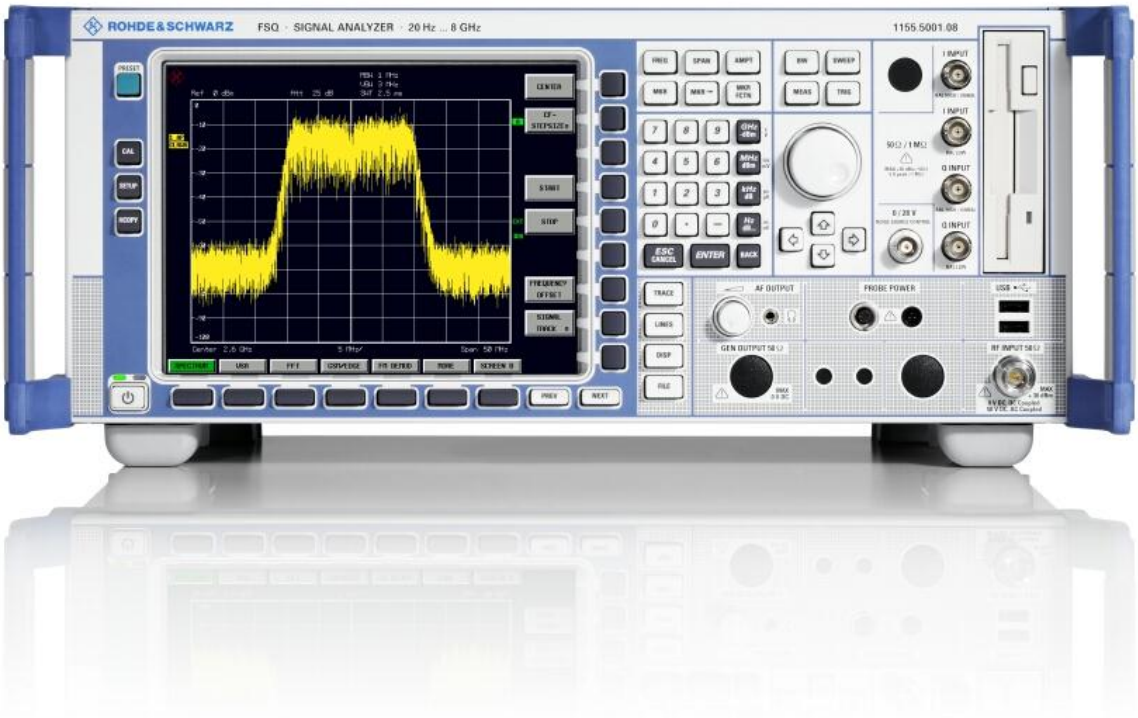
R&S®FSQ-K70/FSMR/FSU-B73
Vector Signal Analysis
Software Manual



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ROHDE&SCHWARZ

Test and Measurement

Software Manual

PAD-T-M: 3574.3259.02/01.00/CI/1/EN

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The following abbreviations are used throughout this manual:
R&S® FSQ-K70/FSMR/FSU-B73 is abbreviated as R&S FSQ-K70/FSMR/FSU-B73

Contents

1 Vector Signal Analysis

When equipped with application firmware R&S FSQ-K70 or the VSA Extension R&S FSMR/FSU-B73, the Analyzer R&S FSQ/FSU/FSUP or the Measuring Receiver R&S FSMR performs vector measurements on digitally modulated signals in the time domain. Based on the vector measurements, further evaluations, e.g. statistical evaluations or distortion measurements can be performed.

1.1 Enabling the Firmware Option

Firmware option R&S FSQ-K70/FSMR-B73/FSU-B73 is enabled by entering a keyword in the *SETUP* → *GENERAL SETUP* menu. The keyword is supplied with the option. If the option is factory-installed, it is already enabled.

GENERAL SETUP Menu:

OPTIONS

The *OPTIONS* softkey opens a submenu where the keywords for new firmware options (application firmware modules) can be entered. Available options are listed in a table displayed when the submenu is opened.

INSTALL OPTION

The *INSTALL OPTION* softkey activates the keyword entry field of a firmware option.

One or more keywords can be entered in the entry field. If a valid keyword is entered, *OPTION KEY OK* is displayed and the option is added to the *FIRMWARE OPTIONS* table.

If an invalid keyword is entered, *OPTION KEY INVALID* is displayed.

After installation of the option, **VSA (= vector signal analysis)** is displayed in the hotkey bar of the R&S FSQ/FSMR/FSU. The position of the **VSA** hotkey may vary depending on the type and number of options installed.

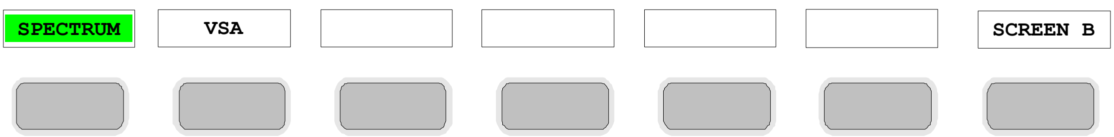


Fig. 1 Hotkey bar of basic unit with option R&S FSQ-K70/FSMR-B73/FSU-B73 installed.

1.2 Test Setup for Measurement on Base Stations and Power Amplifiers

Special precautions are to be observed when measurements on power amplifiers and mobile radio base stations are performed.

1.2.1 Precautions

DANGER

Danger of electric shock or from radiation

The relevant safety standards (e.g. EN 60215 and IEC215) must be complied with when operating transmitters and amplifier output stages.

1.2.2 Standard Test Setup

NOTICE

Destruction of the input mixer

When transmitters or transmitter output stages with an output power of more than 30 dBm are connected, a suitable power attenuator or power coupler must be used to prevent the analyzer input stages from being damaged.

For R&S FSQ/FSMR/FSU devices with an upper frequency limit of 26.5 GHz or less, the RF input is AC-coupled with switchable AC/DC coupling. For all other R&S FSQ/FSMR/FSU devices (upper frequency limit > 26.5 GHz), the RF input is DC-coupled.

For AC-coupling, a DC input voltage of 50 V must never be exceeded. For DC-coupling, DC voltage must not be applied at the input.

In both cases, noncompliance will destroy the input mixers.

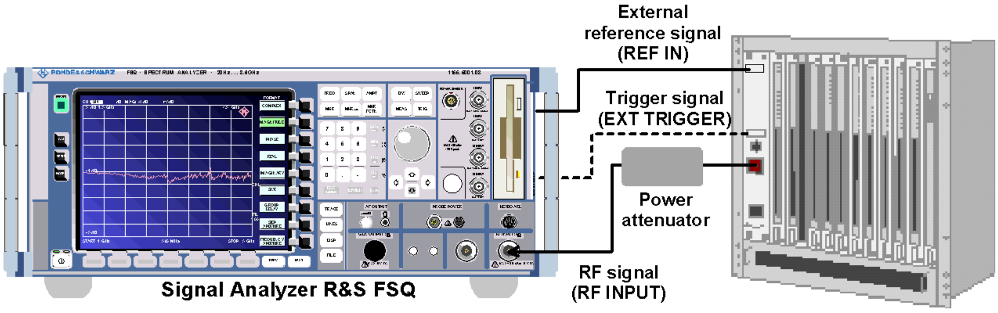


Fig. 2 Connection to RF output of a base station (for example R&S FSQ)

1.3 Calling and Exiting the Option - VSA Softkey

1.3.1 Calling the Option - VSA Softkey

Call the R&S FSQ-K70/FSMR-B73/FSU-B73 option by pressing the **VSA** hotkey.

After activation, the labels in the hotkey bar and the contents of the menus are adapted to the functions of the VSA option. The menus of the option are described in Chapter 5, "*Instrument Settings and Measurements*".

Remote: `INST:SEL DDEM`

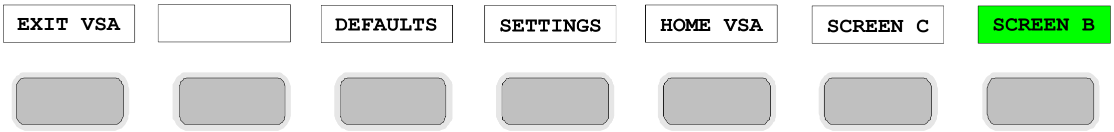


Fig. 3 Hotkey bar when option R&S FSQ-K70/FSMR-B73/FSU-B73 is active

1.3.2 Exiting the Option - VSA Softkey

To exit the R&S FSQ-K70/FSMR-B73/FSU-B73 option, press the **EXIT VSA** hotkey.

When the option is closed, the hotkey bar and the menus of the basic unit are restored.

When the option is closed, the hotkey bar and the menus of the basic unit are restored.

Remote: `INST:SEL SAN`

1.3.3 Return to VSA Menu (Home VSA Hotkey)

HOME VSA

Pressing HOME VSA in any position of the VSA menu branches to the VSA menu.

This function should be used particularly after frequency, level and trigger settings, because automatic return to the VSA menu is not possible in this case.

1.3.4 Overview

The following functions are shown by the diagram below:

- Starting R&S FSQ-K70/FSMR-B73/FSU-B73 in the spectrum analyzer mode
- Navigation within the application
- Exiting the application

The position of the **VSA** hotkey may vary depending on the number of activated options.

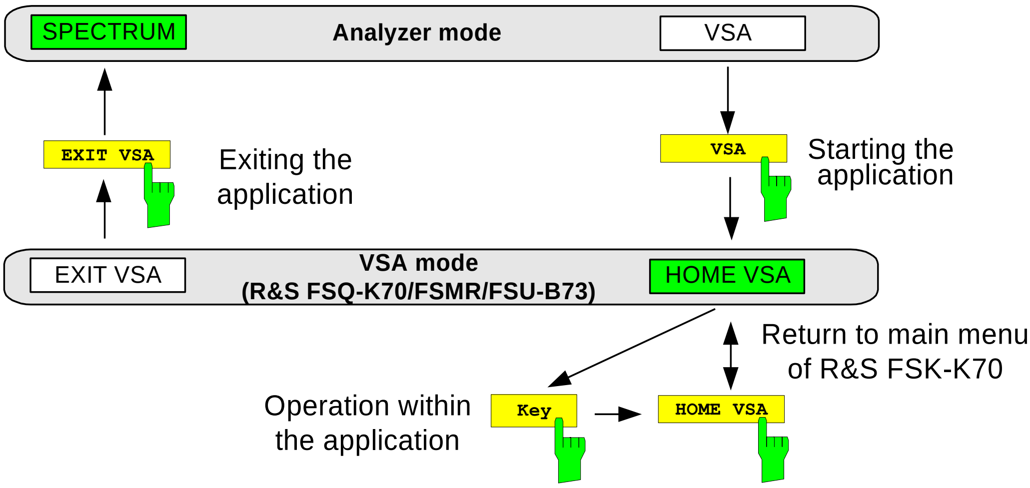


Fig. 4 Overview: calling and ex iting option FSQ-K70/FSMR/FSU-B73

2 First Measurements - Getting Started

With the aid 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. To benefit from this didactics, use the „Continuous – Facing“ view for the display on the screen.
The following equipment is required in addition to the Analyzer R&S FSQ/FSU/FSUP/FSG or Measuring Receiver R&S FSMR with option R&S FSQ-K70/FSMR-B73/FSU-B73:

- 1 test transmitter (GSM-compatible), preferably R&S SMIQ (1125.5555.03)
- 1 ParData Adapter R&S SMIQ-Z5 for R&S SMIQ (1104.8555.02)
- 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.

2.1 Interconnecting Transmitter and Analyzer

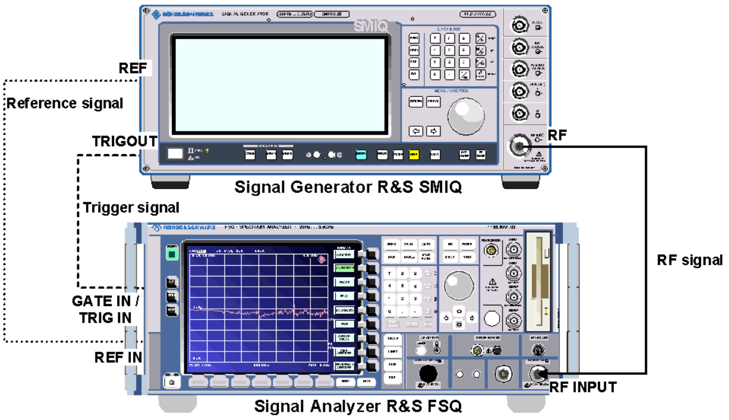


Fig. 5 Connection to a test transmitter (for example R&S FSQ)

2.2 Basic Settings of Test Transmitter

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

Table 1 Basic settings of test transmitter for first measurements

Parameter	Setting
Level	0 dBm
Frequency	2 GHz

Transmitter settings for the various measurements are listed in the table below:

Table 2 Transmitter settings for various measurements

Setting		**Operatingsequence SMIQ**	
Grundeinstellung für GSM / EDGE **Softkey Digital Standard**		Digital Standard GSM/EDGE State ON	<Select> <Select> <Select> <Select> <Return>
Setting	**Measurement**		
EDGE **Single Burst**	1	Save/Recall Frame Get predefined Frame EDGE0	<Select> <Select> <Select> <Return> <Return>
EDGE **Full Frame**	2,3,5,6,7	Save/Recall Frame Get predefined Frame EDGE_ALL	<Select> <Select> <Select> <Return> <Return>
GSM/EDGE **Mixed Frame**	4	Save/Recall Frame Get predefined Frame GSM_EDGE	<Select> <Select> <Select> <Return> <Return>
GSM **Full Frame**	4	Save/Recall Frame Get predefined Frame GSM_ALL	<Select> <Select> <Select> <Return> <Return>
EDGE Slot Att. **(20 dB / slot 1..7)**		Slot Attenuation 20 Select Slot Slot 1..7 Slot Level ATTEN	<Select> <dB> <Select> <mark with rotary knob> <Select> <Select> <select with rotary knob> <Select> <Return> <Return>

2.3 Switching On the R&S FSQ-K70/FSMR-B73/FSU-B73 Option

Hotkeys VSA

Press the **VSA** hotkey to call the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

After activation, the labels in the hotkey bar and the contents of the menus are adapted to the functions of the VSA option. The menus of the option are described in Chapter 5, "***Instrument Settings and Measurements***"

2.4 Basic Analyzer settings for EDGE Measurements

In the default setting after PRESET, the R&S FSQ/FSMR/FSU is in the analyzer mode.

In this mode the following settings must be made:

Table 3 Basic instrument settings

Parameter	Setting
Frequency	2 GHz
Reference level	+6 dBm

The following settings of the R&S FSQ-K70/FSMR-B73/FSU-B73 option are only enabled after the vector signal analyzer mode is set and the digital standard EDGE_NB (normal burst) is selected.

Table 4 Basic setting for vector signal analysis measurements

Parameter	Setting
Digital standard	EDGE_NB
Sweep	CONTINUOUS
Burst search	ON
Pattern search	ON
Pattern	EDGE_TSC0
Display mode	Screen A: EVM Screen B: Symbols & Modulation Accuracy

2.5 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:: Analyzer: Digital GSM standard → EDGE_NB standard
Adjust Ref Level

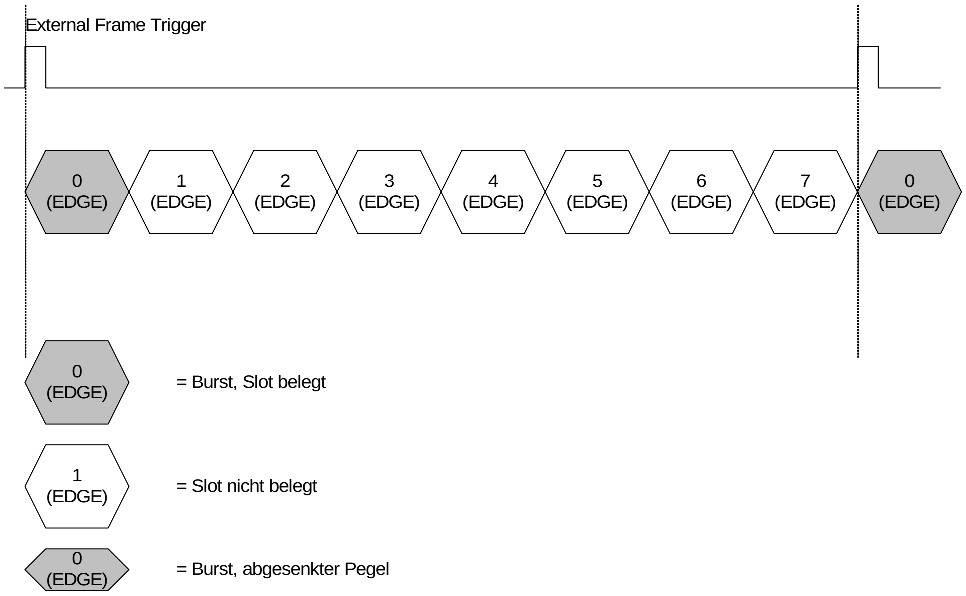


Fig. 6 Measurement 1: Frame structure

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:

Fig. 7 shows a typical result display of the analyzer for the EDGE standard.

In the upper half, the magnitude of the vector error is plotted over time; in the lower half numeric error values in the range of the evaluation lines are listed.

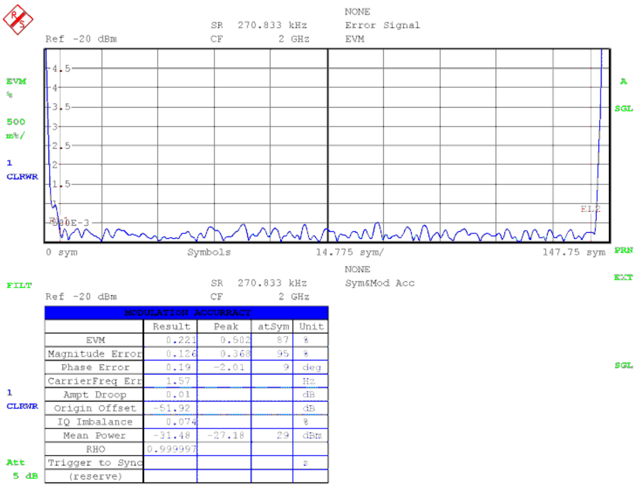


Fig. 7 Measurement 1: Result display of analyzer

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 must be performed with the **measurement filter** prescribed by ETSI. If DIGITAL STANDARD EDGE is selected, this filter is automatically switched on.

With the control sequence <SCREEN A>, <MEAS RESULT>, <MEAS SIGNAL>, <I/Q VECTOR>, the associated I/Q trace is displayed (after filtering with the measurement filter, Fig. 8). With the sequence <MEAS RESULT>, <RESULT RAW>, this filter is switched off and the measurement is performed on the **raw transmitter signal** (before filtering with the measurement filter). The associated display is shown in Fig. 9.

