n> 1..2

Setting parameters:
<QAMNState>

*RST: 16

Example: `DDEM:FORM QAM`
Switches QAM demodulation on.
`DDEM:QAM:NST 64`
Switches 64QAM demodulation on.

Mode: VSA

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

This command defines the demodulation order for QPSK.

FORMat	Order
NORMal	QPSK
DIFFerential	DQPSK
OFFSet	OQPSK
DPI4	PI/4 DQPSK

Suffix:
<n> irrelevant

Setting parameters:
<Name> NORMal | DIFFerential | DPI4 | OFFSet

*RST: NORMal

Example:
`DDEM:FORM QPSK`
Switches QPSK demodulation on.
`DDEM:QPSK:FORM DPI4`
Switches pi/4 DQPSK demodulation on.

Mode: VSA

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

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

Suffix:
<n> 1..2

Setting parameters:
<RecLengthAuto> ON | OFF

*RST: ON

Example:
`DDEM:RLEN:AUTO OFF`
Does not set "RLENgth" automatically.

Mode: VSA

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

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

Suffix:
<n> irrelevant

Setting parameters:

<RecordLength>

Range: 100 to 50000
*RST: 8000
Default unit: SYM

Example: `DDEM:RLEN 1000SYM`
Sets a capture length of 1000 symbols.

Mode: VSA

[SENSe<n>]:DDEMod:SBANd <SidebandPos>

This command selects the sideband for the demodulation.

Suffix:

<n> 1..2

Setting parameters:

<SidebandPos> NORMal | INVerse

NORMal
Normal (non-inverted) position

INVerse
Inverted position

*RST: NORMal

Example: `DDEM:SBAN INV`
Selects the inverted position.

Mode: VSA

[SENSe<n>]: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 (see also "Auto/On/Off" on page 145).

Suffix:

<n> 1..2

Setting parameters:

<AutoBurstSearch> AUTO | MANual

*RST: AUTO

Example: `:DDEM:SEAR:BURS:AUTO AUTO`
Enables auto burst search.

Mode: VSA

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

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

Suffix:

<n> 1..2

Setting parameters:
<AutoConfigure> ON | OFF

*RST: ON

Example: `SENS:DDEM:SEAR:BURS:CONF:AUTO ON`

Mode: VSA

[SENSe<n>]: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 a symbol. The value can also be given in seconds.

Suffix:
<n> 1..2

Setting parameters:
<MinGapLength>

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

Example: `DDEM:SEAR:BURS:GLEN 3US`

Mode: VSA

[SENSe<n>]: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.

Suffix:
<n> 1..2

Setting parameters:
<MaxLength>

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

Example: `DDEM:SEAR:BURS:LENG:MAX 156 us`
The maximum burst length is 156 µs.

Mode: VSA

[SENSe<n>]: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.

Suffix:
<n> 1..2

Setting parameters:
<UsefulLength>

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

Example: `DDEM:SEAR:BURS:LENG 140 us`
The minimum burst length is 140 us.

Mode: VSA

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

This command sets the vector analyzer so that a measurement is performed only if a burst is found ("BURSt"). The command is available only if the burst search is activated beforehand using the `DDEM:SEARch:BURSt:STATe = ON` command (see [SENSe<n>]:DDEMod:SEARch:BURSt:STATe on page 260).

Suffix:
<n> 1..2

Setting parameters:
<MeasOnlyOnBurst> MEAS | BURS

*RST: MEAS

Example: `DDEM:SEAR:BURS:MODE BURS`
Measurement is performed only if burst is found.

Mode: VSA

[SENSe<n>]: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.

Suffix:
<n> 1..2

Setting parameters:
<RunOut>

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

Example: `DDEM:SEAR:BURS:SKIP:FALL 5US`
5 µs of the rising burst edge are not considered

Mode: VSA

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

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

Suffix:
<n> 1..2

Setting parameters:
<RunIn>

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

Example: `DDEM:SEAR:BURS:SKIP:RIS 5US`
5 us of the rising burst edge are not considered

Mode: VSA

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

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

Suffix:
<n> 1..2

Setting parameters:
<SearchState> ON | OFF

*RST: OFF

Example: `DDEM:SEAR:BURS OFF`
Switches burst search off.

Mode: VSA

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

This command controls burst search tolerance.

Suffix:
<n> 1..2

Setting parameters:
<SearchTolerance>

Range: 0 to 100000
*RST: 4
Default unit: SYM

Example: `:DDEM:SEAR:BURS:TOL 1`
Sets the burst tolerance to 1

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:MBURst:CALC <SelectResRangeNr>

Sets the result range to be displayed after a single sweep.

Suffix:
<n> 1..2

Setting parameters:
<SelectResRangeNr>

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

Mode: VSA

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

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

Suffix:

<n> 1..2

Setting parameters:

<AutoConfigure> ON | OFF

*RST: ON

Example: `SENS:DDEM:SEAR:PATT:CONF:AUTO ON`

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:PATTern:SYNC[:STATe] <FastSync>

Switches fast synchronization on and off, if you manually synchronize with a waveform pattern.

Suffix:

<n> 1..2

Setting parameters:

<FastSync> ON | OFF

*RST: OFF

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:PATTern:SYNC:AUTO <UseWfmForSync>

This command selects manual or automatic synchronization with a pattern waveform to speed up measurements.

Suffix:

<n> 1..2

Setting parameters:

<UseWfmForSync> AUTO | MANual

*RST: AUTO

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:AUTO <AutoPatternSearch>

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

Suffix:

<n> 1..2

Setting parameters:

<AutoPatternSearch> AUTO | MANual

*RST: AUTO

Example: `:DDEM:SEAR:SYNC AUTO`

Enables auto pattern search

Mode: VSA

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

This command reads the names of all patterns stored on the hard disk.

Suffix:

<n> 1..2

Return values:

<Result> <pattern_1>,<pattern_2>, ... ,<pattern_n>; pattern names do not include file extension

Setting parameters:

<Patterns> CURRent | ALL

CURRent
Only patterns that belong to the current standard

ALL
All patterns

*RST: ALL

Example:

`:DDEM:PRES 'GSM_AB'`
Selects the digital standard "GSM Access Burst".

`:DDEM:SEAR:SYNC:PATT:ADD 'GSM_TSC1'`
Adds "GSM_TSC1" to standard.

`:DDEM:SEAR:SYNC:CAT? CURR`
Reads out all patterns that belong to the standard.

Mode: VSA

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

This command defines a comment to a sync pattern. The pattern must have been selected before using the `DDEM:SEARch:SYNC:NAME` command (see [SENSe<n>]:DDEMod:SEARch:SYNC:NAME on page 264).

Suffix:

<n> 1..2

Setting parameters:

<Comment>

Example:

`:DDEM:SEAR:SYNC:NAME 'GSM_TSC0'`
Name of pattern.

`:DDEM:SEAR:SYNC:DATA '0001000000000001'`
Data of pattern.

`:DDEM:SEAR:SYNC:COMM 'PATTERN FOR PPSK'`
Comment.

Mode: VSA

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

This command copies a pattern file. The pattern to be copied must have been selected before using the `DDEM:SEARch:SYNC:NAME` command (see `[SENSe<n>]:DDEMod:SEARch:SYNC:NAME` on page 264).

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

Suffix:

<n> 1..2

Setting parameters:

<Pattern>

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

Mode: VSA

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

This command defines the sync sequence of a sync pattern. The pattern must have been selected before using the `DDEM:SEARch:SYNC:NAME` command (see `[SENSe<n>]:DDEMod:SEARch:SYNC:NAME` on page 264).

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<n>]:DDEMod:SEARch:SYNC:NSTate` on page 265).

For details on defining patterns, see "To create a new pattern" on page 177.

Suffix:

<n> irrelevant

Setting parameters:

<Data> 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.

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:DELete

This command deletes a sync sequence. The sync sequence to be deleted must have been selected before using the `DDEM:SEARch:SYNC:NAME` command (see `[SENSe<n>]:DDEMod:SEARch:SYNC:NAME` on page 264).

Suffix:

<n> 1..2

Example: `:DDEM:SEAR:SYNC:NAME 'GSM_TSC0'`
Selects the pattern.
`:DDEM:SEAR:SYNC:DEL`
Deletes GSM_TSC0 pattern.

Usage: Event

Mode: VSA

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

This command sets the IQ correlation threshold for pattern matching in percent. A high level means stricter matching. See "I/Q Correlation Threshold" on page 148 for details.

Suffix:
<n> 1..2

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

Example: `SENS:DDEM:SEAR:SYNC:IQCT 85.5`

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:MODE <MeasOnlyOnPattern>

This command sets the vector analyzer so that the measurement is performed only if the measurement was synchronous to the selected sync pattern (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. The command is available only if the sync sequence search is activated using the `DDEM:SEARch:BURSt:STATe = ON` command (see `[SENSe<n>]:DDEMod:SEARch:BURSt:STATe` on page 260). With "MEAS" selected, the measurement is performed independently of successful synchronization.

Suffix:
<n> 1..2

Setting parameters:
<MeasOnlyOnPattern> MEAS | SYNC
*RST: MEAS

Example: `:DDEM:SEAR:SYNC:MODE SYNC`
The measurement is performed only with successful synchronization.

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:NAME <Name>

This command selects a sync pattern for editing or for a new entry.

Suffix:
<n> 1..2

Setting parameters:
<Name>

Example: `:DDEM:SEAR:SYNC:NAME 'GSM_TSC0'`
Selects the pattern GSM_TSC0.

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:NSTate <NState>

This command selects the degree of modulation (number of permitted states). The pattern must have been selected before using the `DDEM:SEARch:SYNC:NAME` command (see `[SENSe<n>]:DDEMod:SEARch:SYNC:NAME` on page 264).

The number of permitted states depends on the modulation mode.

Suffix:
<n> 1..2

Setting parameters:
<NState>

Example: `:DDEM:SEAR:SYNC:NAME 'GSM_TSC0'`
Selects the GSM_TSC0 pattern.
`:DDEM:SEAR:SYNC:DATA '00010001'`
Enters 00010001 as data.
`:DDEM:SEAR:SYNC:NST 4`
Sets the degree of modulation.

Mode: VSA

[SENSe<n>]: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<n>]:DDEMod:SEARch:SYNC:SELect` on page 266).

Suffix:
<n> 1..2

Setting parameters:
<AddPattern>

Example: `DDEM:PRES 'TETRA_NCDOWN'`
Selects the standard "TETRA_NCDOWN".
`DDEM:SEAR:SYNC:PATT:ADD 'TETRA_S1'`
Adds the pattern "TETRA_S1" to the standard.