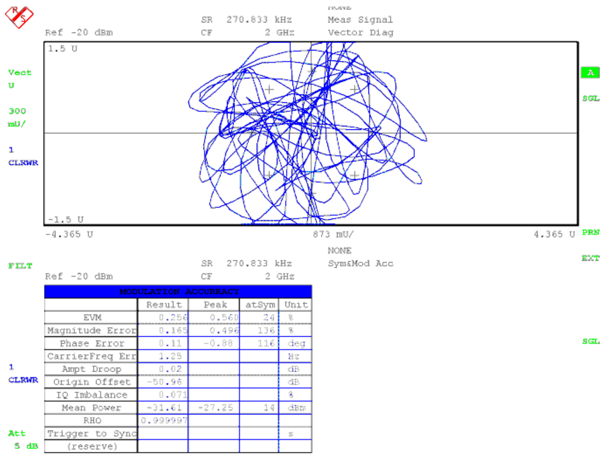


Fig. 8 Measurement 1: I/Q vector

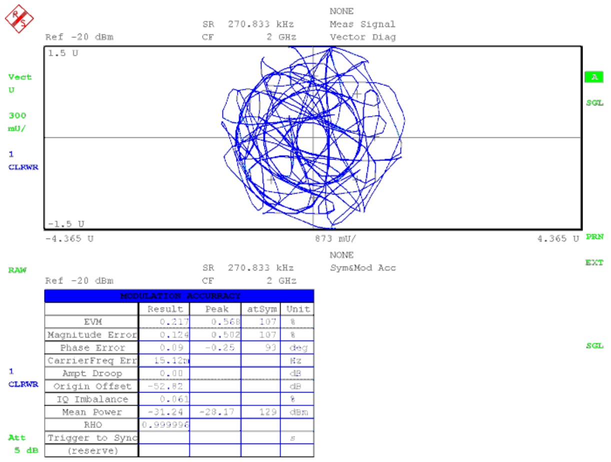


Fig. 9 Measurement 1: RESULT RAW

Switching off the measurement filter may also influence the numeric result display: high-frequency noise components that are to a great extent suppressed by the filter may cause more measurement errors.

2.6 Measurement 2: Selection of a Specific Slot with Trigger Offset

Objective of the measurement:

- Selecting a single EDGE burst by external trigger
- Changing the position of the trace in the display with FIT TRACE
- Reducing the RECORD LENGTH

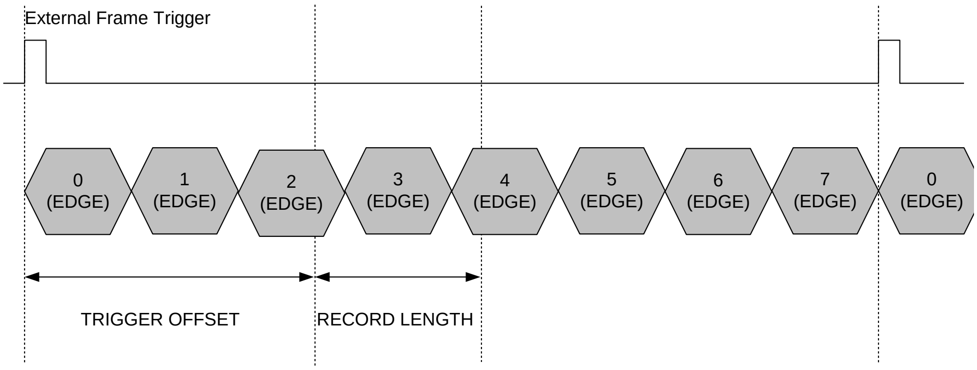
Instrument settings:

► Transmitter: GSM default setting
EDGE Full Frame

► Analyzer: Digital GSM standard → EDGE_NB standard
<Adjust Ref Level>
<TRIGGER> -> EXT
<TRIGGER OFFSET> -100us
< RESULT LENGTH = 200>

1) <MEAS RESULT> <MAG CAP BUFFER>

2) <MEAS RESULT> <RESULT RAW>
<MEAS RESULT> <MEAS SIGNAL> <MAGNITUDE ABSOLUTE>



The transmitter settings cause EDGE bursts in time slots 0 to 7.

Measurement:

In the default setting, the TRIGGER OFFSET is set to -100 µs and the RECORD LENGTH to 10 times the RESULT LENGTH. The received raw signal is displayed (magnitude capture buffer, Fig. 10).

With this setting the first detected pulse is demodulated. The name of the detected sync pattern that is used for synchronization is displayed (**EDGE_TSC0**, Fig. 11).

During the measurement, the TRIGGER OFFSET can be varied with the rotary knob until the **EDGE_TSC3** sync pattern is displayed. Stable demodulation is achieved with a trigger offset of +1.1 ms.

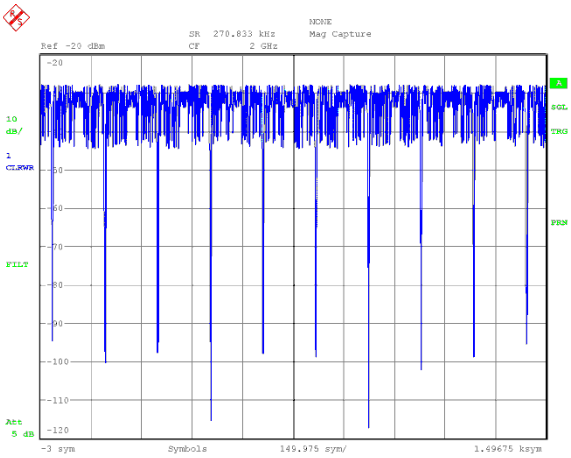


Fig. 10 Meas. 2: Magnitude capture buffer

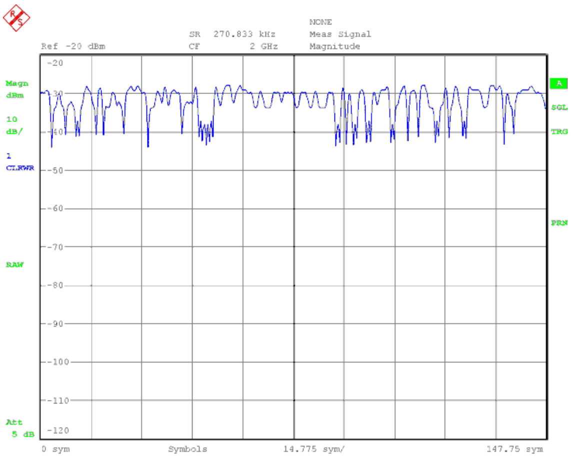


Fig. 11 Meas. 2: EDGE_TSC0

Display positioning

When GSM / EDGE is set, FIT PATTERN TO CENTER is selected for the display: the center of the detected sync pattern is represented in the center of the display.

Other possible settings are shown in the figures below:

- FIT TRIGGER TO LEFT: trigger time + trigger offset are displayed at the left screen edge

- FIT PATTERN TO LEFT: the beginning of the sync pattern is displayed at the left screen edge

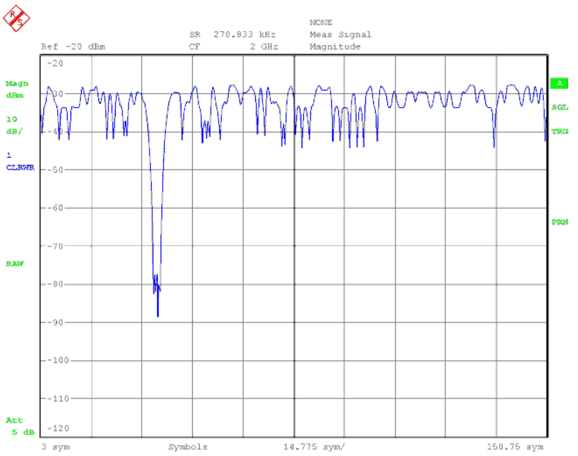


Fig. 12 Meas. 2: FIT TRIGGER TO LEFT

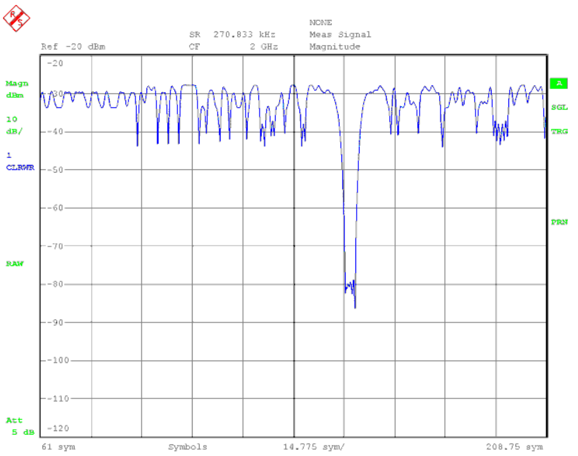


Fig. 13 Meas. 2: FIT PATTERN TO LEFT

Changing the RECORD LENGTH

To speed up the measurement, the data recording time (RECORD LENGTH) can be manually reduced (set RECORD LENGTH = 250 symbols). In some cases, display positioning with FIT TRACE and 'pattern aligned'is no longer possible.

2.7 Measurement 3: Setting the Burst Search Parameters (LEVEL)

Objective of the measurement:

- Manual setting of burst parameters
- Selective search for sync patterns

Instrument settings:

► Transmitter: GSM default setting
EDGE Full Frame
Blank slot 0 and slot 2
Reduce level of slot 1 by 15 dB

► Analyzer: Digital GSM standard → EDGE_NB standard
<Adjust Ref Level>
<TRIGGER> FREE RUN
<MEAS RESULT> <RESULT LENGTH = 200>

1) <DISPLAY><SPLIT SCREEN>
<DISPLAY><SCREEN B>
<MEAS RESULT> <MAG CAP BUFFER>
<DISPLAY><SCREEN A>
<MEAS RESULT> <MEAS SIGNAL> <MAGNITUDE ABS>

2) <DISPLAY><FULL SCREEN>
<MEAS RESULT> <MEAS SIGNAL> <MAGNITUDE ABS>

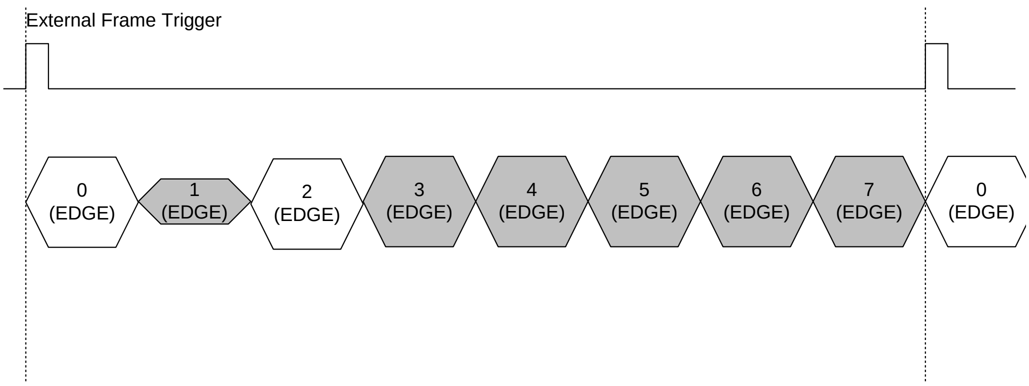


Fig. 14 Burst-search parameter

This basic transmitter setting causes a single burst with reduced level in timeslot 1 and a sequence of bursts in timeslots 3 to 7.

Measurement:

n the previous measurement, a defined burst was selected for the measurement by means of an external trigger signal. If a suitable measurement signal is available, the specific burst can also be selected by manual setting of burst search parameters without external trigger.

The signal consists of a single burst of reduced level and a sequence of bursts of normal level. In automatic burst search, the level threshold depends on the maximum amplitude and slots 3 to 7 are measured. The single burst in slot 2 is not detected. Fig. 15 and Fig. 16 show different untriggered measurements in the AUTO mode.

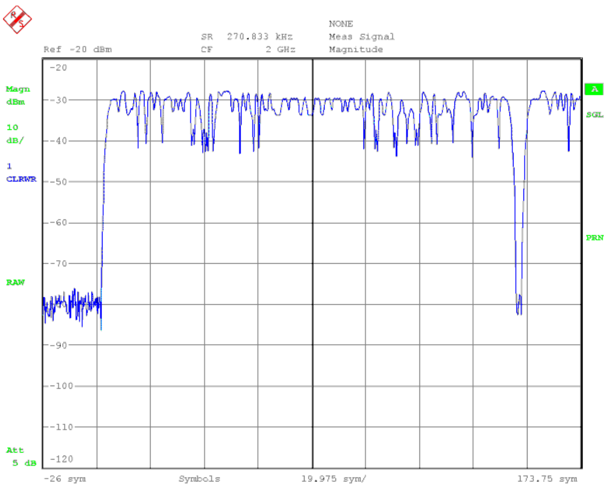


Fig. 15 Meas. 3: Burst search AUTO, EDGE_TSC4

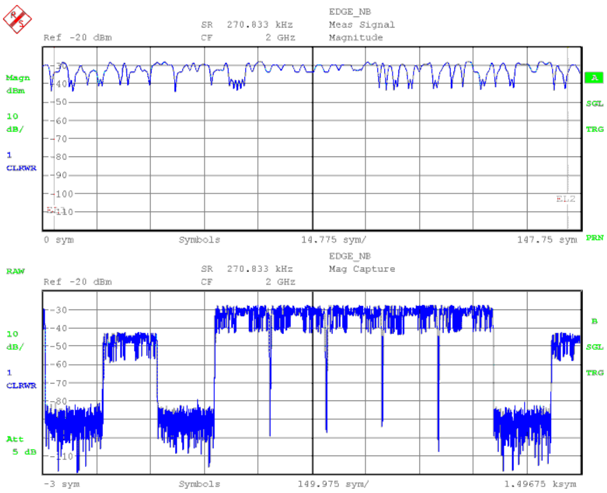


Fig. 16 Meas. 3: Burst search AUTO, EDGE_TSC3

In the next step, the burst search is set with a **level threshold of -30 dB RefLvl** (relative to reference level). Because of manual threshold setting, the level-reduced burst in slot 1 is now also detected and demodulated. Fig. 17 shows such a measurement.

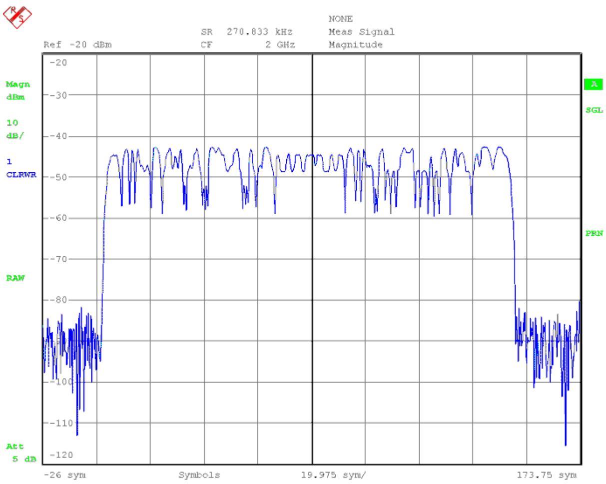


Fig. 17 Meas. 3: Burst search, manual level setting

Knowing that slot 1 contains a single burst, the settings for the burst search can be even more selective:

Under <BURST & PATTERN> <EXPERT SETTINGS>, the GAP LENGTH (i.e. the gap between two consecutive bursts) is increased to 50 symbols.

The search algorithm now rejects all bursts in slots 3 to 7 and only identifies the burst in slot 1 as valid because this burst is between two empty timeslots and the only one in the frame to fulfill the burst conditions (see Fig. 17).

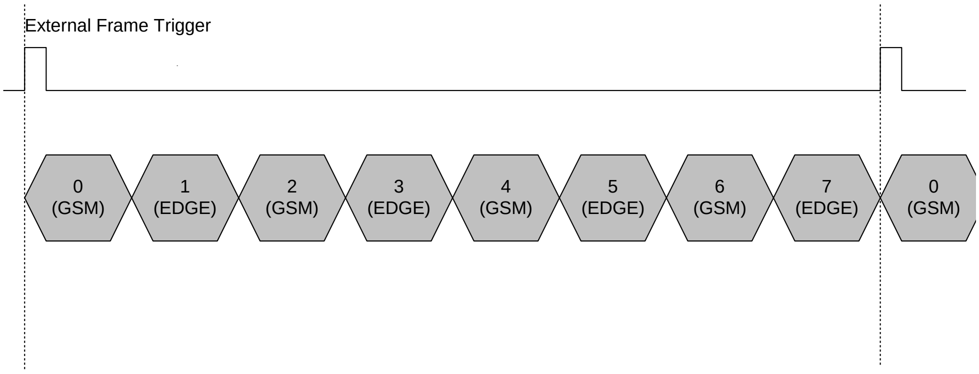
2.8 Measurement 4: Suppression of Incorrect Measurements

Objective of the measurement:

- MEAS ONLY ON PATT operating parameter
- Similarity of GSM and EDGE patterns

Instrument settings:

► Transmitter:	GSM default setting GSM Mixed Frame
► Analyzer:	Digital GSM standard → EDGE_NB standard <Adjust Ref Level> <DISPLAY><FULL SCREEN> <MEAS RESULT> <MEAS SIGNAL> <MAGNITUDE ABS> <MEAS RESULT> <RESULT RAW>



The transmitter settings cause bursts in time slots 1 to 7. GSM and EDGE bursts are transmitted alternately.

Measurement:

The signal consists of a fully used frame in which EDGE and GSM bursts are transmitted alternately. In contrast to the standard setting for EDGE_NB, the MEAS ONLY ON PATT parameter is switched off. As a result, the analyzer tries to demodulate each burst that fulfills the burst conditions.

The EDGE demodulation algorithm is optimized for 3pi/8-8PSK modulation. It also synchronizes to GSM signals patterns of identical name, but a great number of error messages are issued in this case.

In the case of untriggered measurements, the following result displays may be obtained.