Usage: Setting only

Mode: VSA

[SENSe<n>]:DDEMod:SEARch:SYNC:PATTern:REMove <NoPattern>

This command deletes one or all patterns from the current standard.

Suffix:
<n> 1..2

Setting parameters:

<NoPattern> <Pattern> | ALL

<Pattern>
Deletes one pattern. <Pattern> is the name of the pattern you want to delete.

ALL
Deletes all patterns.

Example: `DDEM:PRES 'TETRA_NCDOWN'`
Selects the digital standard "Tetra".
`DDEM:SEAR:SYNC:PATT:REM 'pattern'`
Removes the pattern "pattern" from the "Tetra" standard.

Usage: Setting only

Mode: VSA

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

This command selects a predefined sync pattern file.

Suffix:

<n> 1..2

Setting parameters:

<Select>

Example: `DDEM:SEAR:SYNC:SEL 'GSM_TSC0'`

Mode: VSA

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

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

Suffix:

<n> irrelevant

Setting parameters:

<PatternSearch> ON | OFF

*RST: OFF

Example: `DDEM:SEAR:SYNC ON`
Switches the sync search on.

Mode: VSA

[SENSe<n>]: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<n>]:DDEMod:SEARch:SYNC:COMMent` on page 262).

Suffix:

<n> 1..2

Setting parameters:
<Text>

Example: `SENS:DDEM:SEAR:SYNC:NAME 'GSM_1'`
Selects the "GSM_1" pattern.
`:DDEM:SEAR:SYNC:DATA '1001'`
Enter pattern "1001".
`:DDEM:SEAR:SYNC:TEXT 'TEST S25'`
Enter text for the "GSM_1" pattern.

Mode: VSA

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

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

Suffix:
<n> irrelevant

Setting parameters:
<PatternedSignal> ON | OFF

*RST: OFF

Mode: VSA

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

This command specifies whether the signal is bursted or continuous.

Suffix:
<n> irrelevant

Setting parameters:
<SignalType> CONTinuous | BURSted

*RST: CONTinuous

Mode: VSA

[SENSe<n>]:DDEMod:SRATe <SymbolRate>

This command defines the symbol rate.

The maximum usable I/Q bandwidth for the analyzer 40 model 1307.9002K39 is 10 MHz. Thus, the maximum symbol rate is:

- For capture oversampling =4: symbol rate ≤ 3.125 MHz
- For capture oversampling =8: symbol rate ≤ 1.5625 MHz
- For capture oversampling =16: symbol rate ≤ 0.78125 MHz

Suffix:
<n> irrelevant

Setting parameters:

<SymbolRate>

Range: At the RF input it is from 100.0 to 32e6 Hz, else it is 100.0 to 128e6 Hz.

*RST: 3.84e6

Default unit: Hz

Mode: VSA

[SENSe<n>]: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.

Suffix:

<n> irrelevant

Setting parameters:

<Comment>

Mode: VSA

[SENSe<n>]: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.

Suffix:

<n> 1..2

Setting parameters:

<FileName> File name including the path for the digital standard file

Example: `SENS:DDEM:STAN:DEL 'C:\path\standardname'`

Usage: Setting only

Mode: VSA

[SENSe<n>]:DDEMod:STANdard:PREset[:VALue]

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

Suffix:

<n> 1..2

Usage: Event

Mode: VSA

[SENSe<n>]: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.

Suffix:

<n> 1..2

Setting parameters:

<FileName> 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

Mode: VSA

[SENSe<n>]:DDEMod:STANdard:SYNC:OFFSet:STATe <PatternOffsState>

This command (de)activates the pattern offset.

Suffix:

<n> 1..2

Setting parameters:

<PatternOffsState> ON | OFF

*RST: OFF

Mode: VSA

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

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

Suffix:

<n> 1..2

Setting parameters:

<PatternOffset>

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

Mode: VSA

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

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

Suffix:

<n> 1..2

Setting parameters:

<Alpha>

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

Mode: VSA

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

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

For more information on available TX filters, refer to "TX Filter Type" on page 134

Suffix:
<n> 1..2

Setting parameters:
<Name>

Example: `SENS:DDEM:TFIL:NAME 'RRC'`
Selects the RRC filter.

Mode: VSA

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

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

Suffix:
<n> irrelevant

Setting parameters:
<TXFilterState> ON | OFF

OFF
Switches the TX filter off.

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

*RST: ON

Example: `SENS:DDEM:TFIL:STAT OFF`

Mode: VSA

[SENSe<n>]:DDEMod:TIME <ResultLength>

The command determines the number of displayed symbols (result length).

Suffix:
<n> 1..2

Setting parameters:
<ResultLength>

Range: 10 to 10000
*RST: 800
Default unit: SYM

Example: `DDEM:TIME 80`
Sets result length to 80 symbols.

Mode: VSA

[SENSe<n>]:DDEMod:UQAM:FORMat <Name>

This command selects the type of UserQAM demodulation.

Suffix:

<n> 1..2

Setting parameters:

<Name> Name of the UserQAM demodulation

Example:
`DDEM:FORM UQAM`
Selects user QAM demodulation.
`DDEM:UQAM:FORM '32ary'`
Selects 32ary user QAM name.
`DDEM:MAPP 'DVB_S2_32APSK_34'`
Selects the mapping DVB_S2_32APSK_34.

Mode: VSA

[SENSe<n>]:DDEMod:UQAM:NSTate?

This command returns the order of the active UserQAM.

Suffix:

<n> irrelevant

Usage: Query only

Mode: VSA

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency of the analyzer or the measuring frequency for span = 0.

Parameters:

<Frequency> <numeric_value>

Range: 0 to fmax
*RST: fmax/2
Default unit: Hz
f_{max} is specified in the data sheet. min span is 10 Hz

Example: `FREQ:CENT 100 MHz`

Mode: all

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

This command defines the step size of the center frequency.

Parameters:

<StepSize> <numeric_value>

Range: 1 to 1000000000
*RST: - (AUTO 0.1 × SPAN is switched on)
Default unit: Hz

Example: `FREQ:CENT:STEP 120 MHz`

Mode: all

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

This command links the step width to the current standard (ON) or sets the step width entered using the `FREQ:CENT:STEP` command (OFF) (see `[SENSe:]FREQuency:CENTer:STEP[:VALue]` on page 271).

Parameters:

<State> ON | OFF

*RST: ON

Example: `FREQ:CENT:STEP:AUTO ON`
Activates the coupling of the step size to the span.

Mode: all

[SENSe:]FREQuency:OFFSet <Offset>

This command defines the frequency offset of the instrument.

Parameters:

<Offset> <numeric_value>

Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Mode: all

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

This command sets the statistics count. Entering 0 as a parameter activates "Auto" mode. Entering a number greater than 0 activates "Manual" mode and sets the statistics count to the corresponding number.

For more information see

- "Statistics Count" on page 110

Suffix:

<n> irrelevant

Setting parameters:
<SweepCount>
Range: 0 to 32767
*RST: 0
Default unit: NONE

Example:
`INIT:CONT ON`
Activates continuous sweep mode.
`SWE 0`
Records the I/Q data continuously and uses a sliding window length for averaging of 10.
`INIT:CONT OFF`
Activates single sweep mode
`SWE 5`
Records I/Q data until 5 evaluations have finished.

Usage: SCPI conform

Mode: VSA

[SENSe<n>]:SWEep:COUNt:CURRent? <Mode>

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.

Suffix:
<n> 1..2

Query parameters:
<Mode> CAPTure | STATistics

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

CAPTure
Returns the number of used capture buffers evaluated.

*RST: STATistics

Mode: VSA

4.4.11 SYSTem Subsystem

SYSTem:DISPlay:UPDate <State>

In remote control mode, this command switches on or off the instrument display. If switched on, only the diagrams, traces and display fields are displayed and updated.

The best performance is obtained if the display output is switched off during remote control.

Parameters:
<State> ON | OFF

*RST: OFF

Example: `SYST:DISP:UPD ON`

Mode: all

4.4.12 TRACe subsystem

TRACe<screen>[:DATA]? <Trace>

This command queries the trace data.

The data the analyzer returns for each result display is as follows:

- 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 oversampling rate. For example, a capture buffer of 500 in combination with an oversampling 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 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 with `DISPlay[:WINDow<window>]:TRACe<trace>:X[:SCALe]:STARt` on page 225.
  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 is the product of evaluation range length and points per symbol for the Vector I/Q result display and the evaluation range length for the Constellation I/Q result display.
  The Constellation Frequency and Vector Frequency result display return 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 points per symbol.
- Result Summary
  For the Result Summary, the command returns all values listed in the result table from top to bottom. 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 53 values, FSK modulation returns 42 values. The unit of each value depends on the particular result.

Suffix:

<screen> 1..4
screen number

Query 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.

Example: `TRAC? TRACE1`
Queries data from trace 1.

Usage: Query only

Mode: VSA

4.4.13 TRIGger subsystem

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

This command sets the level of the baseband power trigger source (for digital input via the Digital Baseband Interface, R&S FSV-B17).

Suffix:

<n> irrelevant

Parameters:

<Level>

	Range:	-50 dBm to +20 dBm
	*RST:	-20 DBM

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

Mode: All

TRIGger<n>[:SEQuence]:BBPower:HOLDoff <Value>

This command sets the holding time before the next BB power trigger event (for digital input via the Digital Baseband Interface, R&S FSV-B17).

Suffix:

<n> irrelevant

Parameters:

<Value> <numeric_value> in s: 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.

Mode: all

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

This command sets the level of the IF power trigger source.

Suffix:

<n> irrelevant

Parameters:

<TriggerLevel> -50 to +20 DBM

*RST: -20 DBM

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

Mode: All

TRIGger<n>[:SEQuence]:IFPower:HOLDoff <Value>

This command sets the holding time before the next IF power trigger event.

Suffix:

<n> irrelevant

Parameters:

<Value> <numeric_value> in s: 150 ns to 1000 s

*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.

Mode: A-F, ADEMOD, CDMA, EVDO, GSM, VSA, OFDM, OFDMA/WiBro, TDS, WCDMA

TRIGger<n>[:SEQuence]:IFPower:HYSTeresis <Value>

This command sets the limit that the hysteresis value for the IF power trigger has to fall below in order to trigger the next measurement.

Suffix:

<n> irrelevant

Parameters:

<Value> <numeric_value> in dB: 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.

Mode: ALL

TRIGger<n>[:SEQuence]:HOLDoff[:TIME] <Delay>

This command defines the length of the trigger delay.

A negative delay time (pretrigger) can be set in zero span only.