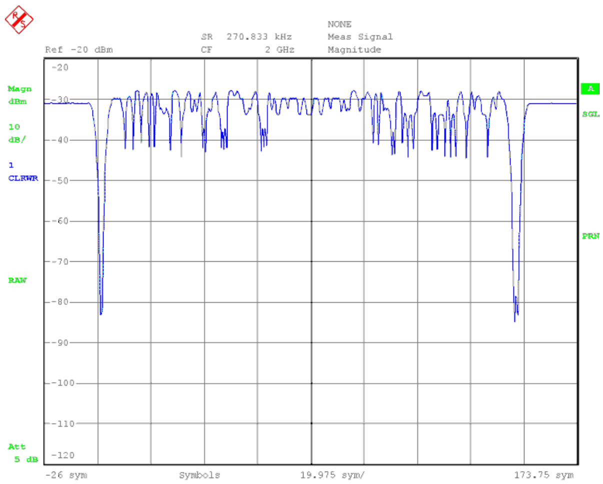


Fig. 18 Meas. 4: EDGE demodulator, correct demodulation

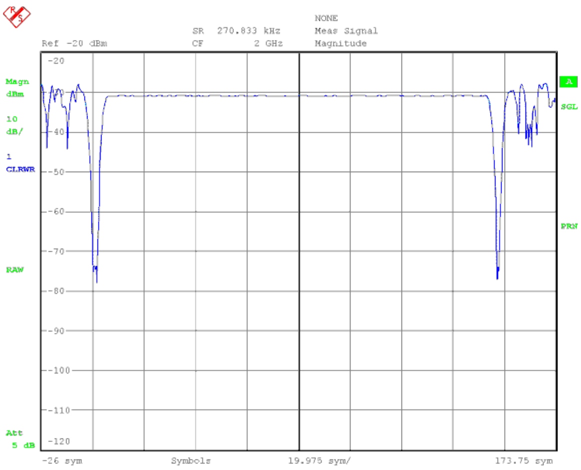


Fig. 19 Meas. 4: EDGE demodulator, incorrect demodulation of a GSM burst

The incorrect measurements can be avoided when the following settings are made:

- Select appropriate patterns for the EDGE signal (e.g. EDGE_TSC1, EDGE_TSC3,EDGE_TSC5, EDGE_TSC7)
- Activate MEAS ONLY ON PATT softkeys

The display is only updated after a valid measurement. After a faulty measurement the display remains unchanged and the SEARCHING PATTERN message is displayed.

Despite the similarity of the GSM and EDGE sync patterns, the GSM demodulator is not able to identify EDGE patterns. To suppress invalid measurements (pattern not found), the MEAS ONLY ON PATT softkey must also be activated.

2.9 Measurement 5: Evaluation Lines

Objective of the measurement:

- Use of evaluation lines for determining result ranges

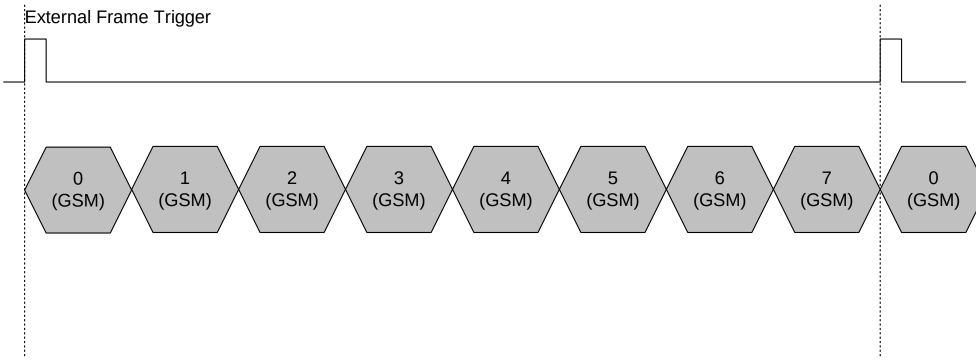
Instrument settings:

► Transmitter: GSM default setting
GSM Full Frame

► Analyzer: Digital GSM standard → GSM_NB standard
<Adjust Ref Level>
<DISPLAY> <SPLIT SCRREN>

1) <SCREEN A> <MEAS RESULT> <MAGNITUDE ABS>
<SCREEN B> <MEAS RESULT> <SYM & MODUL ERR>

2) <SCREEN B> <MEAS RESULT> <MAGNITUDE ABS>
<SIGNAL STATISTIC>



The transmitter settings cause GSM bursts in time slots 0 to 7.

Measurement:

Evaluation lines delimit the range in which numeric results such as EVM, phase error, magnitude error, RHO are determined. The range is preset and automatically considered when a digital standard is set.

In the first figure below, the EVAL LINES are correctly set; in the second, they are set on the burst edge.

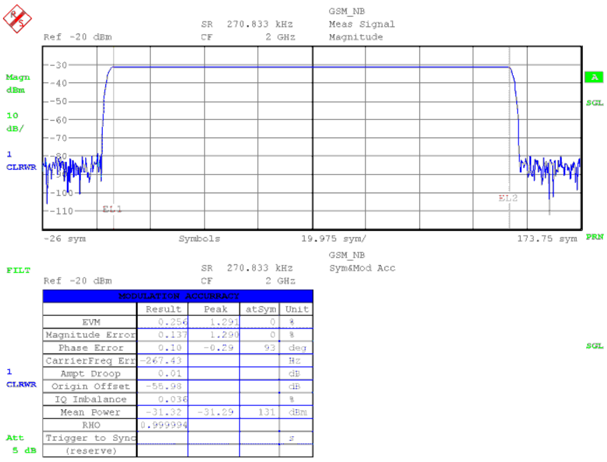


Fig. 20 Meas. 5: Setting the evaluation range: presetting the standard

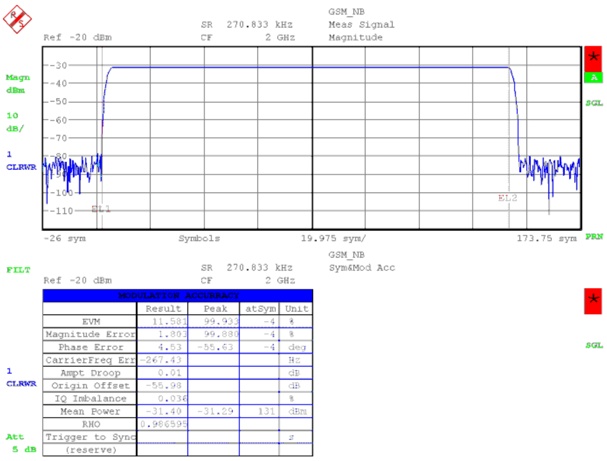


Fig. 21 Meas. 5: Setting the evaluation range: extension to burst edges

The evaluation lines also affect derived displays such as statistical signal evaluation. Fig. 22 shows the statistical level distribution within the burst. In Fig. 23, the EVAL LINES are extended to ranges outside the burst which is reflected by the level's probability of occurrence.

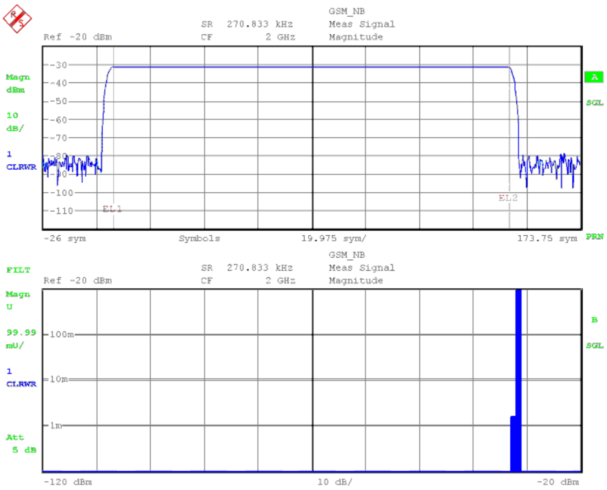


Fig. 22 Meas. 5: Level distribution within the burst

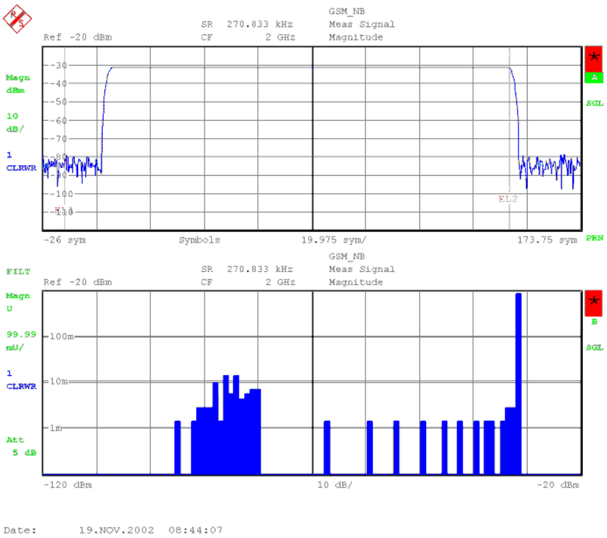


Fig. 23 Meas. 5: Level distribution within and outside the burst

The displayed measurements were performed in the SINGLE SWEEP mode. The display at the right was obtained solely by varying the EVAL LINE 1 without receiving new data. For this reason the measurement is marked with a red asterisk *. Parameters relating to this measurement (e.g. modulation errors or statistics diagrams) are recalculated, however.

3 Brief Description of Vector Signal Analysis (Function)

The "Vector Signal Analysis" software option R&S FSQ-K70/FSMR-B73/FSU-B73 performs vector measurements for analyzing modulation errors of RF signals converted to the complex baseband. Carrier envelope and time domain measurements can also be performed but these measurements can be carried out in the basic unit (frequency analyzer) with a considerably wider bandwidth. The same applies to spectral measurements such as adjacent-channel power measurements on mobile radio signals.

The following sections describe the digital signal processing hardware, the interplay of analog and digital filters for bandwidth limiting, system-theoretical 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. The required calculation formulae are provided in the Annex to this manual.

3.1 Block Diagram of Digital Signal Processing Hardware

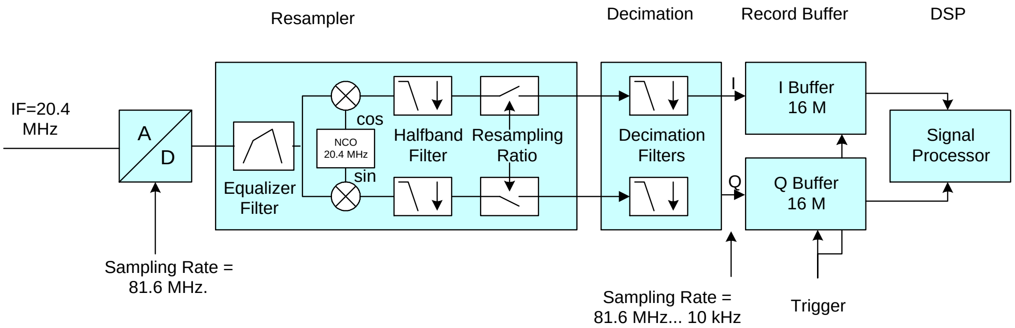


Fig. 24 Block diagram of digital hardware for vector signal analysis

3.1.1 Description of Block Diagram

After having passed several RF, IF and filter stages, the RF input signal is converted to an IF of 20.4 MHz and applied to an A/D converter with a sampling frequency of exactly 81.6 MHz.

The digitized signal is then routed through two ICs for resampling (conversion of sampling rate by a real factor) and for filtering and decimation (reduction of sampling rate by an integral factor). An EQUALIZER FILTER is connected to the RESAMPLER input to compensate for the frequency response of the 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 sampling frequency is obtained at the output of the DECIMATION stage, which exactly corresponds to the following equation:

Sampling rate = Symbol rate * Points/symbol {4,8, or 16};

A higher point/symbol setting automatically results in a corresponding increase of the **I/Q bandwidth**. The resulting measurement bandwidths are described in the sections below.

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.

The data recording length and the result length after DSP processing are limited to about 32k samples (irrespective of the set symbol rate or sampling rate).

The received baseband signal is filtered in the subsequent DSP stage as required by the signal, then demodulated **without the transmitted data being known** (non-data-aided demodulator) and scanned for sync patterns. An ideal transmit signal is reconstructed from the demodulated data, and various modulation and vector errors, which are described in the following sections, are obtained from a comparison of demodulated and ideal I/Q signals.

.In addition to setting the modulation mode, **ACCURATE** setting of **symbol rate** and **filter parameters** is important for a correct demodulation. Even slight deviations may noticeably impair the measurement result.

Examples are given in the Troubleshooting section.

Supplement to the R&S FSQ-B72 Option

The R&S FSQ-B72 option additionally allows sampling rates from >81.6 MHz to 326.4 MHz. With sampling rates ≤81.6 MHz, the R&S FSQ-B72 option is not active. The analyzer then behaves in the way described above. Fig. 25 shows the hardware of the analyzer from IF up to the processor for sampling rates above 81.6 MHz. An IF filter of 120 MHz is effective. The A/D converter samples the IF (408 MHz) at a rate of 326.4 MHz. The points/symbol setting parameter is fixed at {4}.

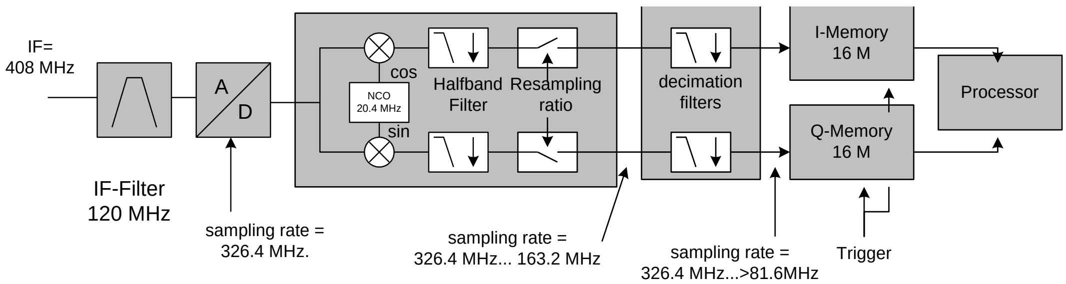


Fig. 25 Block diagram with the signal processing of the R&S FSQ at sampling rates >81.6 MHz

3.1.2 Bandwidths for Signal Processing

Relevant filters for vector signal analysis are shown in the block diagram below.

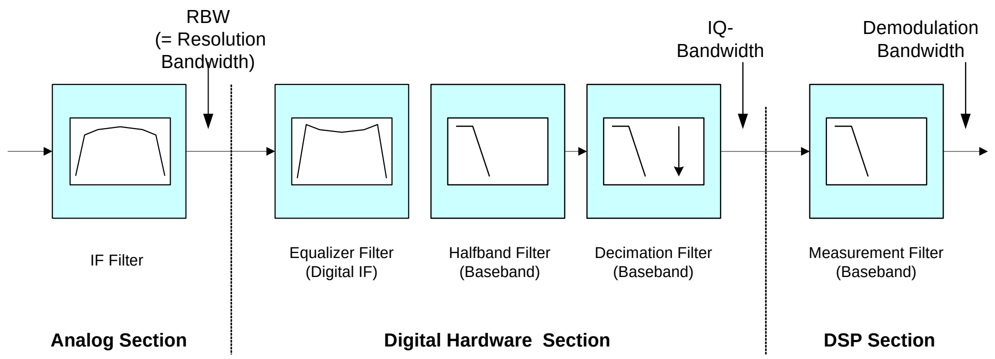


Fig. 26 Block diagram of bandwidth-relevant filters for vector signal analysis

The total bandwidth is obtained when the shown filter stages are series-connected:

- IF filter (RBW) with selectable nominal bandwidths 120 MHz*) 50 MHz**), 20 MHz**), 10 MHz, 5 MHz, 3 MHz, 1 MHz and 300 kHz
- Digital hardware filter (in RESAMPLER and DECIMATION blocks)
- Measurement filter (MEAS FILTER) in the signal processor

Digital filters in the **digital hardware section:**

- Equalizer filter for compensating amplitude and phase distortions of RBW filters
- Halfband filter for limiting the bandwidth to approx. 40 MHz or 160 MHz (if R&S FSQ-B72 is active)
- Decimation filter for limiting the bandwidth to 0.8 times the output sampling rate. Note: In case of very high sampling rates, this filter is bypassed.

In the **DSP section**, the demodulation bandwidth can be further reduced by a measurement filter. If this filter is not required for the measurement, measurements are performed with the I/Q bandwidth.

Equalizer filter and halfband filter are only of minor importance for the total bandwidth. The other filters and the filters required for intersymbol-interference-free (ISI-free) demodulation are described in detail in the sections below.

3.1.2.1 Analog RBW Filters

The spectrum of the receive signal is reduced by means of analog prefilters so that the IF stages of the analyzer are optimally driven by the desired signal and undesired mixer products are reduced.

To obtain optimum characteristics for vector signal analysis, the amplitude and phase frequency response within the demodulation bandwidth should be as flat as possible. The permissible IF filters are listed in the table below.

---

*) only if R&S FSQ-B72 is active; fixed at 120 MHz

**) available for R&S FSQ and R&S FSMR only

Filter bandwidths ≥3 MHz are equalized by means of a built-in calibration procedure and can be used for up to 2/3 of the nominal bandwidth (unless stated otherwise in the table). The maximum equalized IF signal bandwidth that can be used is limited to 28 MHz or 120 MHz (if R&S FSQ-B72 is active).

Filter bandwidths <3 MHz are not equalized and can be used for vector signal analysis up to approx. 1/10 of the nominal bandwidth without noticeably affecting the modulation error. Using the bandwidth above this limit considerably reduces the measurement accuracy.

Unless special measures are required for interference suppression, we recommend using the RBW = AUTO setting.

With **RBW = AUTO**, the analog RBW filter is set by the analyzer so that the "bandwidth used" (see table below) is wider or equal to the bandwidth of the subsequent digital filter stages.

With **RBW = MANUAL**, the filter bandwidth specified in the table below may be reduced. If a **usable filter bandwidth** below the Symbol rate * Points/symbol bandwidth is selected, UNCAL is displayed.

Table 5 RBW filter bandwidths and usable bandwidths

RBW operating parameter	Digitally compensated	Usable bandwidth (effect on filter negligible)	UNCAL display if usable bandwidth is <
300 kHz	N	1/10*300 kHz = 30 kHz	Symbol rate * Points/symbol
500 kHz	N	1/10*500 kHz = 50 kHz	Symbol rate * Points/symbol
1 MHz	N	1/10*1000 kHz = 100 kHz	Symbol rate * Points/symbol
3 MHz	Y	2 MHz	Symbol rate * Points/symbol
5 MHz	Y	3 MHz	Symbol rate * Points/symbol
10 MHz	Y	7 MHz	Symbol rate * Points/symbol
20 MHz*)	Y	17 MHz	Symbol rate * Points/symbol
50 MHz*)	Y	28 MHz	-
120 MHz**)	Y	120 MHz	-

*) available for R&S FSQ and R&S FSMR only
**) only if R&S FSQ-B72 active; other bandwidths cannot be set

3.1.2.2 I/Q Bandwidth

Table 6 specifies the I/Q bandwidth that can be achieved as a function of the sampling rate.

For sampling rates between 40.8 MHz and 81.6 MHz, the bandwidth is limited to approx. 40 MHz by the halfband filter but the RBW of the preceding IF filter (max. 28 MHz, R&S FSU max. 10 MHz) is decisive for the total bandwidth. A decimation filter is not active with this setting.