Suffix:

<n> irrelevant

Parameters:

<Delay>

Range: zero span: -sweeptime (see data sheet) to 30 s; span: 0 to 30 s

*RST: 0 s

Example: `TRIG:HOLD 500us`

Mode: All

TRIGger<screen>[:SEQuence]:LEVel:BBPower <LevelBBPower>

This command sets the level of the BB power trigger source (for Digital Baseband Interface (R&S FSV-B17) only).

Suffix:

<screen> 1..4

Setting parameters:

<LevelBBPower>

Range: -50 to 20
*RST: -20
Default unit: DBM

Example: `TRIG:LEV:BBP -17DBM`

Mode: VSA

TRIGger<screen>[:SEQuence]:LEVel[:EXTernal] <LevelExternal>

This command sets the level of the external trigger source.

Suffix:

<screen> 1..4

Setting parameters:

<LevelExternal>

Range: 0.5 to 3.5
*RST: 1.4
Default unit: V

Example: `TRIG:LEV 2V`

Mode: VSA

TRIGger<screen>[:SEQuence]:LEVel:IFPower <LevelIFPower>

This command sets the level of the IF power trigger source.

Suffix:

<screen> 1..4

Setting parameters:

<LevelIFPower>

Range: -50 to 20
*RST: -20
Default unit: DBM

Example: `TRIG:LEV:IFP -17dBm`

Mode: VSA

TRIGger<n>[:SEQuence]:SLOPe <Type>

This command selects the slope of the trigger signal. The selected trigger slope applies to all trigger signal sources.

Suffix:

<n> irrelevant

Parameters:

<Type> POSitive | NEGative

*RST: POSitive

Example: `TRIG:SLOP NEG`

Mode: all

TRIGger<n>[:SEQuence]:SOURce <Source>

This command selects the trigger source for the start of a sweep.

Suffix:

<n> irrelevant

Parameters:

<Source>

IMMediate
Free Run

EXTern
External trigger

IFPower
Second intermediate frequency

VIDeo
Video mode is only available in the time domain and only in Spectrum mode.

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

*RST: IMMediate

Example:
```
TRIG:SOUR EXT
```
Selects the external trigger input as source of the trigger signal

Mode: ALL

4.5 Support

4.5.1 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**

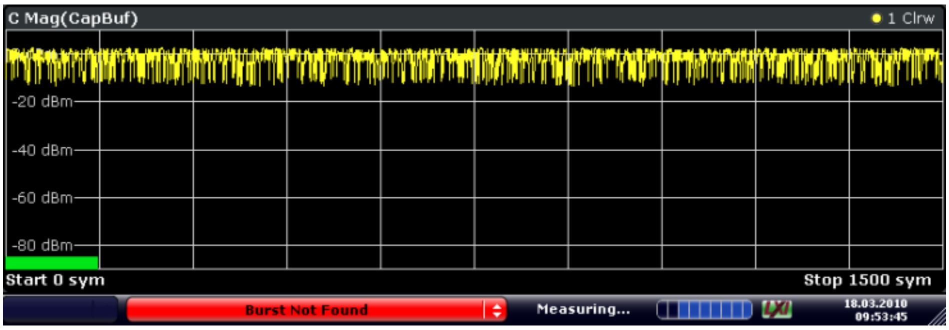


Fig. 4-86: Example for active burst search with continuous signal

Solution: Select "Continuous Signal" as the signal type.
For more information, see
– "Signal Description", on page 135.

- **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.

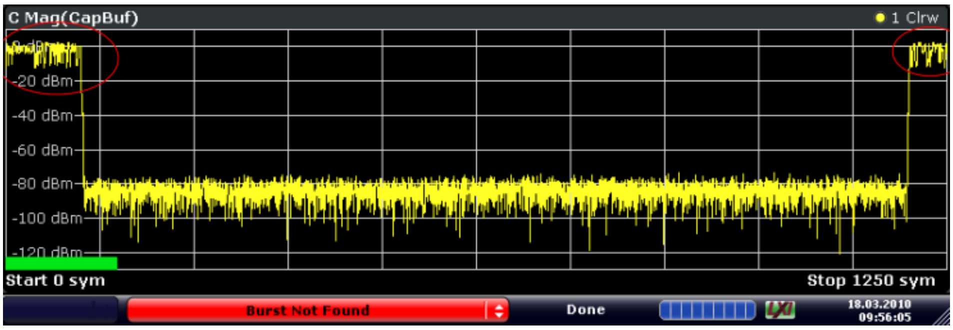


Fig. 4-87: Example for incomplete burst capture

Solution: Change the trigger settings and/or enlarge the capture length.
For more information, see
– "I/Q Capture", on page 140

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

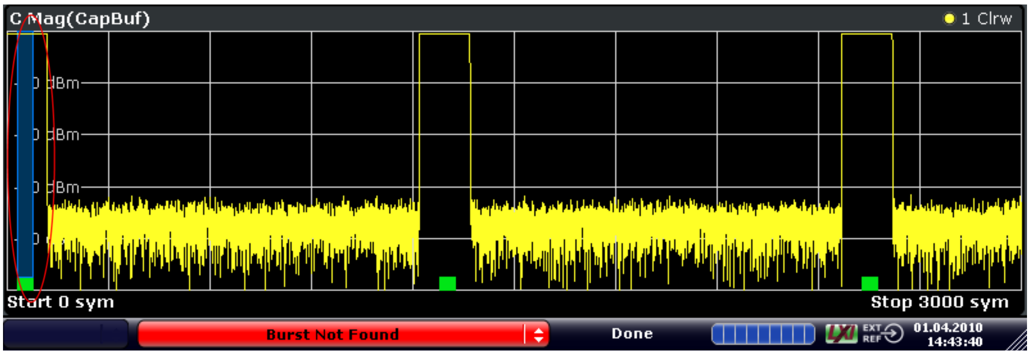


Fig. 4-88: Example for measurement on incomplete burst capture

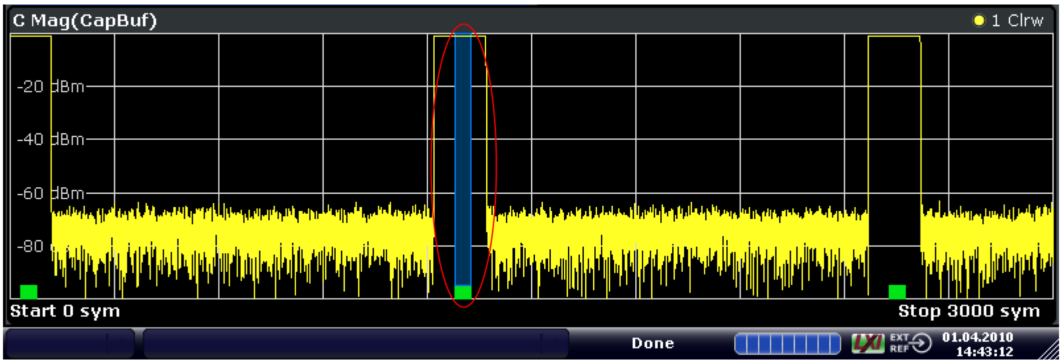


Fig. 4-89: Example for measurement on complete burst capture

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.

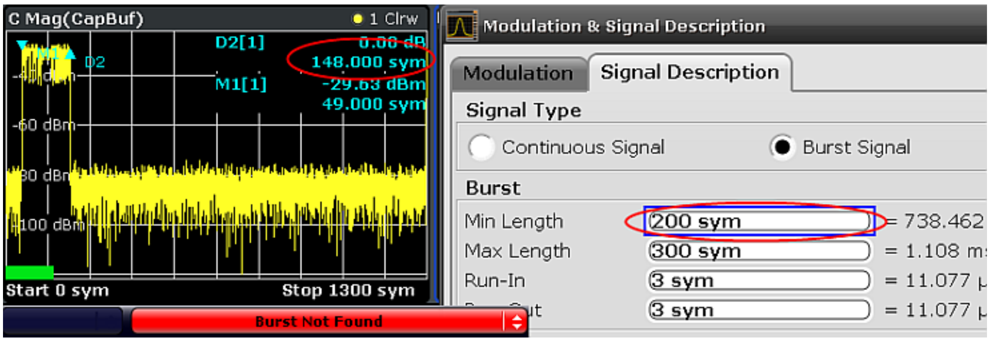


Fig. 4-90: Example for a failed burst search due too a burst that is too short

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 (see "Search Tolerance" on page 146). 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:

– "Signal Description", on page 135
– chapter 4.3.2.9, "Softkeys of the Marker Menu (R&S FSV-K70)", on page 119
– "Burst Search", on page 144

- **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.

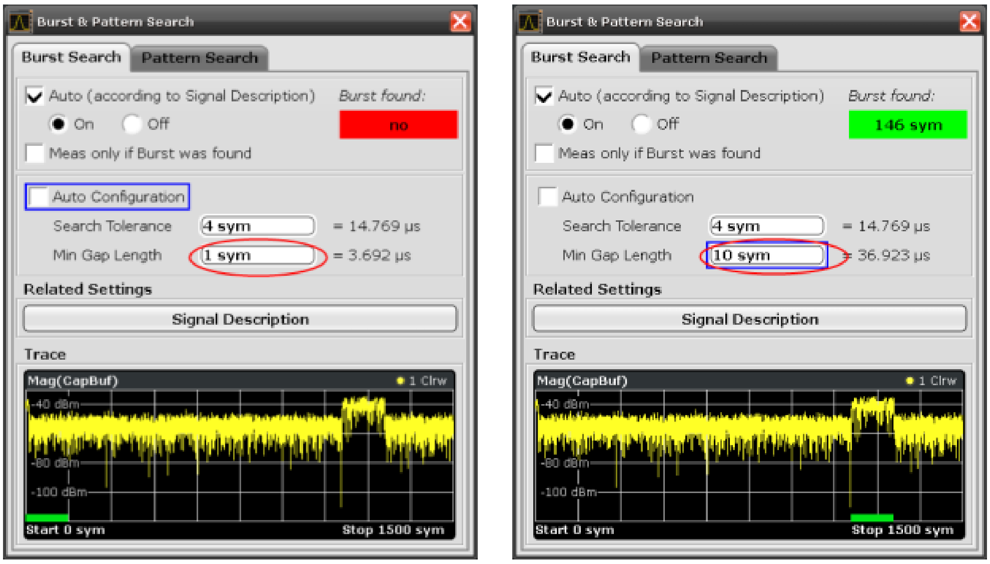


Fig. 4-91: Example for adjusting the minimum gap length

For more information, see
"Burst Search", on page 144

- **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 283
  – Switch the pattern search off.