For lower sampling rates, the bandwidth of the decimation filter is decisive provided no narrower (equalized) RBW is set.

Sampling rates between 81.6 MHz and 100 MHz are achieved by sampling at a fixed rate of 81.6 MHz followed by interpolation. Although a decimation filter is activated again in this mode, the RBW of the IF filter is the determining factor for the total bandwidth. If the R&S FSQ-B72 option is activated, an RBW of 120 MHz, a halfband filter of 160 MHz, as well as a bandwidth of the decimation filter of 0.68 * F_symbol/2 is always active.

Table 6 Maximum I/Q bandwidths of data recording

Sampling rate f_{sample} [MHz]	RBW bandwidth	Equivalent IF BW (halfband filter)	Equivalent IF BW (decimation filter)
81.6...326.4 MHz*)	120 MHz	approx. 160 MHz	0.68* f_sample
81.6...100 MHz (Interpolation)	Equalized RBW, max. 28**)	approx. 40 MHz	0.35* f_sample
40.8 ... 81.6	Equalized RBW, max. 28**)	approx. 40 MHz	-
20.4 ... 40.8	Equalized RBW, max. 28**)	approx. 40 MHz	0.68* f_sample
< 20.4	Equalized RBW, max. 28**)	approx. 40 MHz	0.8* f_sample

*) only if R&S FSQ-B72 active

**) or R&S FSU max. 7 MHz

The table below shows the effect of the symbol rate and of points/symbol parameters on the sampling rate.

Table 7 I/Q bandwidth as a function of POINTS/SYM setting

Parameter POINTS / SYM	IQ baseband-BW (single side)	IQ-IF-BW (double side)	Example: IQ-IF-BW (f_symbol = 100 kHz)
1, 2, 4	(0.8 * F_symbol/2) * 4	(0.8 * F_symbol/2) * 4 *2	360 kHz
4*) (fixed)	(0.68 * F_symbol/2) * 4	(0.68 * F_symbol/2) * 4 *2	-
8	(0.68 * F_symbol/2) * 8	(0.8 * F_symbol/2) * 8 *2	720 kHz
16	(0.8 * F_symbol/2) * 16	(0.8 * F_symbol/2) * 16 *2	1440 kHz

*) only if R&S FSQ-B72 active

For common **PSK**, **QAM** and **MSK** systems, signal sampling with 4 points/symbol fulfills the system-theoretical requirements for a measurement demodulation.

A higher oversampling rate yields a better resolution of displayed traces but it may cause more measurement errors if the extended I/Q bandwidth contains interferences (and the measurement bandwidth corresponds to the I/Q bandwidth). An example is given in the following section.

With **FSK** systems, oversampling must be set to match the modulation index so that no modulation errors are produced by I/Q filtering.

3.1.2.3 Demodulation Bandwidth (Measurement Bandwidth)

The demodulation bandwidth is the part of the spectrum used for demodulation and measurement of the digitally modulated signal. In most cases, the spectrum is routed through a receive filter to obtain intersymbol-interference-free conditions permitting optimum symbol decision. After this receive filter, the modulation error is also measured. For this reason the term MEASUREMENT FILTER (Meas_Filter) is used here. A few modulation systems, especially MSK and FSK, do not use this input filtering. In these cases special care should be taken that no interference or adjacent channels occur within the demodulation bandwidth.

The figure below shows the demodulation bandwidths with different settings of the oversampling rate.

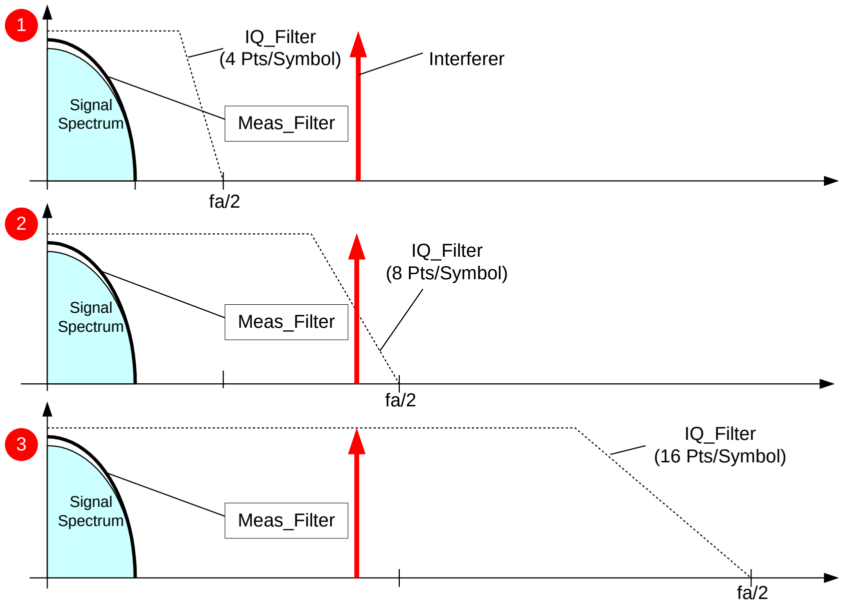


Fig. 27 Selected oversampling rates (I/Q bandwidth, interference)

Fig. 27 shows the spectrum of a digitally modulated signal that was sampled with the oversampling rates 4 (1), 8 (2) and 16 (3).

In addition to the signal spectrum - which is identical in all three cases - different I/Q bandwidths and a single-frequency interfering signal are shown.

If a demodulation or measurement filter is used, the interferer is suppressed in all three examples and the measurement bandwidth corresponds to that of the measurement filter.

If no filter is used for the measurement, the interfering carrier is suppressed by the I/Q filter only in example 1; in example 2 it is partly suppressed and in example 3 not at all.

The same effect occurs if the measurement filter is switched off for special measurements on unfiltered PSK and QAM signals (RESULT = RAW setting).

Typical PSK systems prescribe 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.

3.1.2.4 System-Theoretical Modulation and Demodulation Filters

Sampling 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 (ISI 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.

n many PSK systems, RRC filters are used as transmit, ISI and measurement filters. To determine the I/Q measurement error, the measurement signal must be compared with the I/Q trace of an ideal signal. For this purpose a REFERENCE FILTER is required which is calculated by the analyzer from the coefficient convolution of the transmit filter (TX FILTER) and the MEAS FILTER (see Fig. 28, RESULT = FILT).

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 with the Tx filter (see Fig. 29, RESULT = RAW)

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

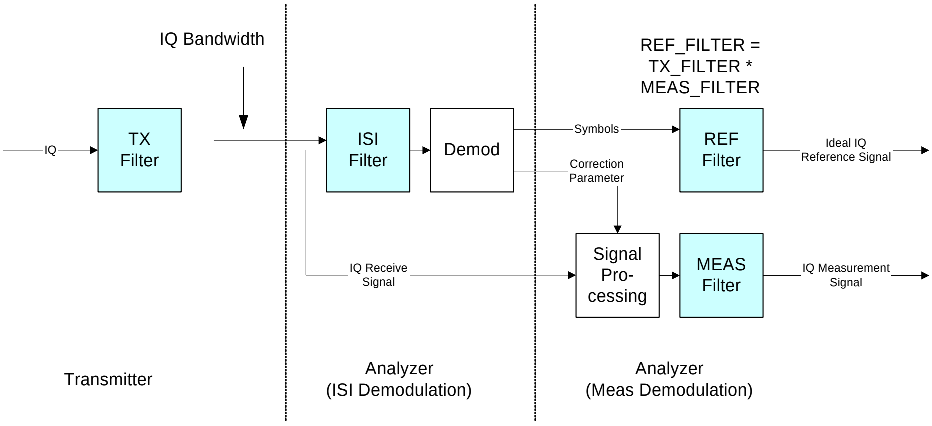


Fig. 28 Block diagram of filters in the PSK mode (RESULT = FILT setting)

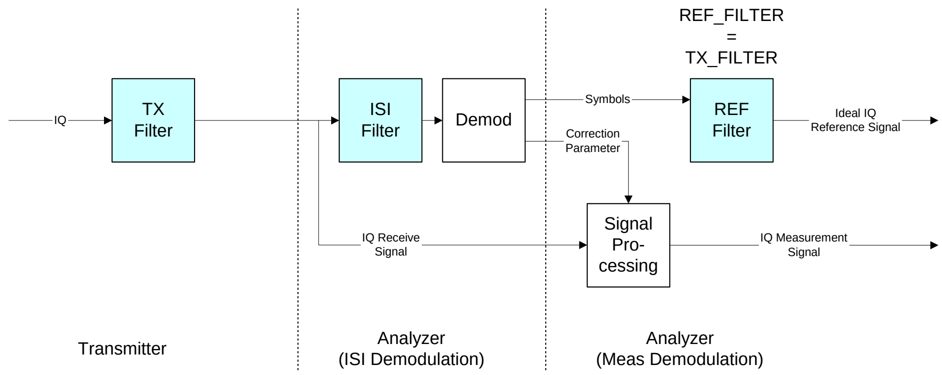


Fig. 29 Block diagram of filters in the PSK mode (RESULT = RAW setting)

For a correct demodulation, 3 filters have to be accurately specified for the analyzer:

- **transmit filter (TX filter)**: filter characteristic of transmitter
- **receive filter (ISI filter)**: filter characteristic of a receive filter producing intersymbol-interference-free points from the Tx-filtered signal
- **MEAS** filter: filter used for measurements. In many applications, this filter is identical with the ISI filter.

The **REFERENCE** filter synthesizes the ideal transmit signal (after MEAS filtering). It is calculated by the analyzer from the above filters (convolution operation TX_FILTER * MEAS_FILTER).

Table 8 Typical combinations of TX, ISI and MEAS filters

Mod. type	**Modulation filter (transmit filter)**	**Demodulation filter = receive filter (analyzer)**	**Measurement filter (analyzer)**	**Remarks**
PSK, QAM, VSB	RC (Raised Cosine)	-	-	ISI system
PSK, QAM, VSB	RRC (Root Raised Cosine)	RRC	RRC	ISI system
FSK	Gauss	-	-	Near ISI system
MSK	Gauss	-	-	Near ISI system
EDGE	GAUSS_LINARIZED	EDGE_ISI	EDGE_MEAS	**Standard specific filters NO ISI system!**
Cdma2k	CDMA2k_1X_TX	CDMA2k_1X_ISI	CDMA2k_1X_ISI	**Standard specific filters**, but ISI-system

Typical combinations of TX, ISI and MEAS filters are shown in the table above; they can be set in the analyzer as a FILTER SET. If RC (raised cosine), RRC (root-raised cosine) and GAUSSIAN filters are used, the ALFA (RC, RRC filters) and BT (GAUSSIAN filters) parameters must be set in addition to the filter characteristic (roll-off factor).

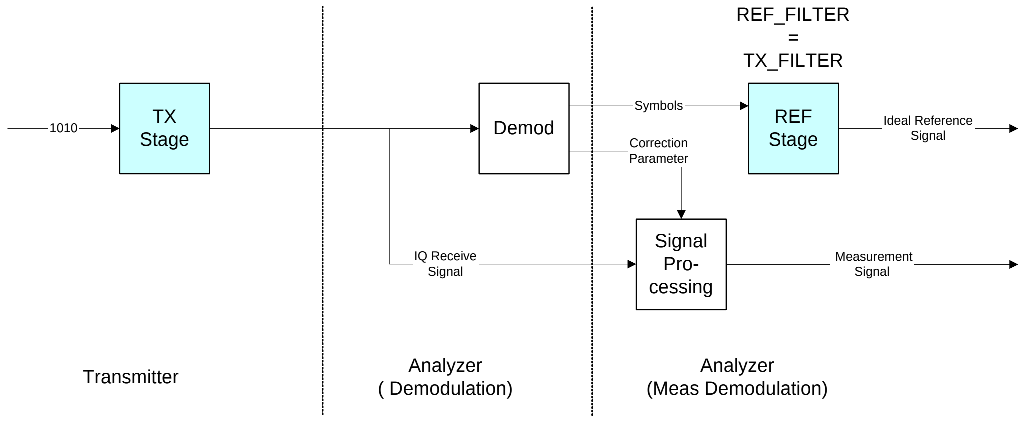


Fig. 30 Block diagram of filter stages in the MSK and FSK modes

No further band limiting is performed in FSK and MSK systems by MEAS or ISI filters in the signal path. Some parts of signal generation in the transmitter and generation of the reference signal in the analyzer are much more involved. The next section contains detailed block diagrams for signal generation and describes requirements caused by customized filters in the instrument.

3.1.2.5 Design and Use of Customized Filters

The analytical filter types RC (raised cosine), RRC (root-raised cosine) and GAUSSIAN as well as the most important standard-specific filters are already integrated in the basic unit. The requirements described in this chapter should be observed when customized filters are designed.

Customized filters may be useful for the following purposes:

- Development of new networks and modulation methods for which no filters are defined yet.
- Measurements of transmitter characteristics with slightly modified (e.g. shortened) transmitter filters.

Filter for PSK, QAM, USER-QAM and VSB

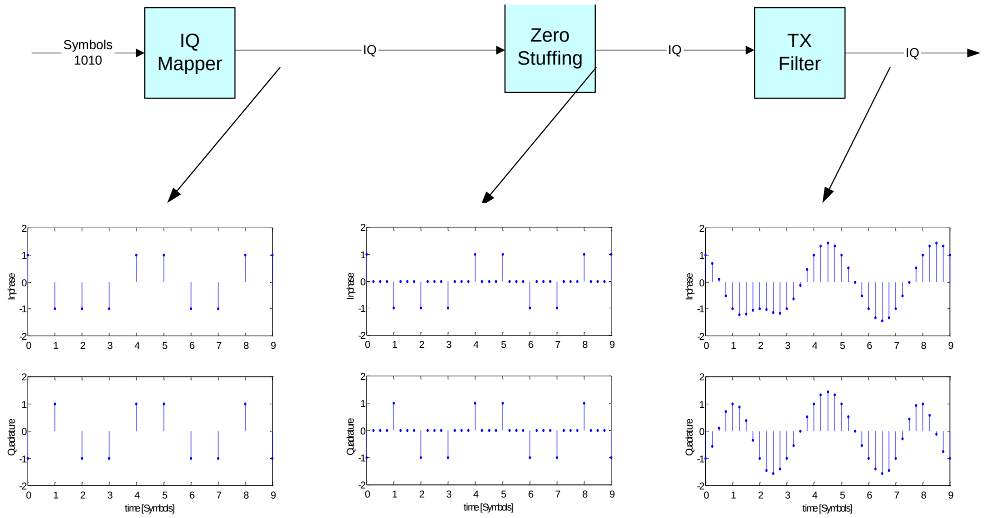


Fig. 31 Generation of baseband transmit signal (PSK, QAM, USER-QAM and VSB)

Fig. 31 illustrates generation of a QPSK signal in the complex baseband.

In an I/Q mapper, logic symbols are mapped onto complex symbols in the I/Q plane. In the ZERO STUFFING stage, zeros are inserted between the symbols, and this oversampled signal is then filtered in the TX filter stage. For the sake of clearness, the signals in the figures are oversampled with 4 points/symbol.

Filter for FSK / MSK

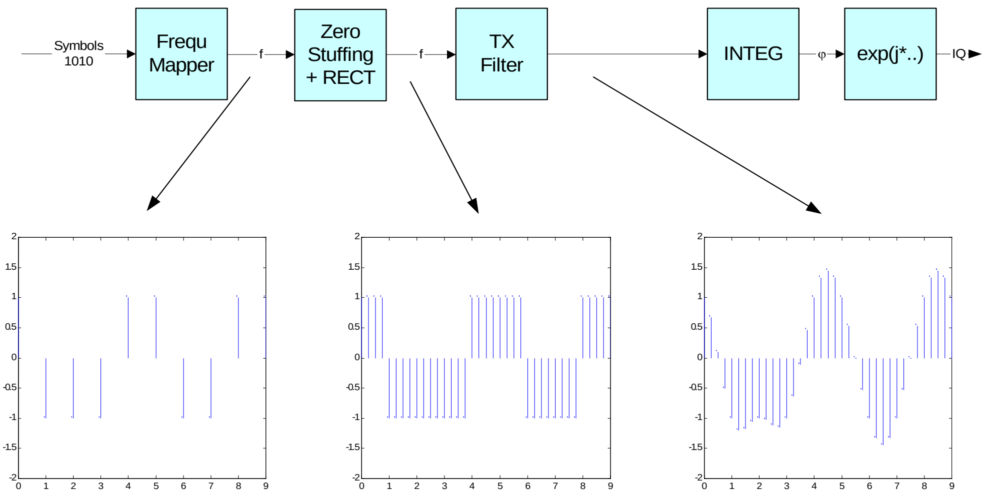


Fig. 32 Generation of transmit signals (FSK, MSK)

Fig. 32 illustrates the generation of a 2-level FSK signal.

An I/Q mapper maps logic symbols onto real Dirac pulses in the frequency-versus-time plane. In the ZERO STUFFING + RECT stage, each Dirac pulse is replaced by a square pulse of one symbol length. This oversampled signal is then filtered in the TX filter stage.

The INTEGRATOR and EXP stages have nothing to do with filtering; they only convert the signal to the I/Q plane. As in the previous example, the signals are oversampled by the factor 4.

The following requirement must be met by all customized filters:

- Oversampling rate (f_{sample} / f_{symbol}) of 32 in the time domain
- The filter must feature purely real coefficients
- The number of coefficients must be uneven
- The filter must be symmetrical to the central filter coefficient.

3.1.2.6 Adaptive Equalizer Filter

A possible source of high modulation errors of the DUT with PSK and QAM signals is a non-flat frequency response or ripple in frequency response within the modulation bandwidth.

This could be caused by the DUT's:

- Analog filter sections
- Digital filter sections, if a shortened filter length is used
- Digital arithmetic sections, if a shortened bit-length is used

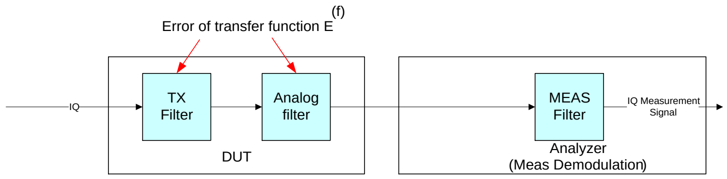


Fig. 33 Base band schematic of the modulation- and demodulation stages

In the case of low linear distortions an equalizer filter (with reverse frequency response characteristic) is able to compensate the distorted frequency response in order to improve the modulation analysis results (see figure below).

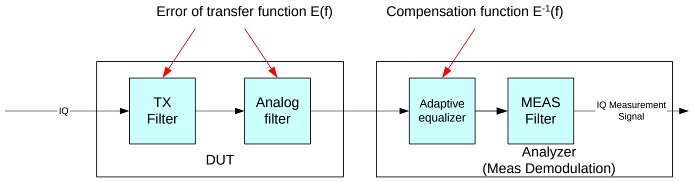


Fig. 34 Base band schematic: compensation of the transfer function's error by inserting an adaptive equalizer in the receive path

The measurement demodulator's signal path -including the adaptive equalizer filter- is shown in following figure . In front of the demodulation chain the adaptive filter is arranged. The filter coefficients are adapted in such a way that the mean square value of the error vector magnitude (EVM) is minimized. By comparing the demodulated measuring signal and the ideal signal (generated from the demodulated symbols) a control signal for the equalizer is extracted.
When analyzing the filter coefficients (trained equalizer state) with a FFT the compensating transfer function can be gained and from it the error function E(f) can be gathered.

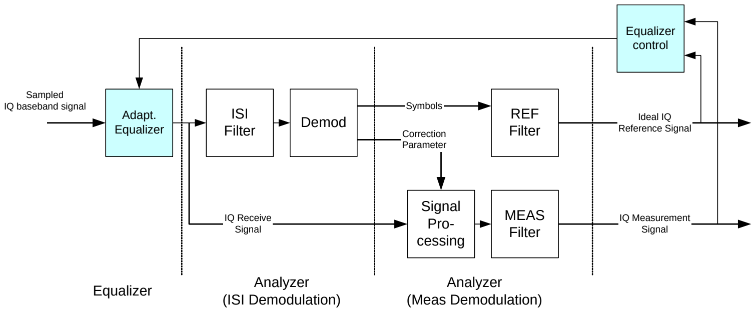


Fig. 35 Base band schematic: compensation of the transfer function's error by inserting an adaptive equalizer in the receive path

Another range of application is the analysis of an unknown or approximately known transmitter filter. The adaptive filter algorithm delivers a matched receiver filters for an intersymbol-interference-free demodulation when the following filter setting is set.

- Transmit-Filter = raised cosine
- Receive-Filter = none
- Measurement-Filter = none

The algorithm is limited to PSK and QAM modulation schemes, because of the optimization criterion of the algorithm is based on minimizing the mean square error vector magnitude. So it cannot be used for MSK, FSK and VSB schemes.

3.1.2.7 Training process of the equalizer

During operation of the equalizer we have to distinguish between two states:

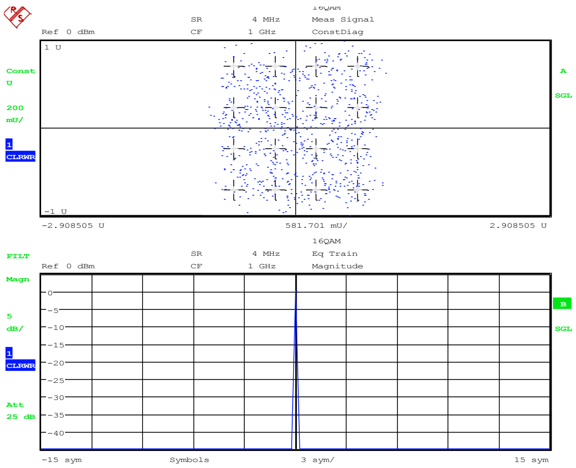
TRAIN The equalizer is trained; the filter coefficients are continual adjusted by using the current demodulation results in order to minimize the RMS EVM. This process needs a lot of calculation so that the measurement update rate of the instrument decreases distinctly.

FREEZE The current filter coefficients are frozen, that means they no longer adapted. The display update rate increases distinctly again

Training phase of the adaptive equalizer starts

The screen plot (upper diagram) shows a broad distribution of the constellation points (dots) around the ideal decision points (cross hairs)

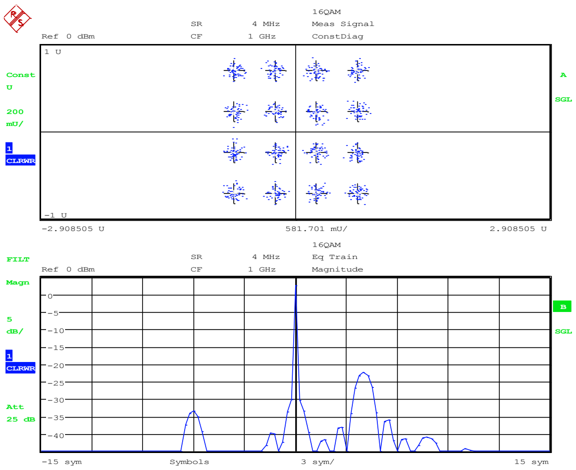
The magnitude of the filter coefficients is shown in the lower part of the diagram in logarithmic scaling. The equalizer has not been trained yet, so a neutral filter is arranged in the signal path (all filter coefficients are zero, only the middle filter tap has the value 'one')



During the training phase

The screenshot (upper diagram) indicates a distinct improvement because of the variance of constellation points distribution has decreased observably. On either side of the adaptive filter's middle filter tap more non-zero coefficients are coming up (lower diagram). The logarithmic scaling makes the diagram very sensitive to.

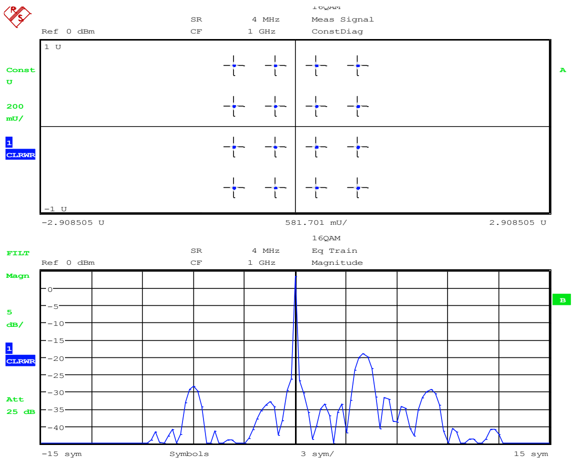
Slight variations of the filter coefficients are easy to observe due to the logarithmic scaling of the diagram.



End of the training phase

The screenshot (upper diagram) indicates a nearly perfect constellation diagram. All constellation points are located close to their ideal positions in the cross hairs. The variance of the constellation distribution cannot be observed anymore. The accuracy of equalizer's coefficients has further improved and the number of non-zero coefficients has slightly increased.

Please note that there are still some zero coefficients, so the filter length could be a little reduced for the shown measurement problem (saves calculation time during the equalizer's training phase).



Operating range of the Equalizer

The total frequency response can be flattened by the equalizer filter only in the pass-band of the transmitter- and receiver filter respectively. Because of the ideal reference signal doesn’t generate any signal power outside of the pass-band, the equalizer eliminates most of the measurement signal’s out of band power if necessary. The equalizer’s out-of- band characteristic is mainly influenced by the existence or not-existence of any interfering signal power (e.g. noise, spurious signals, interfering signals). If there are any interfering out-of-band signals, the equalizer algorithm is going to suppress by its transfer characteristic (high out of band attenuation).

If there are no interfering signals, there is no need for the equalizer to suppress out of band signals (flat but poor out-of-band attenuation). The user has to consider this behavior when interpreting the filter’s frequency characteristic.

The following figure exemplifies the equalizer’s frequency response for a linear distorted measurement signal (raise cosine filter, alpha = 0.22). The optimization range is enhanced by red lines. An estimate of the pass-band with the pre-known signal parameters gives a good approximation to the equalizer’s optimization range as demonstrated in the figure (signal has a very good signal to noise ratio, therefore the out-of band response is flat):

Filter-bandwidth = symbol-rate*(1+alpha) = 4MHz*1.22=4.88 MHz

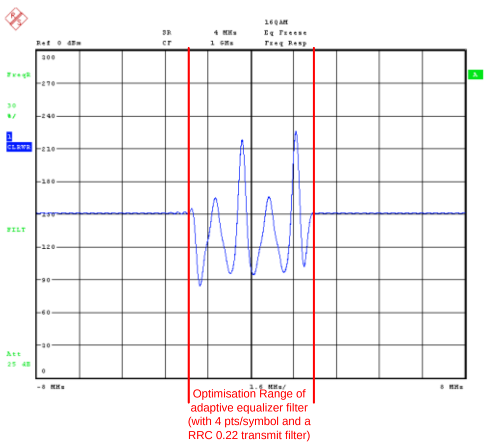


Fig. 36 Optimization range of the adaptive equalizer filter

The adaptive equalizer's out-of-band transfer function is mainly influenced by the signal to noise ratio and interfering signals, as mentioned before. The algorithm tries to suppress any interfering signals in order to improve the RMS EVM value. Hence the out-of-band transfer function does not represent an inverse frequency response of the DUT or the channel.

The equalizer's frequency response to an input signal providing with poor SNR is shown in Fig. 37 whereas the response to a signal with good SNR is demonstrated in Fig. 38. The left diagram (bad SNR) indicates a good suppression of interfering signals.

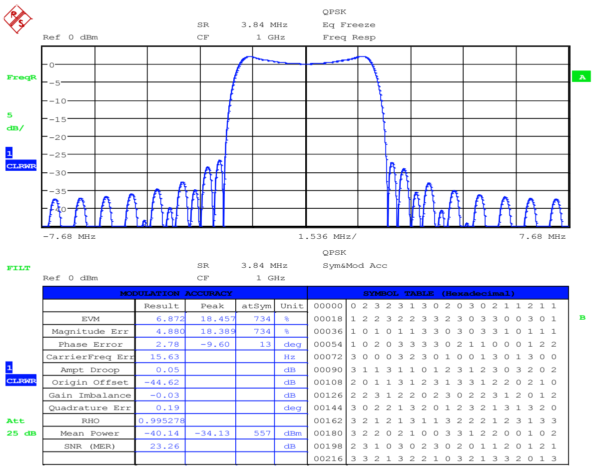


Fig. 37 Upper diagram: frequency response of a trained equalizer filter (bad SNR at the instrument's input)

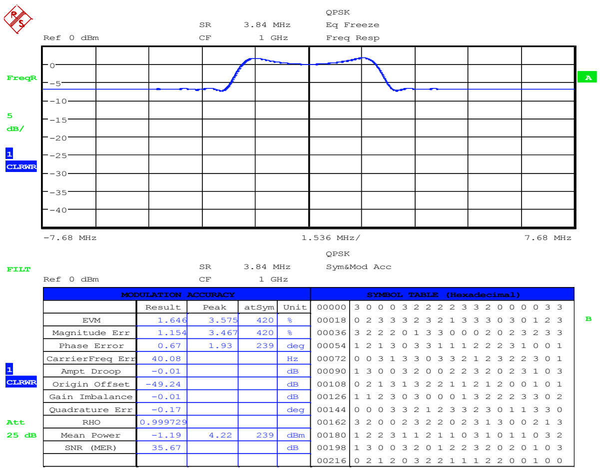


Fig. 38 Upper diagram: frequency response of a trained equalizer filter (good SNR)

3.2 Symbol Mapping

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

Mapping in the analyzer serves for decoding 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).

If logical symbol mapping does not exactly correspond to the display on the screen, the corresponding physical constellation diagram is shown in addition to mapping.

3.2.1.1 Phase Shift Keying (PSK)

With this type of modulation, the information is represented by the absolute phase position of the receive signal at the decision points. All transitions in the I/Q diagram are permissible for modulation types using static mapping. The complex constellation diagram is shown. The symbol numbers are entered in the diagram according to the mapping rule. The diagram displayed on the analyzer corresponds to symbol mapping.

BPSK (NATURAL)

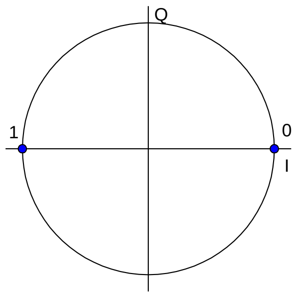


Fig. 39 Symbol mapping – BPSK / NATURAL

QPSK (WCDMA)

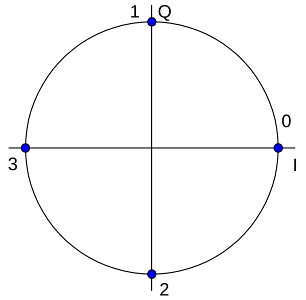


Fig. 40 Symbol mapping – QPSK / WCDMA

QPSK (NATURAL)

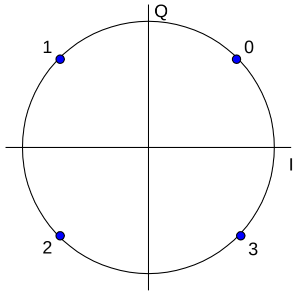


Fig. 41 Symbol mapping – QPSK / NATURAL

QPSK (CDMA2K_FWD)

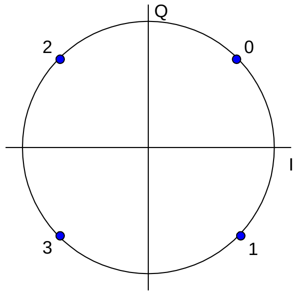


Fig. 42 Symbol mapping – QPSK / CDMA2K_FWD

8PSK (NATURAL)

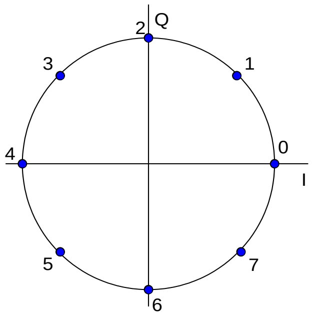


Fig. 43 Symbol mapping – 8PSK / NATURAL

3.2.1.2 Phase Offset PSK

With this type of modulation, the digital information is represented by the absolute position in the constellation diagram, a phase offset of (n*phi_offset) (n = symbol number) being taken into account for each I/Q symbol. This offset has the same effect as a rotation of the basic system of coordinates by the offset angle after each symbol.

This phase offset is automatically considered when the symbols are decoded and displayed.

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 3pi/8-8PSK and (in conjunction with phase-differential coding) for pi/4-DQPSK.

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

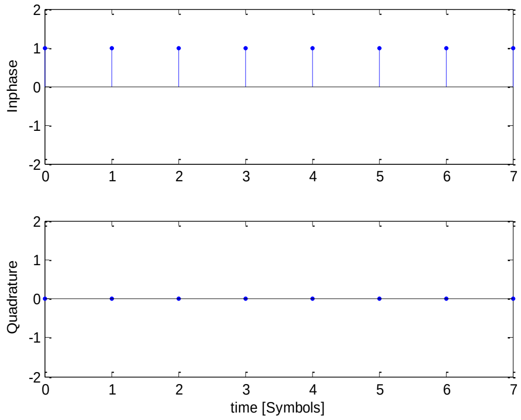


Fig. 44 I/Q symbol stream before 3pi/8 rotation

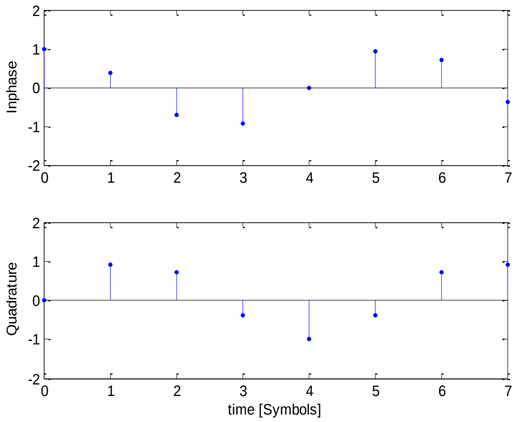


Fig. 45 IQ-I/Q symbol stream after 3pi/8 rotation

Fig. 44 and Fig. 45 illustrate the influence of the 3pi/8 rotation. Fig. 44 shows the I/Q symbol stream in the transmitter before rotation (corresponding to an 8PSK modulation), Fig. 45 after rotation (3pi/8 PSK). 1+j*0 was constantly assumed as the modulating symbol.

Fig. 46 and Fig. 47 show the corresponding display in the I/Q plane.

The logical constellation diagram (Fig. 46) comprises 8 points corresponding to the modulation level. When looking at the decision points of an ISI-free receive signal, a physical constellation diagram (Fig. 47) with 16 possible points is obtained.

Eingezeichnet sind Examplehaft 5 Symbolübergänge ‚Symbol 7'->'Symbol 7'in der Five symbol transitions are shown in the 'symbol 7'→ 'symbol 7'diagram in Fig. 47.

3pi/8-8PSK (EDGE)

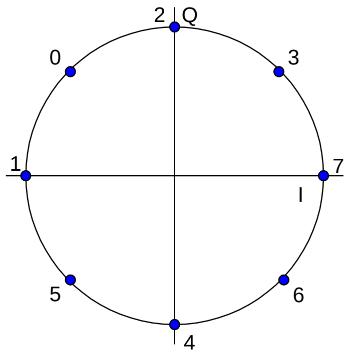


Fig. 46 Logical symbol mapping – 3pi/8-8PSK / EDGE

3pi/8-8PSK (display)

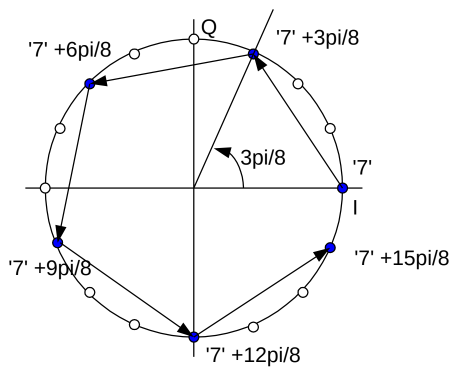


Fig. 47 Physical constellation diagram with ISI-free demodulation (taking into account the 3pi/8 phase offset)

Fig. 48shows the TX filter prescribed for the EDGE standard. Fig. 49 shows the vector diagram of a transmitted EDGE signal and the reduced dynamic range of the signal in the case of phase offset modulation (eye aperture in the center of the diagram). The displayed signal is not filtered at the receiver end so that the ISI-free points cannot be seen in the diagram.