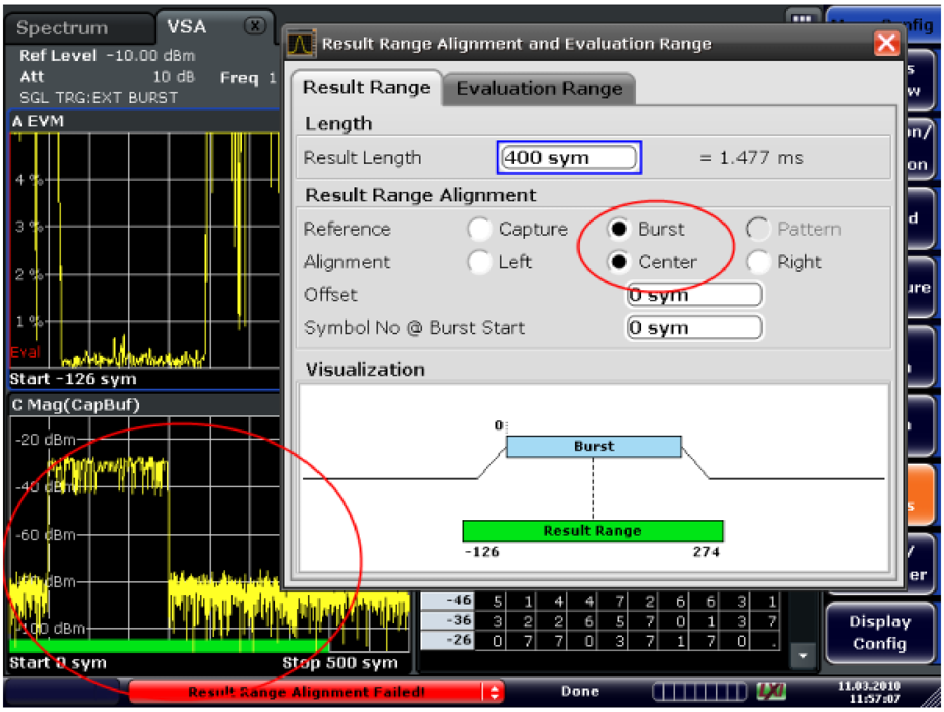


Fig. 4-92: Burst not found due to false alignment settings

– 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 was successful (see "Message: 'Burst Not Found'" on page 279).
  – Deactivate the burst search but keep the pattern search active.

  For more information, see
  – "Message: 'Burst Not Found'" on page 279
  "Burst Search", on page 144
- **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.

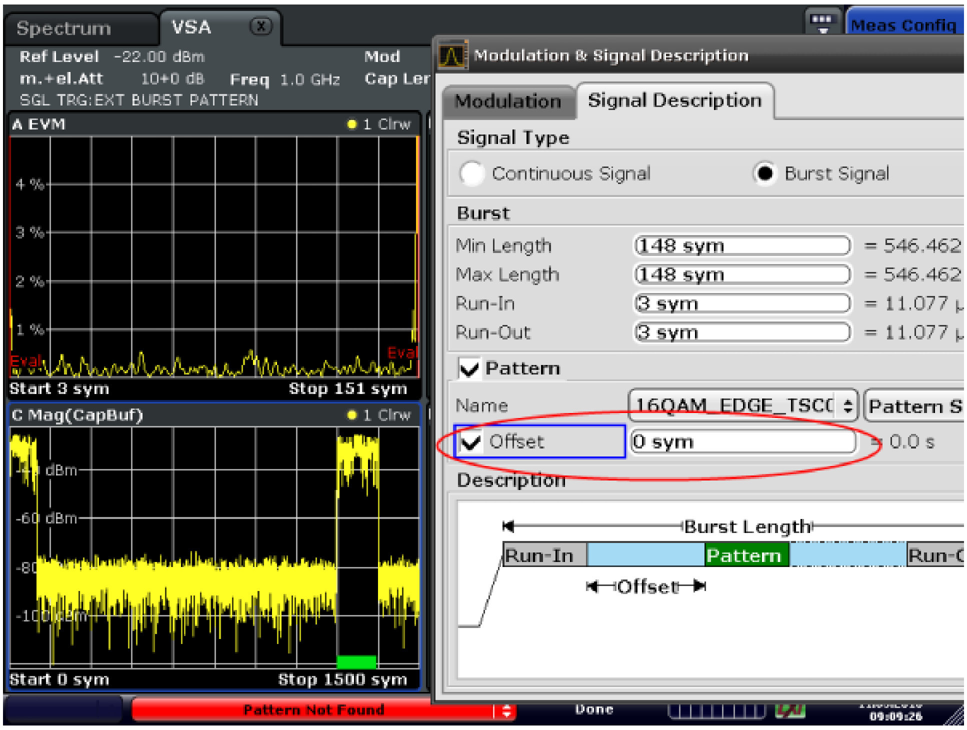


Fig. 4-93: GSM EDGE burst; Pattern is actually located in the middle of the burst. The correct value for "Offset" here would be 58.

Solution: Try one of the following:

– Remove the offset ('unknown').
– Enter the correct offset (within about 4 symbols of tolerance).

For more information, see

– "Signal Description", on page 135

- The specified pattern does not coincide with the pattern in your signal:
  In the R&S FSQ-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 FSV-K70.
  Solution:
  Make sure that the correct pattern is specified in the "Signal Description" dialog.
  For more information, see
  – "Signal Description", on page 135

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.

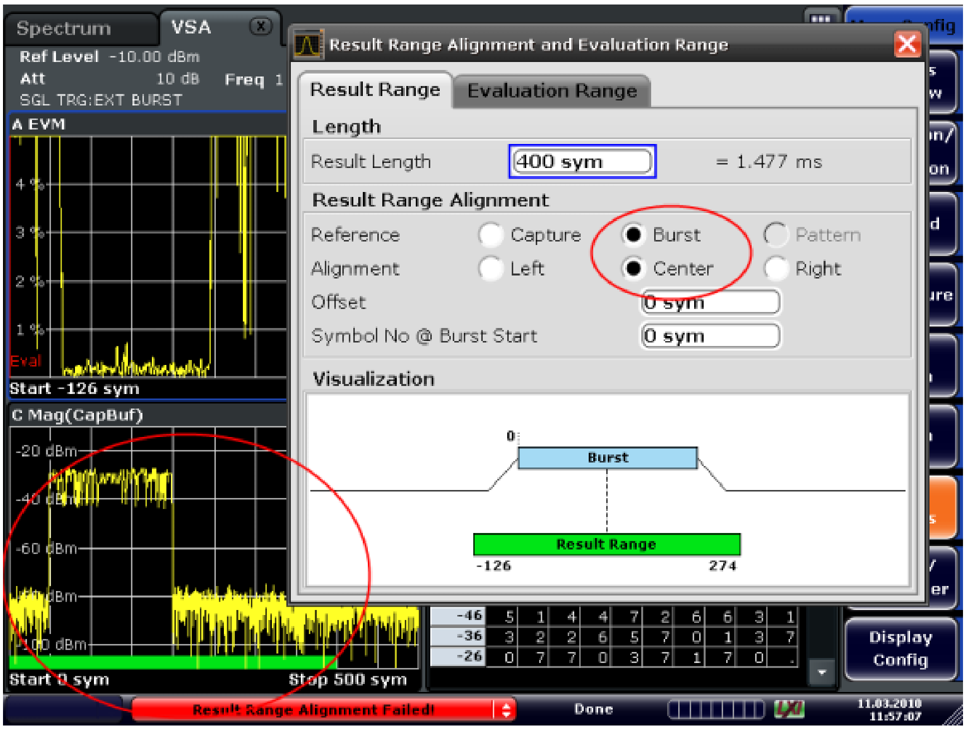


Fig. 4-94: Example for failed alignment

In this screenshot, 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:

- "I/Q Capture", on page 140

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

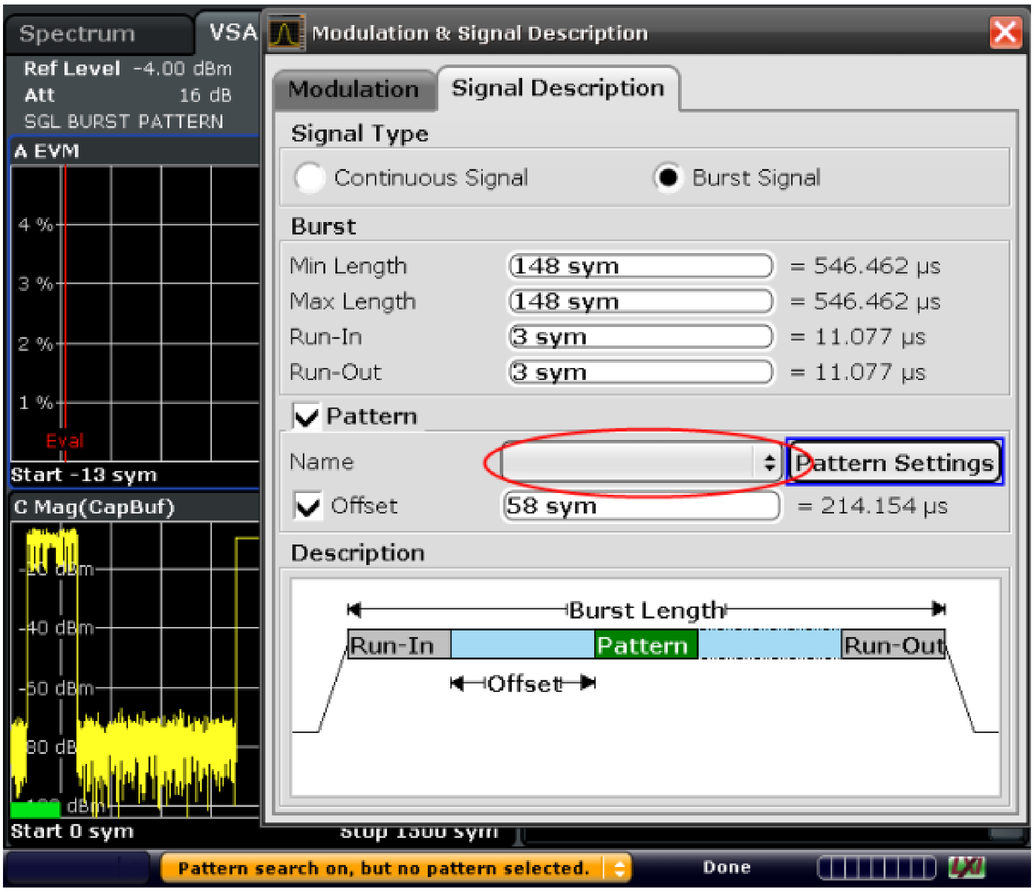


Fig. 4-95: The red circle shows the place where you can specify a pattern

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

For more information, see

- "Signal Description", on page 135
  chapter 4.3.3.5, "Working with Pattern Searches", on page 174

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

- "Result Range", on page 152
- chapter 4.3.3.2, "Defining the Result Range", on page 168

Message: 'Short pattern: Pattern search might fail'
The analyzer 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 was found".
  – Increase the "I/Q Correlation Threshold" (see "I/Q Correlation Threshold" on page 148).
- False negative
  The I/Q pattern search misses a position where transmitted symbols match the pattern symbols.
  Solution:
  – Increase the "I/Q Correlation Threshold" (see "I/Q Correlation Threshold" on page 148).

  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 was found" 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 R&S FSV-K70 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 "Estimation", on page 51)
- Fine Synchronization:
  Estimation range shorter than 10 symbols (see "Estimation", on page 51)

Solution:

- If the signal contains a pattern, set "Use Pattern for Sync" to "On" (see "Use Pattern For Sync" on page 158).
  Example: measurement of a GSM EDGE pattern that has a length of 26 symbols.

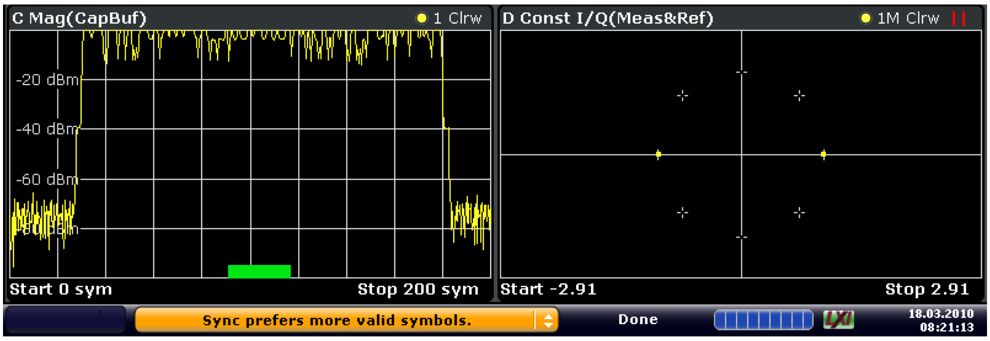


Fig. 4-96: User Pattern for Sync = Off

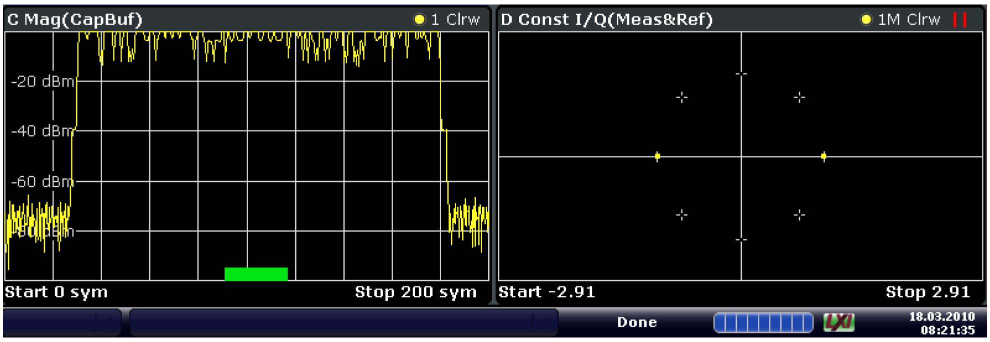


Fig. 4-97: User Pattern for Sync = On

- 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 4.1.5, "Demodulation Overview", on page 41

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, data-aided 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:

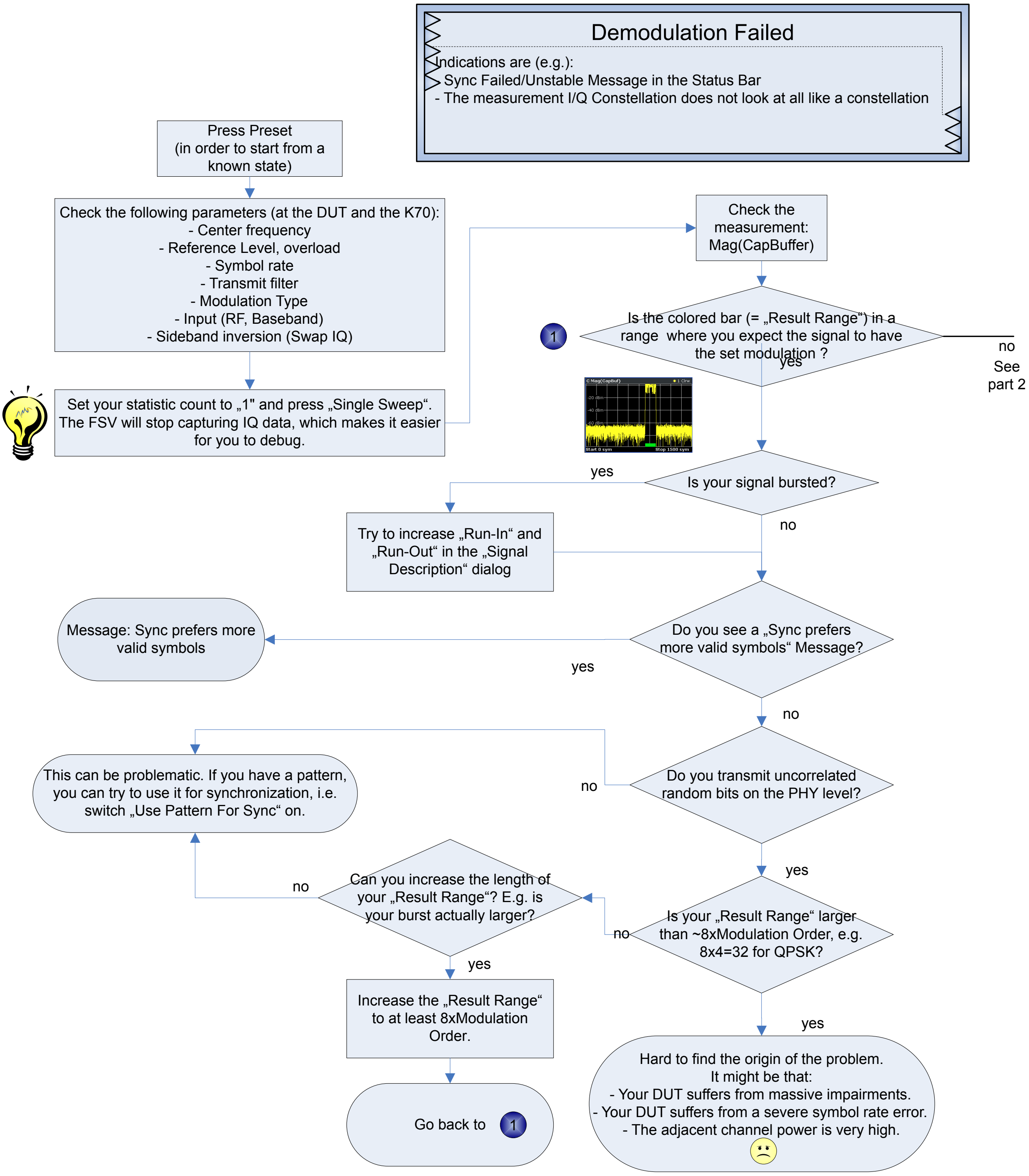
- Switch to the non-data-aided mode by setting the parameter "Use Pattern for Sync" to "Off" (see "Use Pattern For Sync" on page 158
- If possible, use a longer pattern.