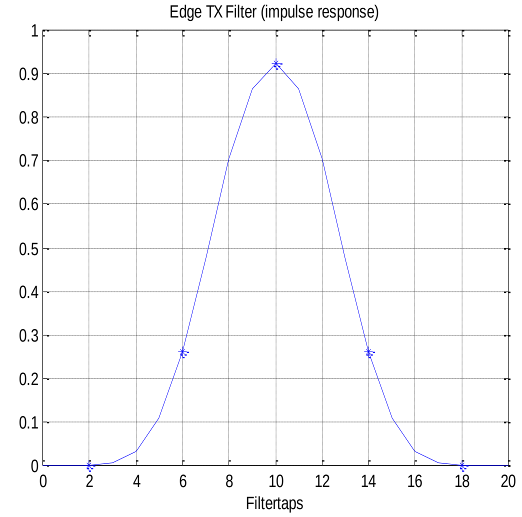


Fig. 48 EDGE TX filter

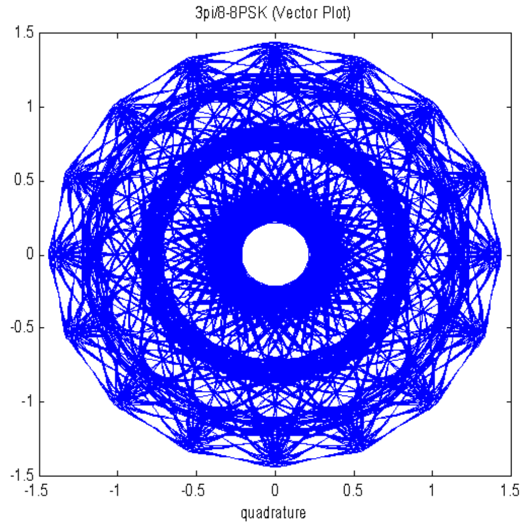


Fig. 49 Vector diagram: transmitted EDGE signal

3.2.1.3 Differential PSK (DPSK)

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

In the **logical mapping diagram**, all permissible symbol transitions (phase transitions) are represented by points in the I/Q plane. The phase position of a point corresponds to the phase difference of the symbol transition. The arrow in the diagram highlights the phase shift and indicates the corresponding symbol number.

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.

The symbol transitions at any constellation point in the diagram are indicated by arrows and labelled according to the mapping.

The indicated QPSK (ISAT) mapping corresponds to simple QPKS with phase-differential coding. Other types of modulation using this coding method are described in the section 'Mixed PSK modulation'.

DQPSK (INMARSAT)

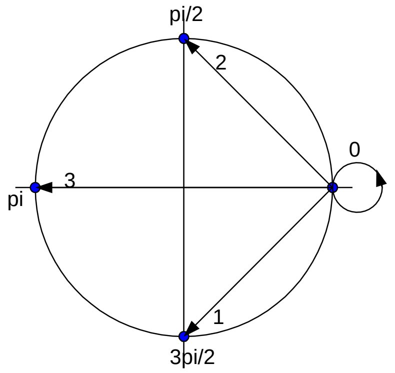


Fig. 50 Logical symbol mapping – DQPSK / INMARSAT

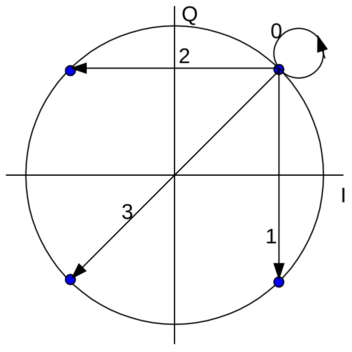


Fig. 51 Physical constellation diagram – DQPSK / INMARSAT

D8PSK (NATURAL)

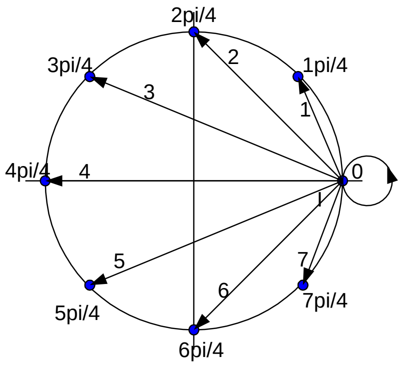


Fig. 52 Logical symbol mapping – D8PSK / NATURAL

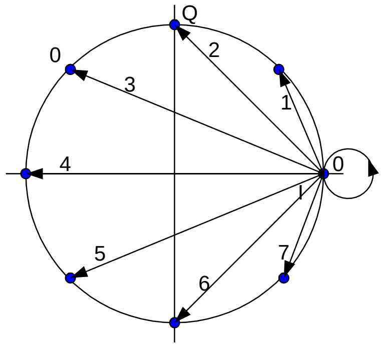


Fig. 53 Physical constellation diagram – D8PSK / NATURAL

3.2.1.4 Mixed PSK Modulation

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

The logical mapping diagram corresponds to the diagram for DPSK.

In the **physical constellation diagram**, the constellation points at the symbol decision points obtained after ISI-free demodulation are shown. This diagram corresponds to the display on the analyzer and, in the case of pi/4-QPSK modulation, the displayed constellation points are doubled.

Pi/4 DQPSK (NADC, PDC, PHS, TETRA)

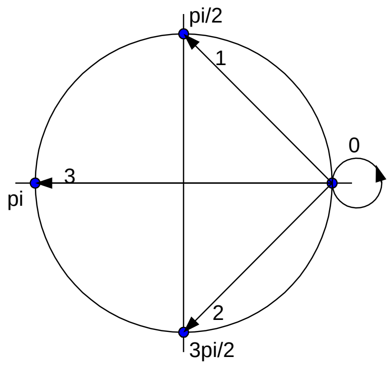


Fig. 54 Logical mapping – (NADC, PDC, PHS, TETRA)

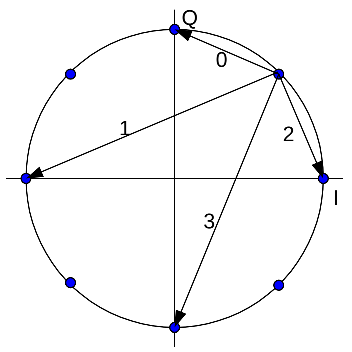


Fig. 55 Physical constellation diagram –pi4-DQPSK (NADC, PDC, PHS, TETRA); the pi/4 phase offset is taken into account

Pi/4 DQPSK (TFTS)

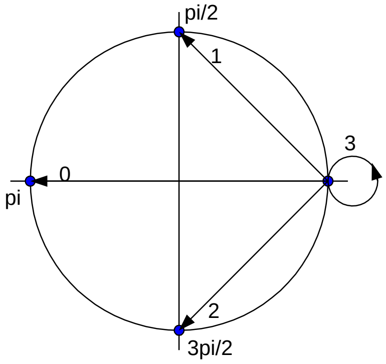


Fig. 56 Logical mapping – pi/4 DQPSK (TFTS)

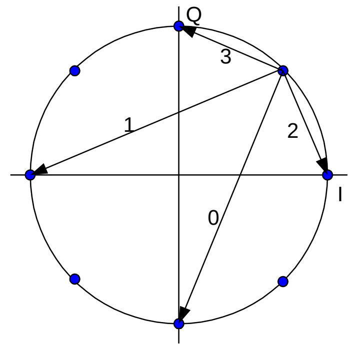


Fig. 57 Physical constellation diagram – pi/4DQPSK (TFTS); the pi/4 phase offset is taken into account

3.2.1.5 Offset QPSK

With this method, the Q component is delayed by half a symbol period against the I component in the time domain. This method is used with QPSK and illustrated by the diagrams below.

Derivation of OQPSK

QPSK

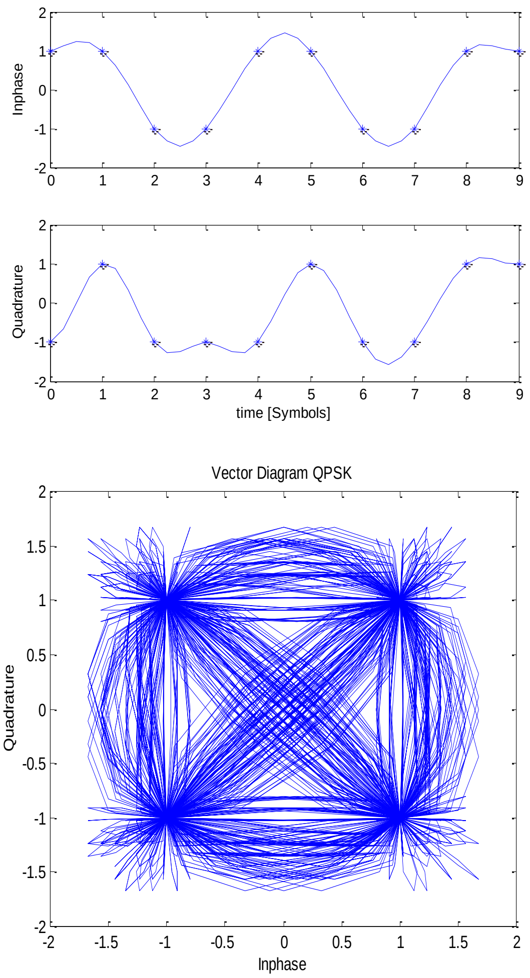


Fig. 58 PSK vector diagram with alpha = 0.35

OQPSK (delayed Q component)

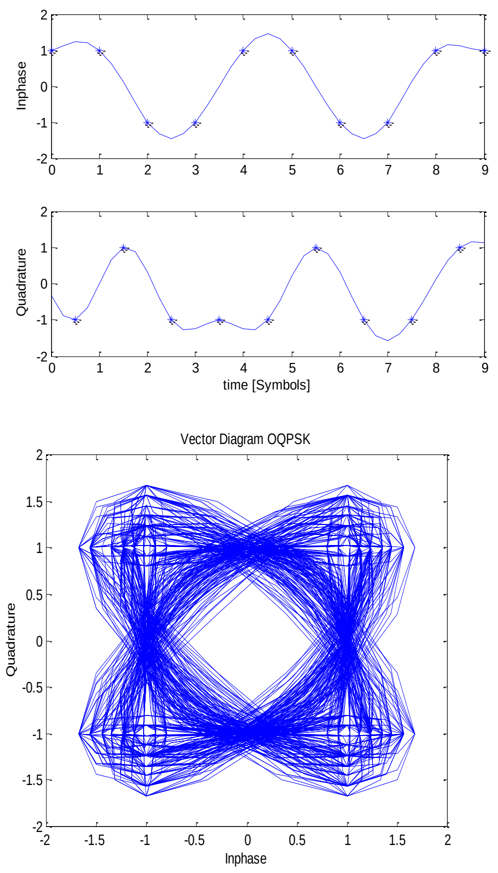


Fig. 59 OQPSK vector diagram with alpha = 0.35

This method (as phase offset PSK) reduces the dynamic range of the modulated signal and the demands on amplifier linearity by avoiding the zero crossing.

A distinction is made in the analyzer display:

- In the I/Q diagram (I/Q VECTOR), the time delay is not compensated for. The display corresponds to the physical diagram shown in Fig. 59.
- In the constellation diagram (I/Q CONSTELLATION), the time delay is compensated for. The display corresponds to the logical mapping (Fig. 60)

OQPSK (CDMA2K_REV)

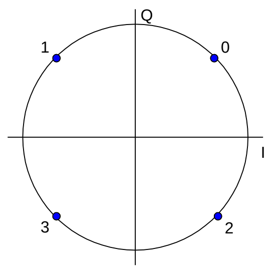


Fig. 60 Logical symbol mapping – OQPSK / CDMA2K_REV

3.2.1.6 Frequency Shift Keying (FSK)

In the case of FSK demodulation, a frequency/time diagram is displayed instead of the constellation and vector diagrams. The symbol decision is based on the signal frequency at the decision points.
To illustrate the symbol decision thresholds, the symbol numbers are marked in the logical mapping diagram versus the instantaneous frequency f_i . The 0 frequency in the baseband corresponds to the input frequency of the analyzer.

2-FSK (NATURAL)

With 2FSK, the symbol decision is made by a simple frequency discriminator with reference to the 0 frequency in the baseband:

$$s(t) = \begin{Bmatrix} 1 & \textit{für} & f_i(t) \geq 0 \\ 0 & \textit{für} & f_i(t) < 0 \end{Bmatrix}$$

for all symbol decision points t = n*Ts,

f_i = instantaneous frequency normalized to FSK REF DEVIATION

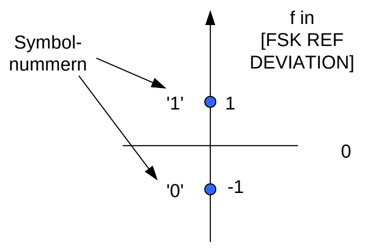


Fig. 61 Symbol mapping – 2FSK / NATURAL

4-FSK

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

$$s(t) = \begin{Bmatrix} 0 & \textit{für} & f_i(t) < -\frac{2}{3} \\ 1 & \textit{für} & -\frac{2}{3} \leq f_i(t) < 0 \\ 2 & \textit{für} & 0 \leq f_i(t) < \frac{2}{3} \\ 3 & \textit{für} & \frac{2}{3} \leq f_i \end{Bmatrix}$$

for all symbol decision points t = n*Ts,

f_i = normalized instantaneous frequency

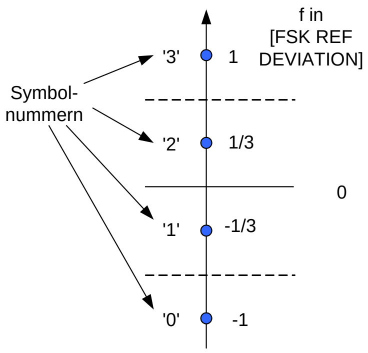


Fig. 62 Symbol mapping – 4-FSK / NATURAL

3.2.1.7 Minimum Shift Keying (MSK)

MSK modulation is a special case of 2FSK with FSK REF DEVIATION = ¼ * symbol rate. This special characteristic 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.

MSK (NATURAL)

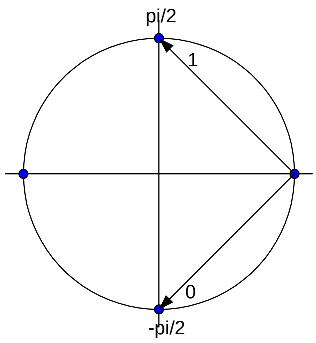


Fig. 63 Logical symbol mapping – MSK / NATURAL

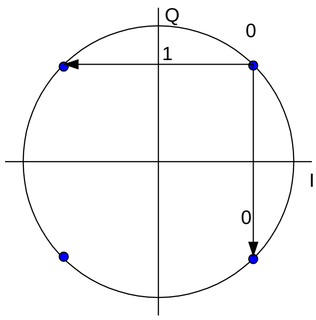


Fig. 64 Physical constellation diagram – MSK

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.

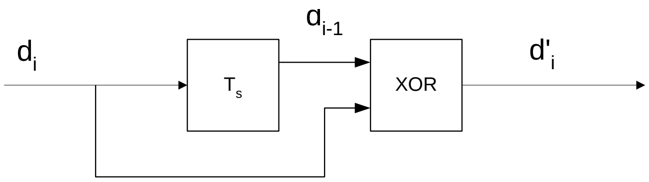


Fig. 65 DMSK: differential encoder in the transmitter

d_i input symbol {0;1} of differential encoder

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

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

During demodulation and symbol decision in the analyzer, the original symbols are restored by a differential decoder and displayed.

This modulation method used for the digital GSM standard in conjunction with a GAUSSIAN transmitter filter is called GMSK.

Signal mapping with the differential encoder is called MSK / GSM.

3.2.1.8 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 (16, 64, 256QAM) or as cross-shaped structures (21, 128QAM) in the I/Q plane.

The differential mappings below meet ETSI EN 300429 V1.2.1 (DVB-C).

NOTICE

To ensure reliable demodulation, the statistical distribution of the available symbol quantity should be as even as possible.

For instance, if only

- single symbols
- single amplitude ranges or
- single quadrants

are used, demodulation errors may occur. As a rule of thumb, the RESULT LENGTH should correspond to at least 8 times the modulation level. For example, with 64 QAM a RESULT LENGTH of at least 4*64 = 256 symbols should be used.