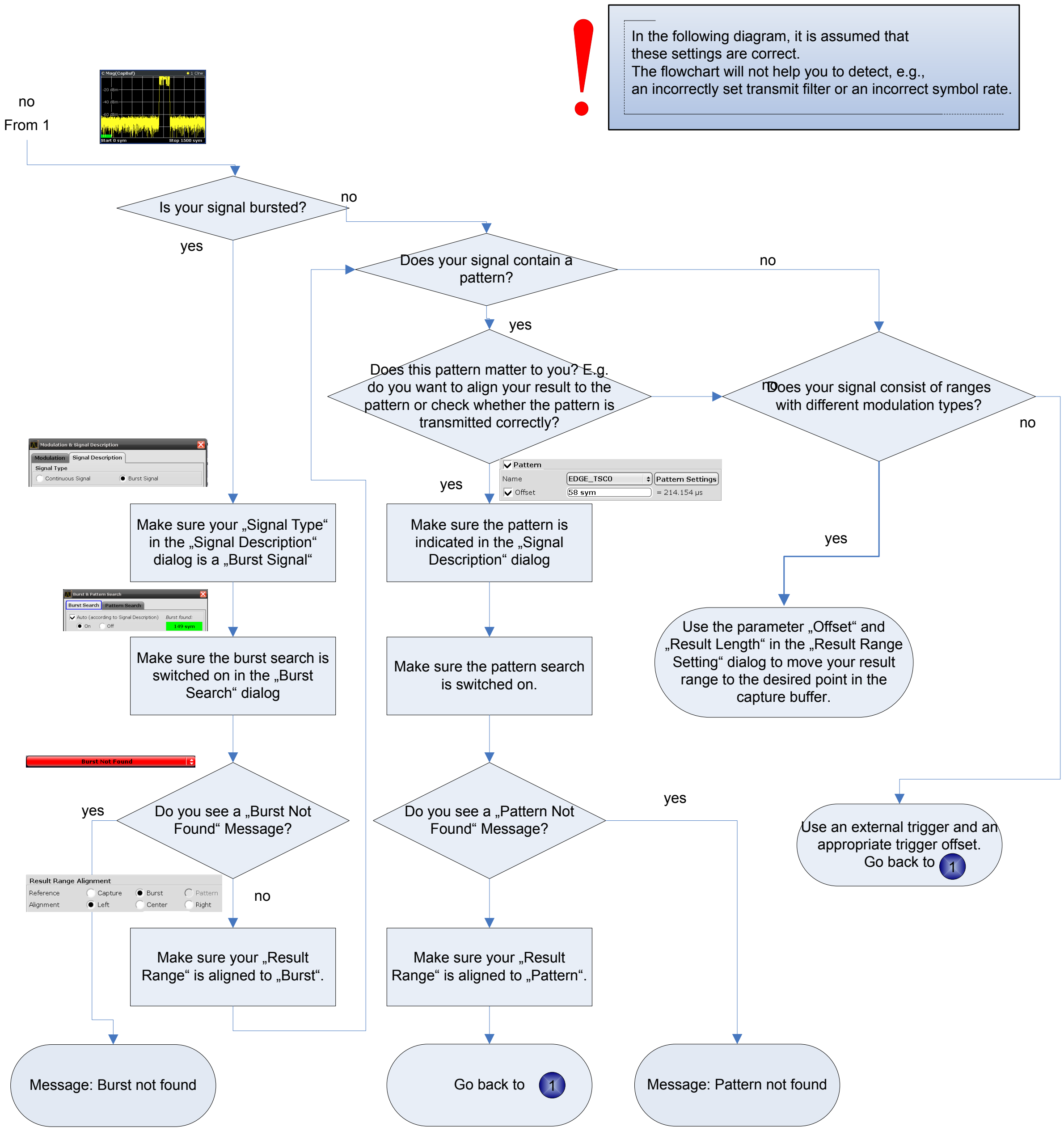
For more information, see

- chapter 4.1.5, "Demodulation Overview", on page 41

4.5.2 Troubleshooting

Troubleshooting Overview





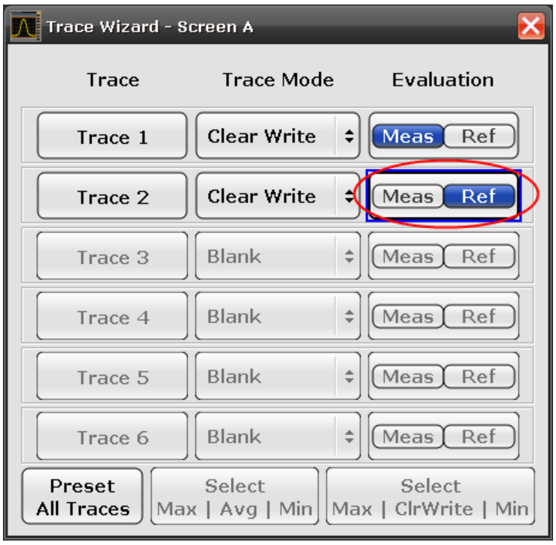
Problems and possible solutions

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

- 1. Press the key to select the measurement screen.
- 2. Press the AUTO key.
- 3. Press the "Y-Axis Auto Range" softkey.

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

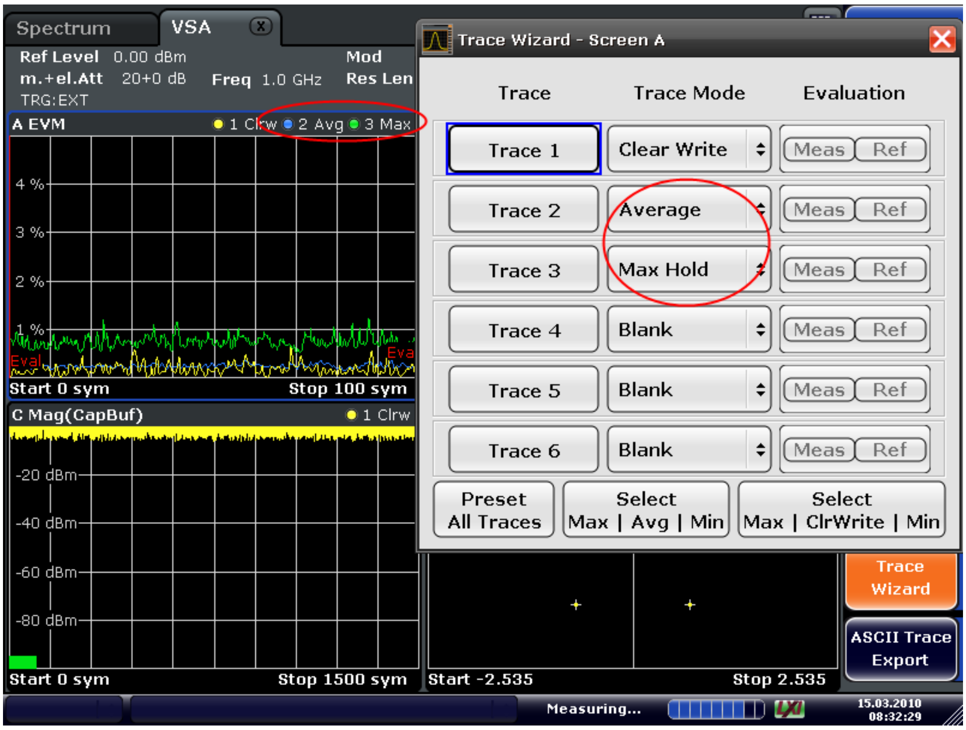
- 1. Press the key to select the measurement screen.
- 2. Press the TRACE key.
- 3. Press the "Trace Wizard" softkey.
- 4. Select a second trace, choose "Clear Write" as "Trace Mode" and toggle to "Ref" in the "Evaluation" column.



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

- 1. Press the key to select the measurement screen.
- 2. Press the TRACE key.
- 3. Press the "Trace Wizard" softkey.

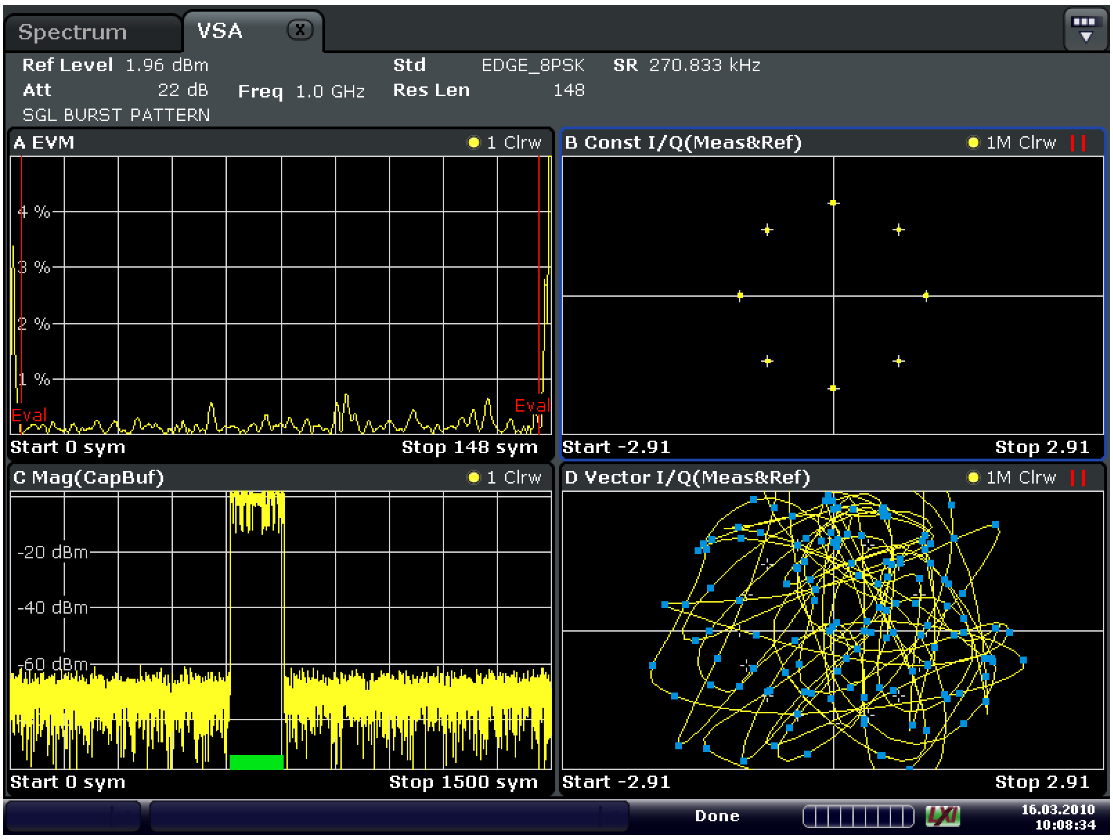
- 4. Select a second trace and choose the preferred "Trace Mode", e.g. "Max Hold" or "Average".



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

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

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



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

Solution:

- The I/Q Vector diagram shows the measurement signal after the measurement filter and synchronization.
- The I/Q Constellation 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 screens show measurements that are significantly different.

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

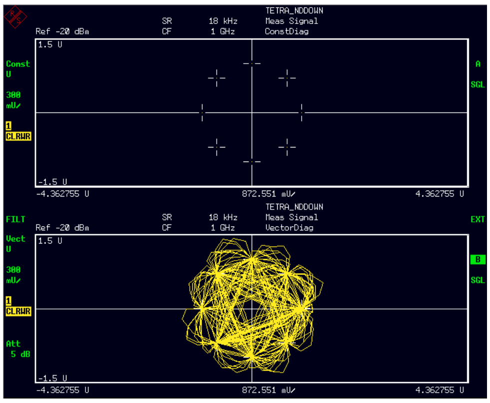
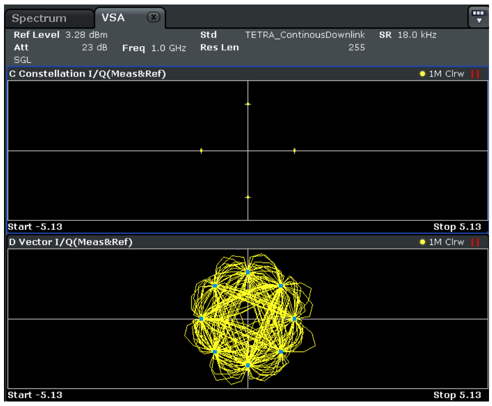
Reason:

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

In the R&S FSV-K70, the I/Q Constellation 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.

For details on the I/Q constellation diagram in the R&S FSV-K70, see "Constellation I/Q", on page 80.

Table 4-30: I/Q Constellation and I/Q Vector for pi/4-DQPSK modulation

	
R&S FSQ	R&S FSV

Problem: the MSK/FSK signal demodulates on the R&S FSQ-K70, but not on the R&S FSV-K70 or: Why do I have to choose different transmit filters in the R&S FSQ and the R&S FSV?

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 FSV-K70, however, this "replacement" is part of the transmit filter routine. Thus, the R&S FSQ and the R&S FSV 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 FSV.
- 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 FSV.

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.

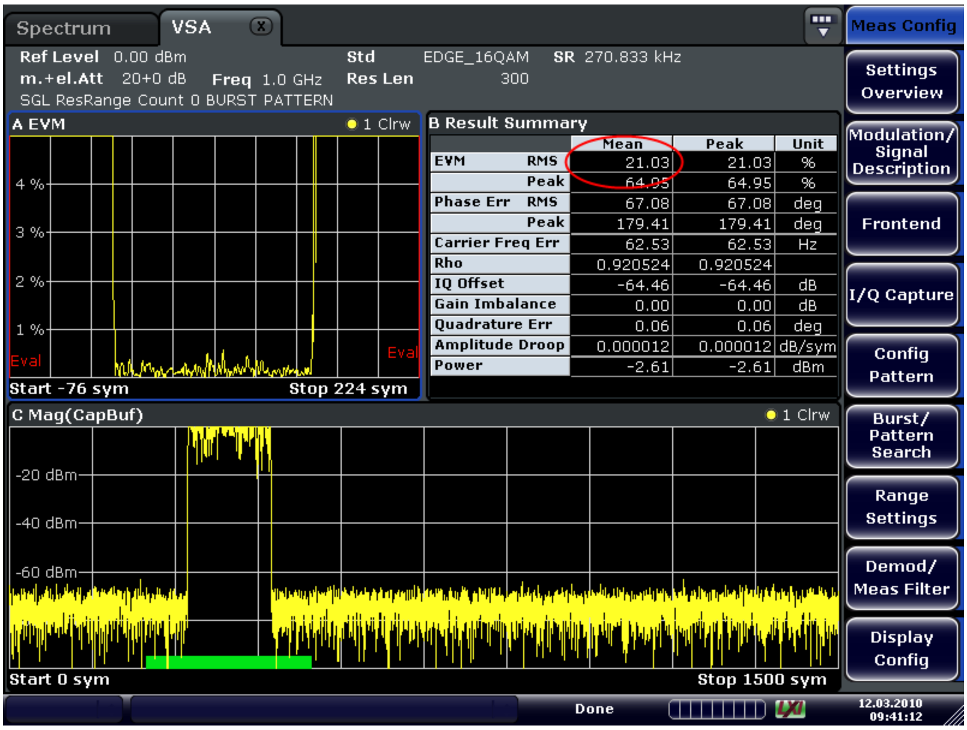


Fig. 4-98: Problem: EVM in result summary does not correspond with trace display

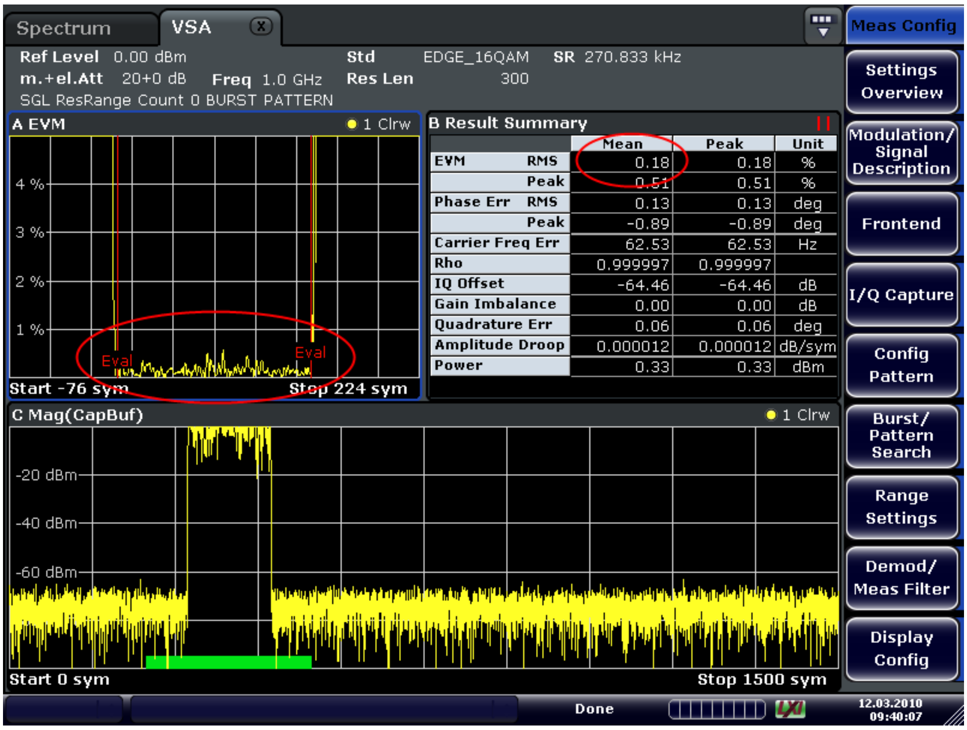
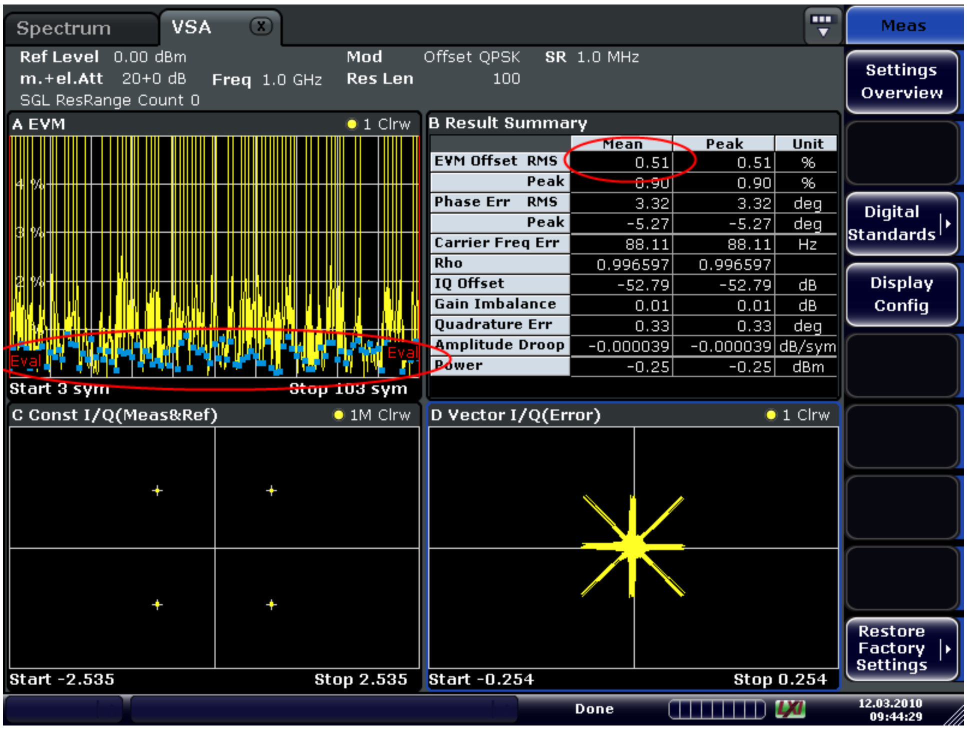
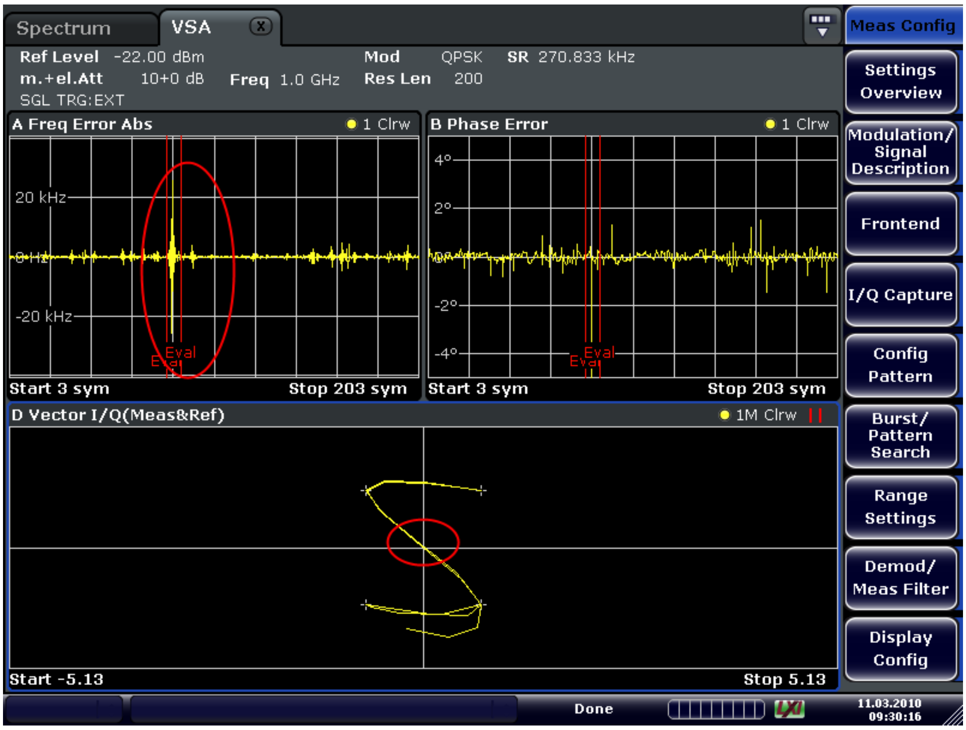


Fig. 4-99: Solution: Result Summary with correct evaluation range setting

- Make sure that the same samples are evaluated. The EVM trace displays (as default) all sample instants, e.g. if the "Capture Oversampling" is 4, the EVM trace shows 4 samples per symbol. The Result Summary does not forcefully evaluate all sample instants. E.g. for a PSK modulation, as default only symbol instants contribute to the EVM result.