Statistical QAM Mappings

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

Derivation of QAM mappings

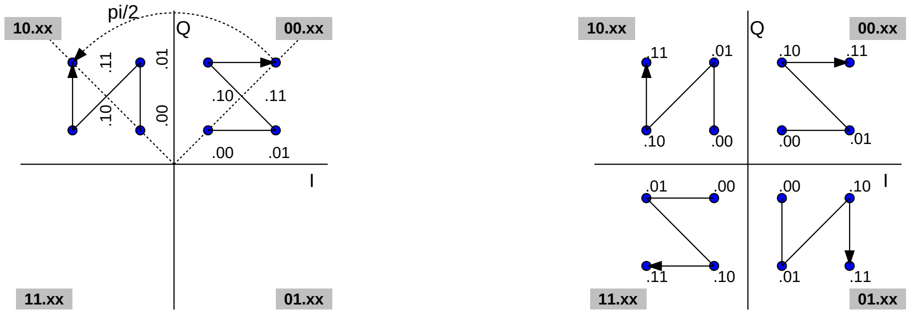


Fig. 66 Rotation of 1st quadrant

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

16 QAM (DVB-C)

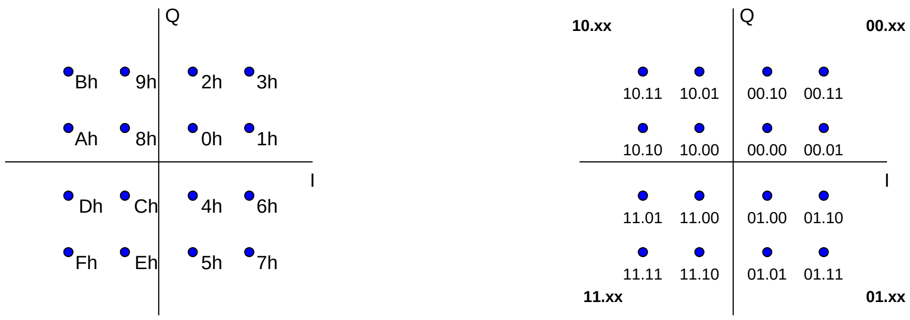


Fig. 67 Symbol mapping – 16QAM / DVB-C

32 QAM (DVB-C)

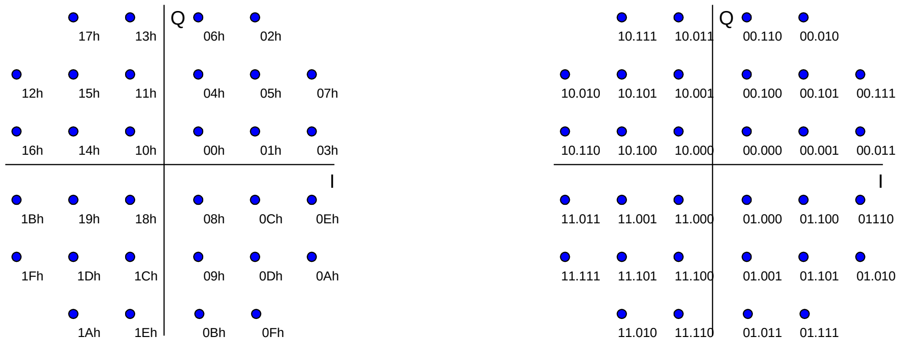


Fig. 68 Symbol mapping – 32QAM / DVB-C

64 QAM (DVB-C)

Fig. 69 Symbol mapping – 64QAM / DVB-C

128 QAM (DVB-C)

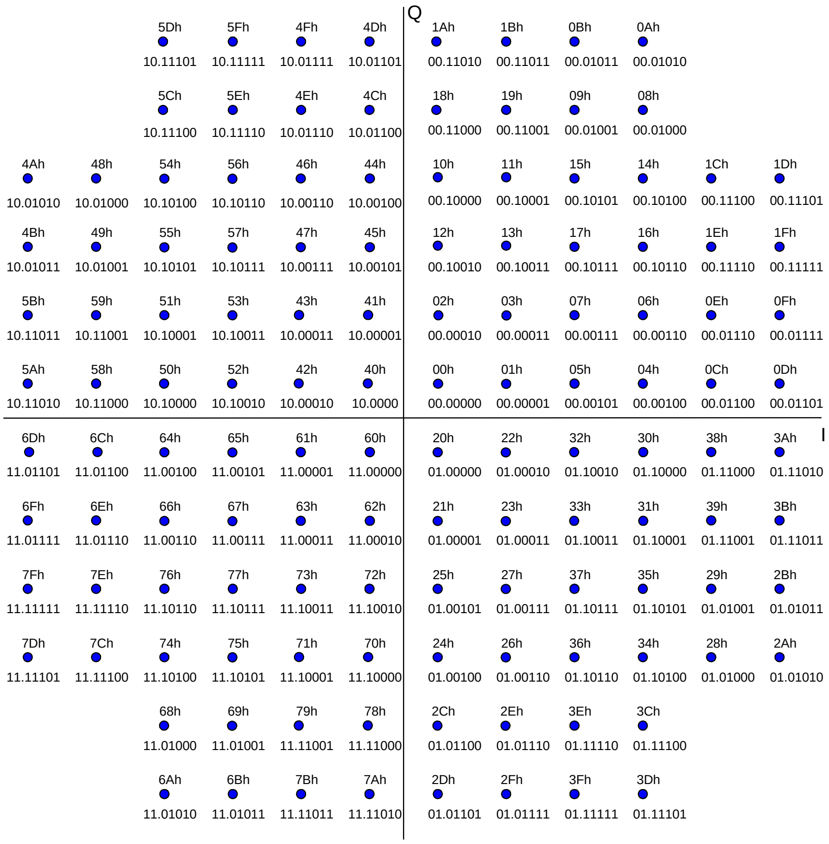


Fig. 70 Symbol mapping 128 QAM / DVB-C

256 QAM (DVB-C)

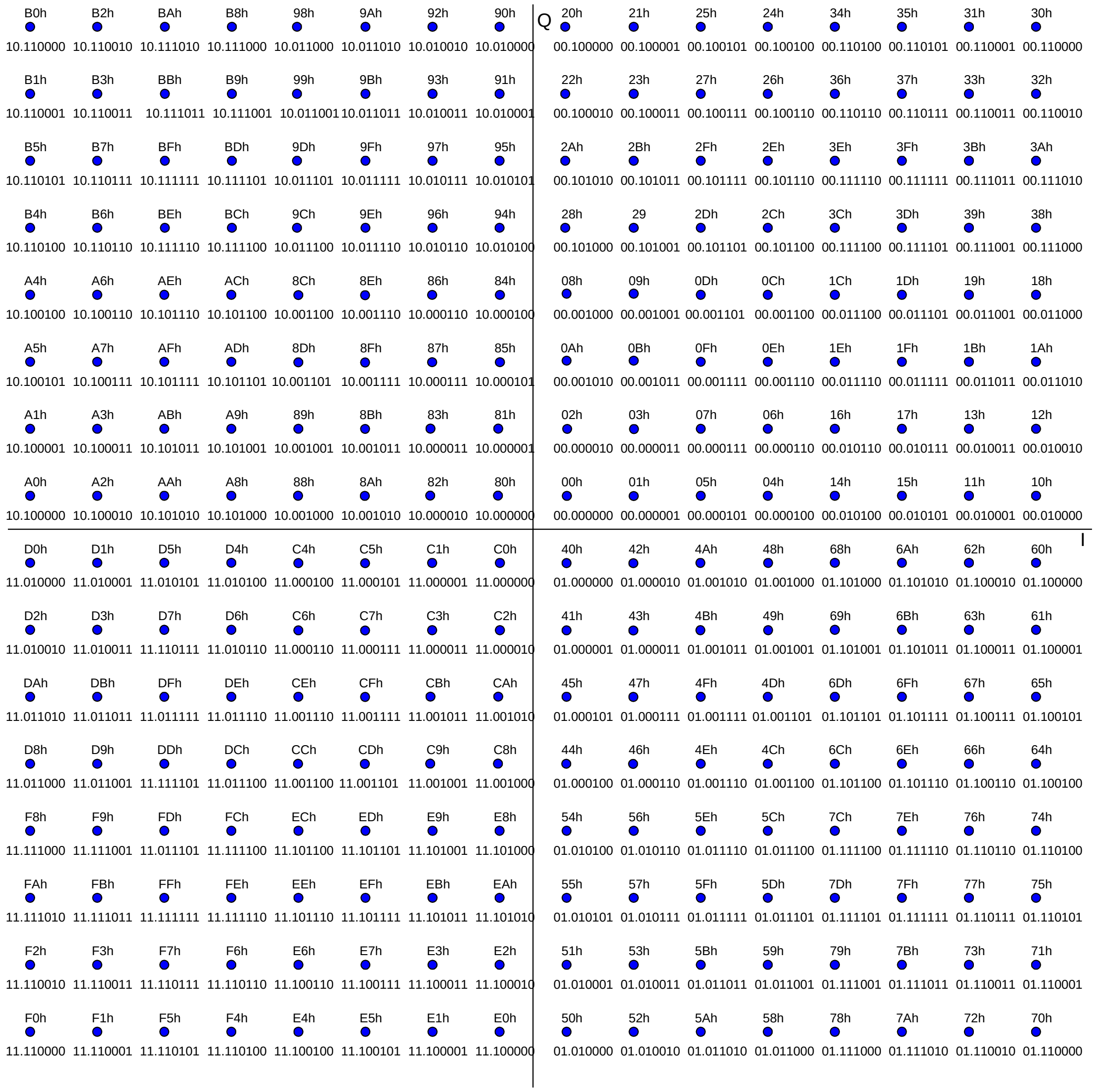


Fig. 71 Symbol mapping 256 QAM / DVB-C

3.2.1.9 Differential QAM Mappings

The following differential QAM mappings show the mapping in a quadrant (1st quadrant) and differential mapping. In the case of differential mapping, the quadrant transitions are coded (as with DQPSK).

Differential 16 QAM (DVB-C)

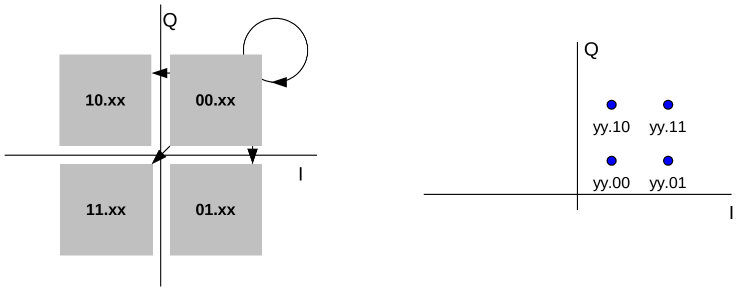


Fig. 72 Symbol mapping D16 QAM / DVB-C

Differential 32 QAM (DVB-C)

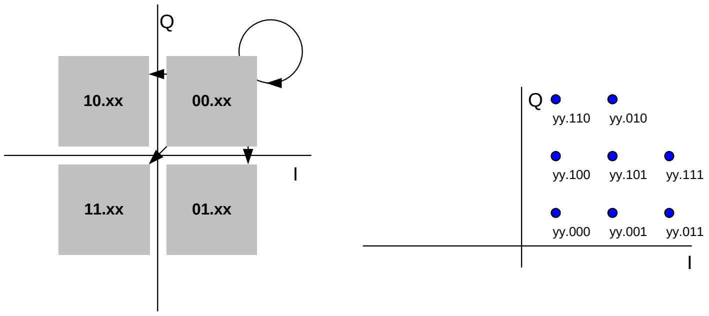


Fig. 73 Symbol mapping D32 QAM / DVB-C

Differential 64 QAM (DVB-C)

Fig. 74 Symbol mapping D64 QAM / DVB-C

Differential 128 QAM (DVB-C)

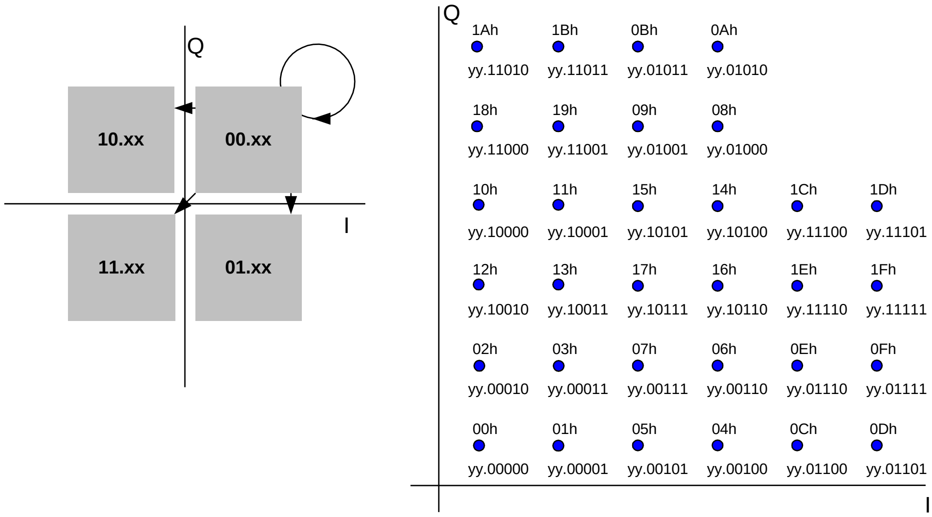


Fig. 75 Symbol mapping D128 QAM / DVB-C

Differential 256 QAM (DVB-C)

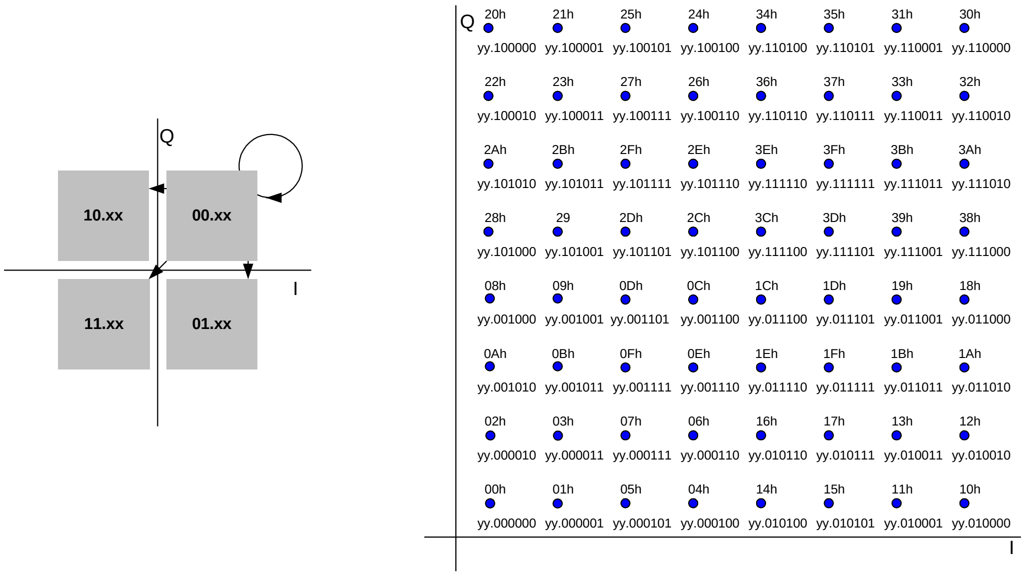


Fig. 76 Symbol mapping D256 QAM / DVB-C

3.2.1.10 User Defined Constellations (USER-QAM)

Customized constellations (including symbol mappings) can be defined with the external utility MAPWIZ (PC Windows environment).

For a description of this tool see chapter 8, Utilities /External Programs

The example in the following figure shows the constellation diagram of the 16-level USER-QUAM that has the minimum probability of symbol errors in the case of AWGN (Source: "Optimization of Two-Dimensional Signal Constellations in the Presence of Gaussian Noise", G. J. Foschini et al., IEEE Transactions on Communications, Vol. COM-22, 01/1974, pp. 28).

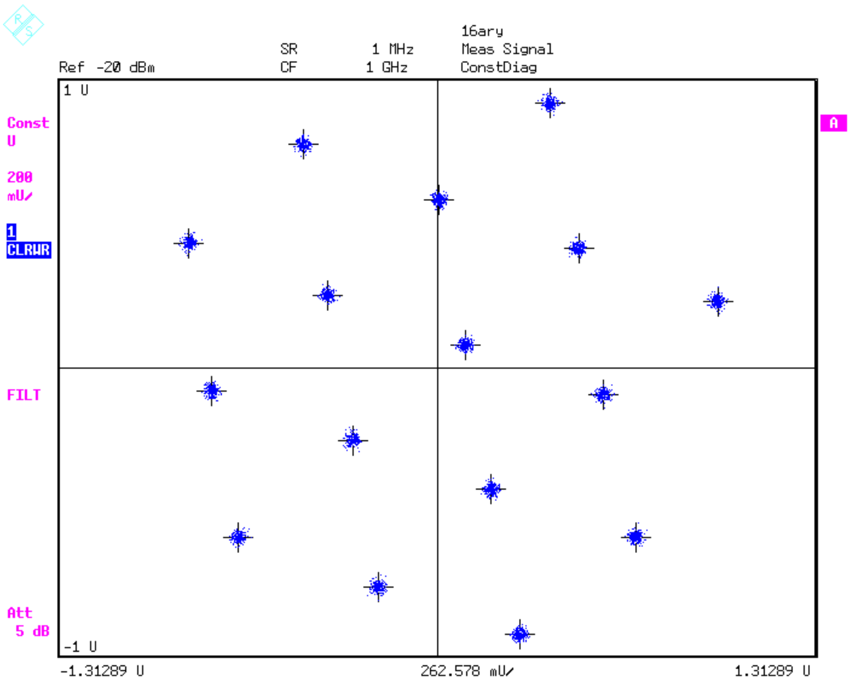


Fig. 77 Demodulation of a 16ary USER-QAM

3.2.1.11 Vestigial Sideband Modulation (VSB)

Like BPSK, digital vestigial sideband modulation (VSB) transfers the information in the real component, in which case different amplitude stages must additionally be used. Owing to the real baseband signal, transmitting a single sideband is sufficient, e.g. VSB signals have half the bandwidth of BPSK signals. Rather than completely suppressing one of the two sidebands, a vestige of the sideband to be suppressed is permitted, thus reducing the effort for implementing filters. However, halving the bandwidth produces intersymbol interference (ISI), which is indicated by vertical lines in the constellation diagram (see Fig. 78).

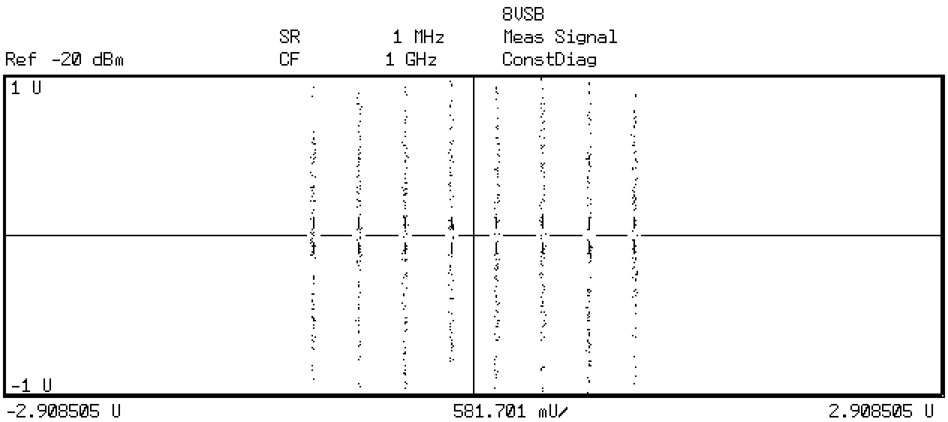


Fig. 78 8VSB constellation diagram

A further and primary difference compared to PSK methods is that VSB signals additionally contain a pilot carrier. The pilot carrier is removed from the signals for all measurements (except capture buffer). To make it possible to analyze VSB signals with the vector signal analyzer, the center frequency and the frequency position (normal position or inverted position) must be adjusted in such a manner that a spectrum that is symmetrical about the center frequency is present at the analyzer input. In this case, the pilot carrier must be located to the left of the center frequency (see Fig. 79). Compared with the true VSB spectrum that has been freed from the pilot carrier (see Fig. 80), the spectrum must be shifted to the left by symbol rate/4.