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?
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 screen D
End
```

4.6 Annex: Formulae and Abbreviations

The following sections are provided for reference purposes and include detailed formulae and abbreviations

4.6.1 Formulae

4.6.1.1 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 165). 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)	$EVM(t) = \frac{EV(t)}{C}$ 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 = 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

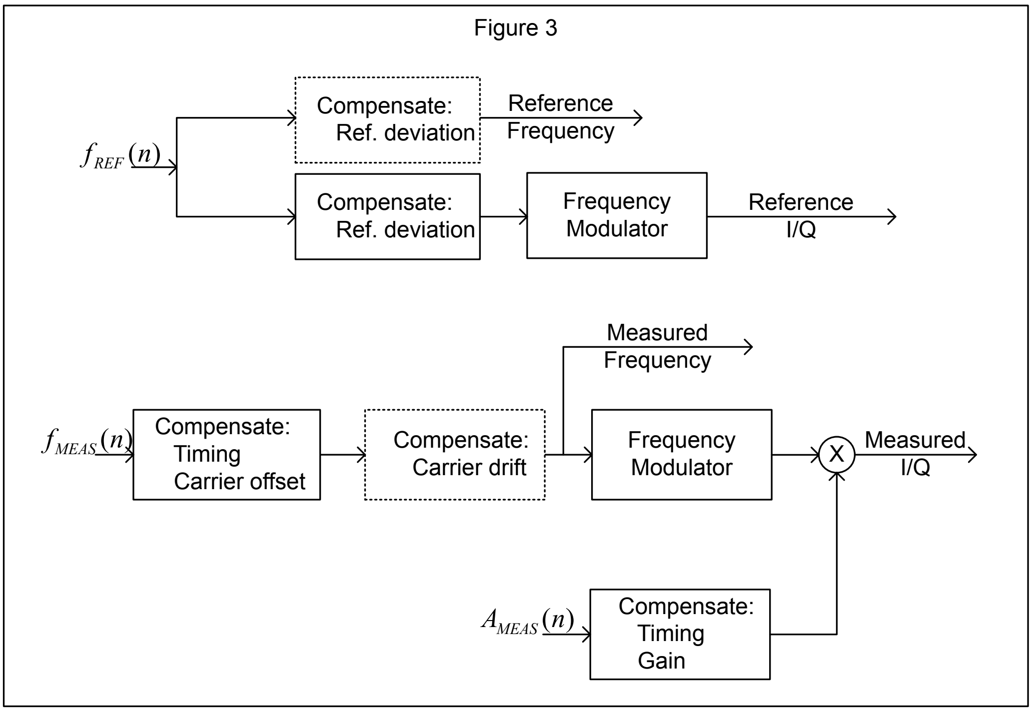


Fig. 4-100: Reconstruction of the reference and measured I/Q waveforms for FSK modulation

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.

4.6.1.2 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 165). This value can either be or .

- "1", meaning that only the symbol instant contributes to the result
- "2", meaning that two samples per symbol instant contribute to the result, or
- the "Capture Oversampling" rate (see "Capture Oversampling" on page 166), meaning that 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

EVM	RMS	$\sqrt{\frac{1}{N}\sum_{n}\lvert EVM(n\cdot T_D)\rvert^2}$
	Peak	$\max(\lvert EVM(n\cdot T_D)\rvert)$
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	$\min(\lvert MER(n\cdot T_D)\rvert)$ $with\ MER(n\cdot T_D)=-20\cdot\log_{10}\left(\frac{EV(n\cdot T_D)}{\sqrt{\frac{1}{K}\sum_{k}\lvert REF(k\cdot T)\rvert^2}}\right)$
Magnitude error	RMS	$\sqrt{\frac{1}{N}\sum_{n}\lvert MAG\_ERR(n\cdot T_D)\rvert^2}$

	Peak	$MAG\_ERR(idx)$ with $idx = \arg\max_n \lvert MAG\_ERR(n \cdot T_D) \rvert$
Phase error	RMS	$\sqrt{\frac{1}{N}\sum_n \lvert PHASE\_ERR(n \cdot T_D)\rvert^2}$
	Peak	$PHASE\_ERR(idx)$ with $idx = \arg\max_n \lvert PHASE\_ERR(n \cdot T_D) \rvert$
RHO (correlation coefficient)		$\rho = \frac{\left\lvert \sum_n REF^*(n) \cdot MEAS(n) \right\rvert^2}{\sum_n \lvert REF(n)\rvert^2 \cdot \sum_n \lvert MEAS(n)\rvert^2} = \frac{\lvert KKF(MEAS, REF)\rvert^2}{AKF(REF) \cdot AKF(MEAS)}$

PSK, QAM and MSK Modulation

For PSK, QAM and MSK modulation the estimation model is described in detail in chapter chapter 4.1.6.1, "PSK, QAM and MSK Modulation", on page 50. The parameters of the PSK, QAM and MSK-specific result summary table can be related to the distortion model parameters as follows:

Table 4-31: Evaluation of results in the PSK, QAM and MSK result summary

IQ Offset C	$C_{[lin]} = \frac{\left(\frac{c_I}{g_I}\right)^2 + \left(\frac{c_Q}{g_Q}\right)^2}{\frac{1}{K}\sum_k \lvert REF(k \cdot T)\rvert^2}$ $C = 10 \cdot \log_{10}\left(C_{[lin]}\right)[\text{dB}]$
IQ Imbalance B	$B_{[lin]} = \frac{\lvert g_I - g_Q \cdot e^{j\theta}\rvert}{\lvert g_I + g_Q \cdot e^{j\theta}\rvert}$ $B = 20 \cdot \log_{10}\left(B_{[lin]}\right)[\text{dB}]$
Gain Imbalance G	$G_{[lin]} = \frac{g_Q}{g_i}$ $G = 20 \cdot \log_{10}\left(G_{[lin]}\right)[\text{dB}]$

Quadrature Error Θ	$\theta_{[lin]} = \vartheta/\pi \cdot 180°$ $\theta = \theta_{[lin]} [\deg]$
Amplitude Droop A	$A_{[lin]} = e^{-\alpha \cdot T}$ $A = 20 \cdot \log_{10}(A_{[lin]}) [dB/Sym]$

FSK Modulation

For FSK modulation the estimation model is described in detail in section chapter 4.1.6.2, "FSK Modulation", on page 59. The parameters of the FSK-specific result summary table can be related to the distortion model parameters as follows:

FSK Reference Deviation Λ_{REF}	FSK reference deviation as entered by the user [Hz].
FSK Measurement Deviation Λ_{MEAS}	$\Lambda_{MEAS} = B \cdot \Lambda_{REF}$ Estimated FSK deviation of the meas signal [Hz].
FSK Deviation Error Λ_{ERR}	$\Lambda_{ERR} = \Lambda_{MEAS} - \Lambda_{REF} = (B-1) \cdot \Lambda_{REF}$ Estimated FSK deviation error [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].

4.6.1.3 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 table 4-31.

	Mathematical expression	analyzer calculation
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 $idx = \arg\max_m \lvert x_m \rvert$	$\hat{x}_M = x_M$ if $\lvert x_M \rvert > \lvert \hat{x}_{M-1} \rvert$ $\hat{x}_M = x_{M-1}$ if $\lvert x_M \rvert \le \lvert \hat{x}_{M-1} \rvert$ with $\bar{x}_0 = 0$
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.

4.6.1.4 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	analyzer calculation
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	$\bar{x}_{s,M} = \frac{(M-1)\cdot \bar{x}_{s,M-1} + x_{s,M}}{M}$

4.6.1.5 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 $\rho=\frac{\sqrt{\ln 2}}{2\pi BT}$

4.6.1.6 Standard-Specific Filters

Tx 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

Measurement Filter

EDGE Measurement filter

RC filter, Alpha = 0.25, single-side-band 6 dB bandwith = 90 kHz Windowing by multiplying the impulse response according to the following equation:

$$w(t)=\begin{cases}1, & 0 \le |t| \le 1.5T \\ 0.5(1+\cos[\pi(|t|-1.5T)/2.25T]) & 1.5T < |t| < 3.75T \\ 0, & |t| \ge 3.75T\end{cases}$$

The following figure shows the frequency response of the standard-specific measurement filters.

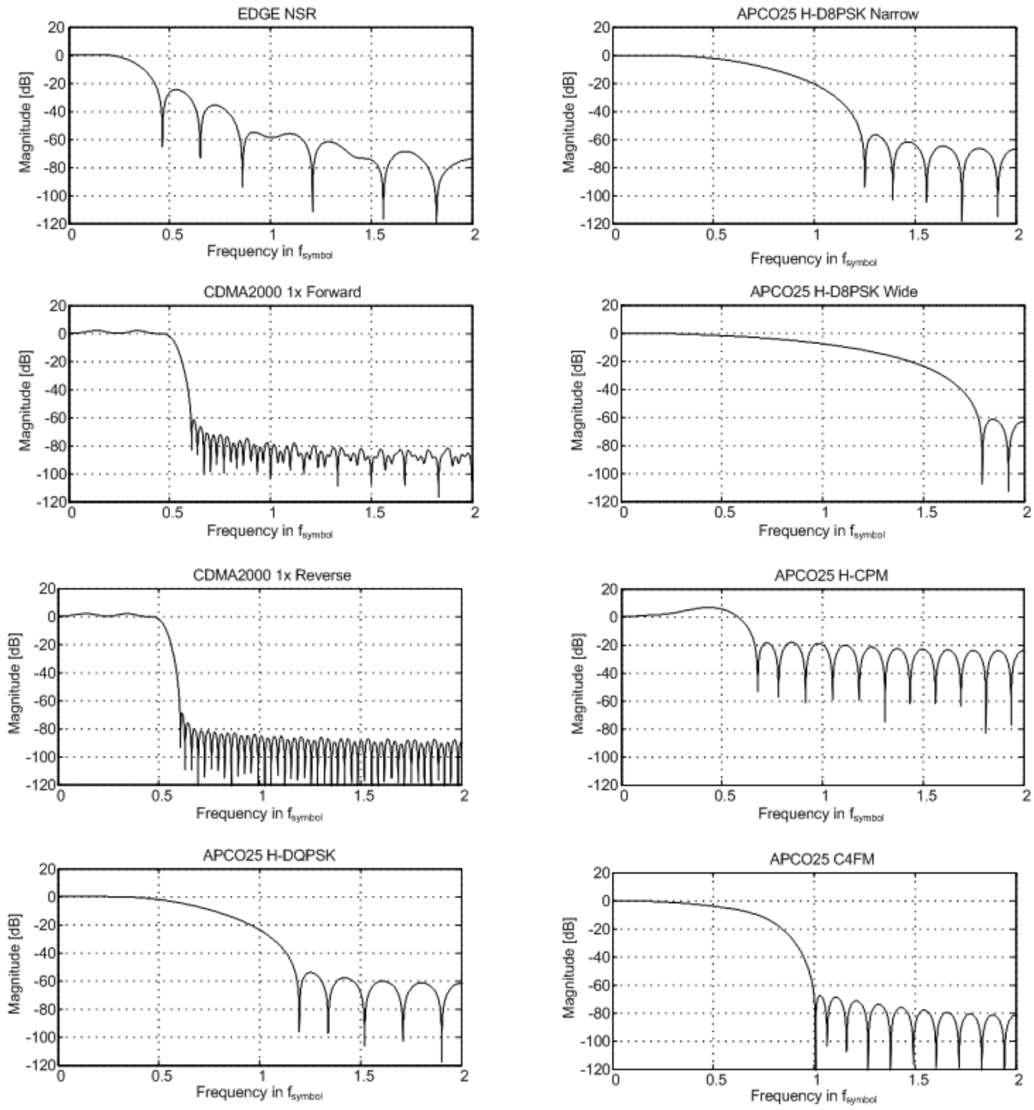


Fig. 4-101: Frequency response of the measurement filter

4.6.2 Abbreviations

The following abbreviations are commonly used in the description of the R&S FSV-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
TX 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 Commands

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