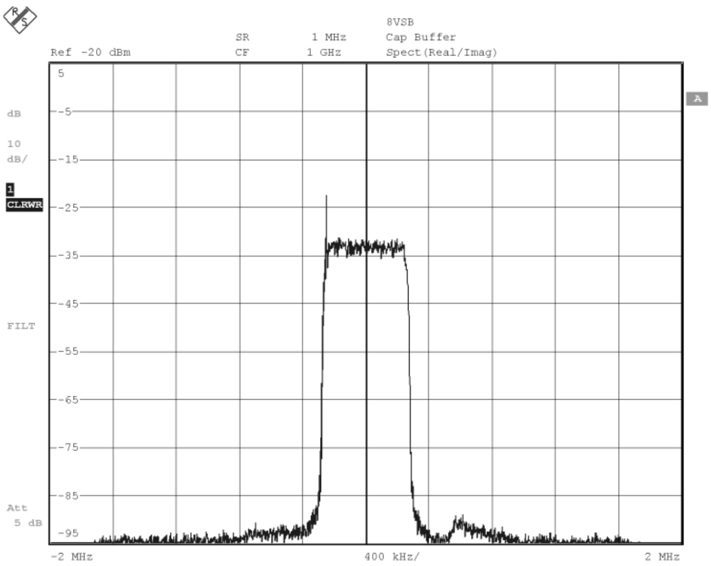


Fig. 79 8VSB spectrum at the input of the analyzer (pilot carrier visible to the left)

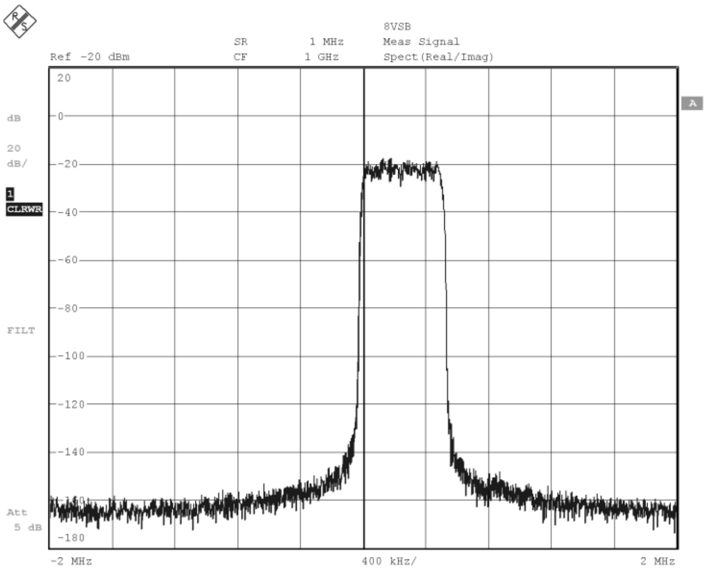


Fig. 80 Spectrum of measurement signal 8VSB (pilot carrier always removed)

8VSB (ATSC)

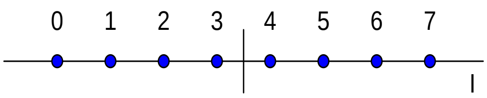


Fig. 81 Symbol mapping 8VSB (ATSC)

3.3 Demodulation and Algorithms

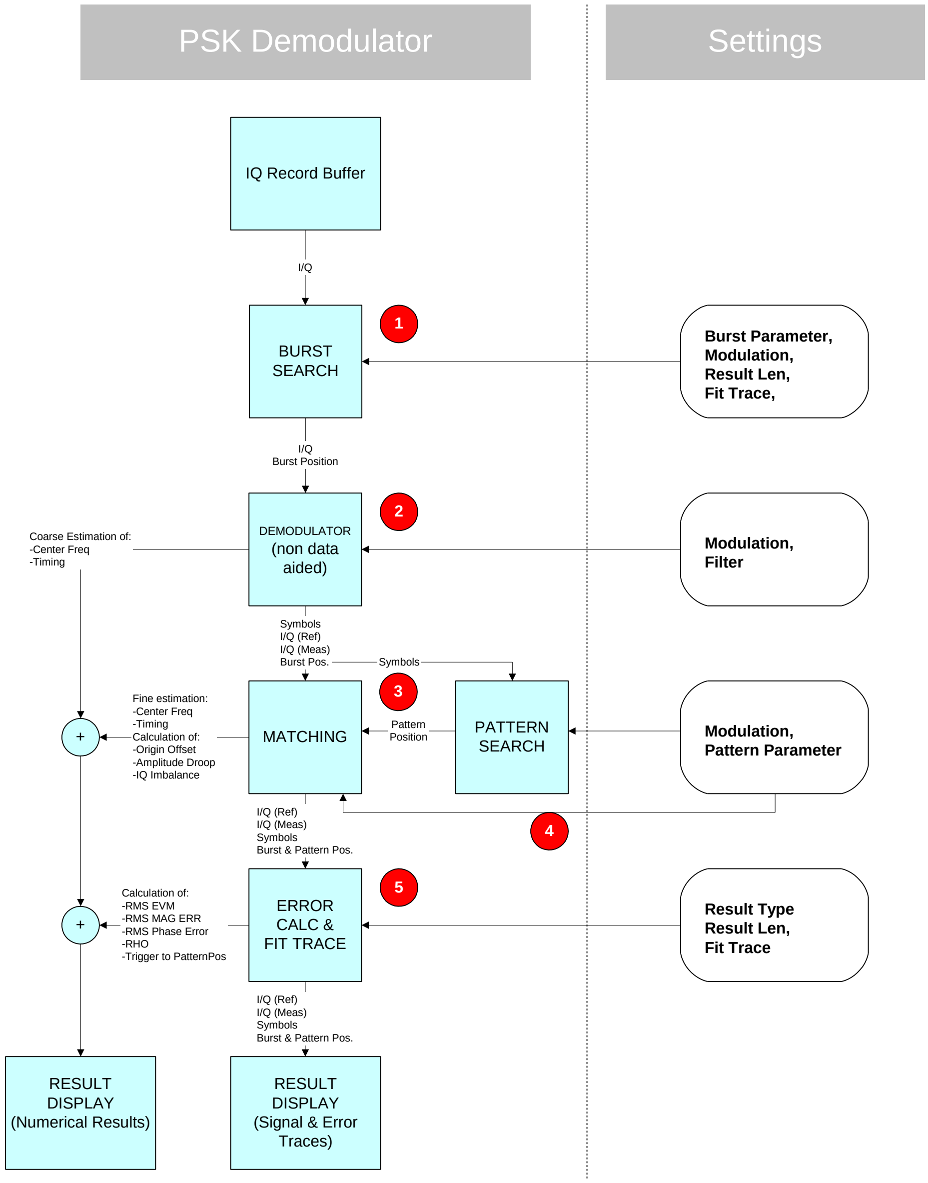


Fig. 82 Digital demodulation of a PSK demodulator

Fig. 82 gives an overview of the demodulation stages of the vector signal analysis option, using PSK demodulation as an example. Differences to other types of modulation will be dealt with at the end of this chapter.

The function blocks for demodulation are shown at the left, settings for the function blocks at the right.

After data recording in the RECORD BUFFER, the I/Q data is forwarded to the

BURST SEARCH

In this stage, the RECORD BUFFER is searched through for burst structures. The first burst found is forwarded together with its environment to the next processing stage.

The length of the transferred data record normally corresponds to the RESULT LENGTH. The internal length may be automatically extended because of the delays required by the demodulation filters to settle and for trace positioning in the display (FIT TRACE).

If the burst search is switched off, a data record from the beginning of the RECORD BUFFER is transmitted.

DEMODULATOR

This stage performs demodulation down to symbol level. Correction values for timing, frequency and phase position are determined during demodulation and applied to the data record so that a correct symbol decision is possible. Network-specific synchronization aids such as sync patterns are not used in this case so that the measurement demodulator operates without knowing the transmitted data contents (NDA (non-data-aided) demodulator). A reference signal corresponding to an ideal, error-free transmission signal is regenerated from the various symbols and forwarded to the MATCHING stage together with the corrected measurement signal.

PATTERN SEARCH

The symbol data record is searched through for one or more user-defined sync patterns. The measurement results (TRACES) can be positioned with the aid of the patterns found. The pattern search is optional.

MATCHING

In this stage the reference and measurement signals are correlated. The matching algorithm determines accurate correction values for signal amplitude and signal timing as well as for frequency errors and phase position of the measurement signal with the aid of the optimization criterion in order to minimize the RMS vector error, and then corrects the measurement data record.

First numeric measurement results such as center frequency error, origin offset and I/Q imbalance are obtained at this stage.

ERROR CALC & FIT TRACE

At this processing stage, further modulation errors are calculated which are either displayed as results or used for further result calculation. Results are available in numeric form (e.g. RMS EVM), display versus time (EVM trace) or as a statistical evaluation of error parameters (e.g. 95:th percentile).

RESULT DISPLAY

The selected measurement results are positioned in the display and scaled according to user settings. Special points in time or ranges of the measurement signal (e.g. sync pattern or symbol decision points) can be highlighted in the display.

A detailed description of the function blocks follows on the next pages.

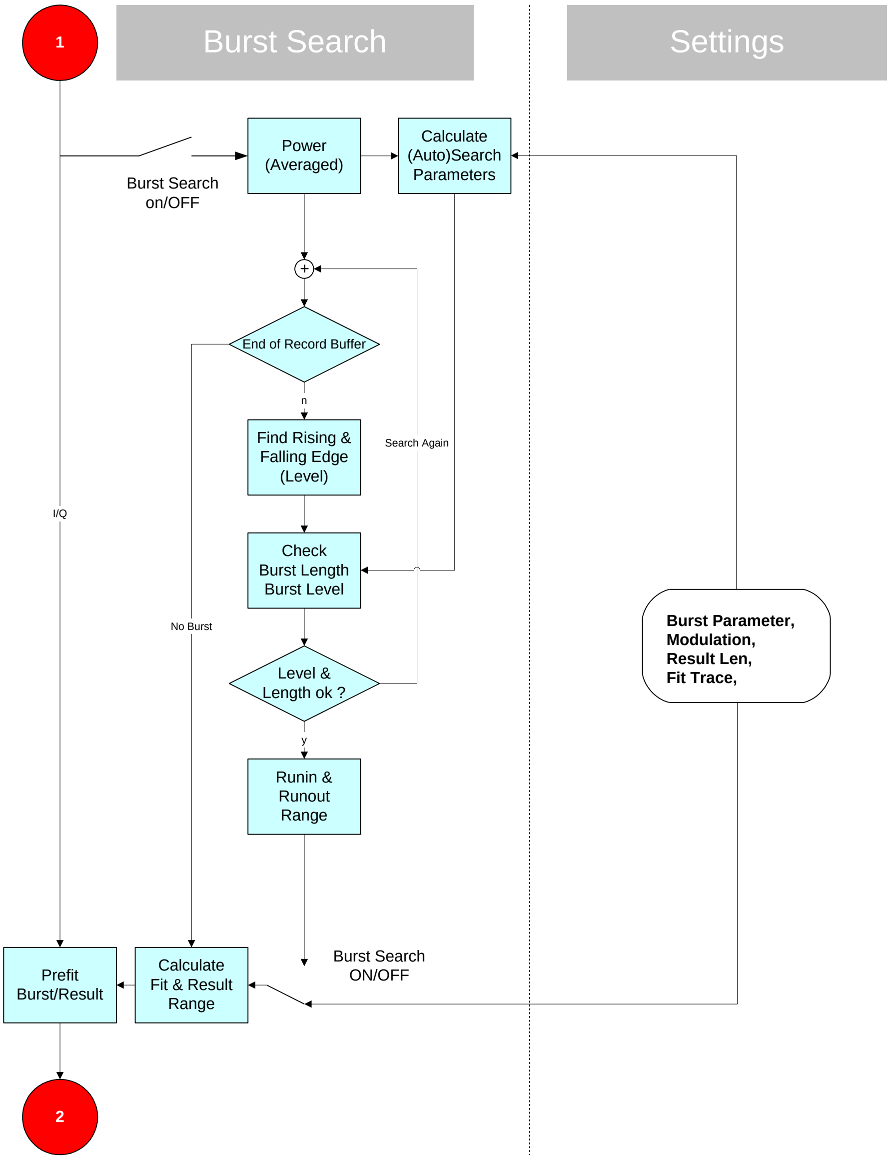


Fig. 83 Burst Search

3.3.1 Burst Search

With the **burst search switched on**, the magnitude of the sample in the record buffer is calculated and then averaged with a square filter to reduce modulation-responsive signal amplitude variations and to suppress short noise peaks.

In the **AUTO** mode, the global minimum and maximum of this data record are determined and two level threshold values are calculated by taking into account a modulation-responsive factor.

With the aid of these thresholds, the magnitude data record is searched through for rising and falling burst edges. Brief level drops are ignored.

When the first burst is found that fulfills the requirements regarding minimum and maximum length, the burst search is terminated and the part of the record buffer containing the burst is forwarded to the subsequent processing stage.

The minimum and maximum lengths that can be detected, the calculation of threshold values and the sensitivity for short level drops can be varied in the AUTO mode by selecting a digital standard.

In the **MAN** (manual) mode, these parameters can be set by the user. However, the MAN mode is only recommended under difficult receive conditions.

If the **burst search is switched off**, a block with a length required for result display from the beginning of the record buffer is forwarded to the next processing stage.

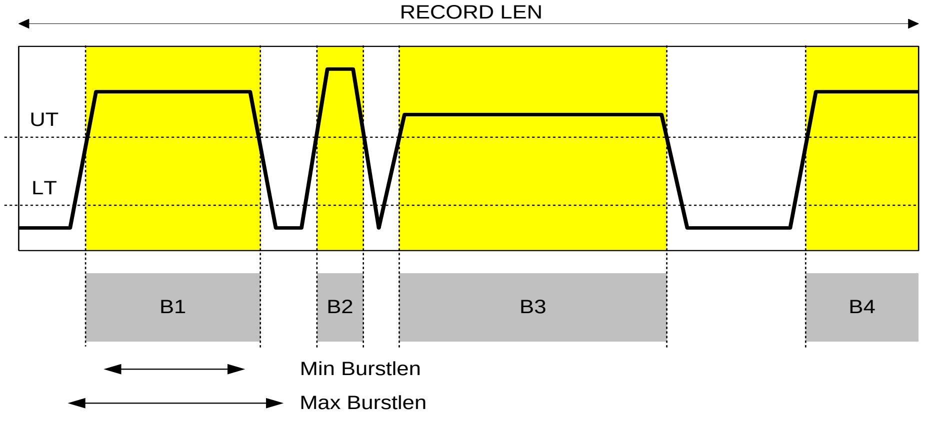


Fig. 84 Record buffer containing several bursts

Fig. 84 shows the contents of a record buffer with several bursts.

The upper (UT) and the lower burst threshold (LT) and bursts of different levels are shown.

All bursts fulfill the level requirements, i.e. the burst edges cross both burst thresholds; burst B1 also has the required length, B2 is too short, B3 is too long and B4 has no falling burst edge.

B1 is the first burst to fulfill all requirements and therefore forwarded to the subsequent processing stages.

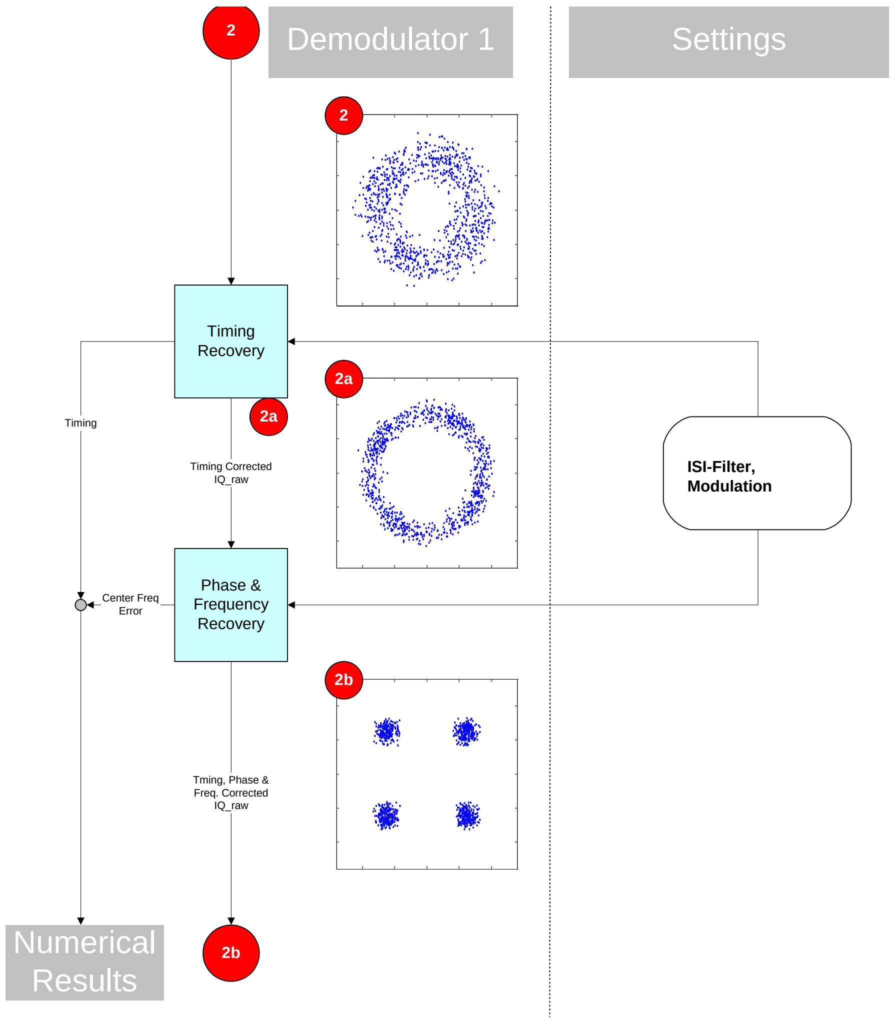


Fig. 85 IQ-Demodulator: Timing, Phase, Frequency Recovery

3.3.2 Demodulator 1

The first part of the demodulator comprises the following function groups:

- Timing recovery
- Phase & frequency recovery

3.3.2.1 Phase & Frequency Recovery

If a burst structure is found, the burst (without edges) is used as the demodulator estimation range although the determined correction parameters are applied to the full demodulation range.

For reasons of algorithm, the signals are filtered in these function blocks to obtain ISI-free points. However, the output signals are timing-, frequency- and phase-corrected raw signals (as shown in the drawings) so that subsequent distortion measurements can be performed or customized measurement filters used.

At the input of this stage, the I/Q data record in the complex baseband contains

- a time offset τ;
- a center frequency error and a phase error of $\Delta\varphi_0$.

3.3.2.2 Timing Recovery

This function group determines the ideal symbol decision points in the signal. The I/Q data record must then be corrected so that the samples occur exactly at the symbol decision points (resampling).

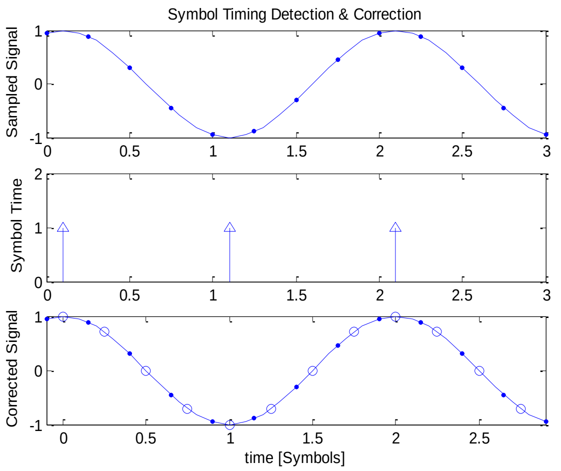


Fig. 86 Symbol timing detection & correction

Fig. 86 illustrates the correction using the sampled input signal, the ideal symbol decision points and the corrected data record (time axis adapted).

A calculated timebase correction also affects numeric results (e.g. trigger to sync measurement).

SIGNAL 2(Fig. 85) corresponds to the I/Q data record before timing correction,

SIGNAL 2a to the record after timing correction. Since the frequency error is not yet eliminated, the symbol points in the constellation diagram are shown as a circular band.

3.3.2.3 Phase & Frequency Recovery

This function group determines and corrects the frequency and phase offset. With the aid of a robust, maximum-likelihood frequency and phase estimator, the stage determines the optimum estimation value for the data record after timing correction (center frequency error $\Delta\varphi_0$).

After correction of these quantities, a 'non-rotating constellation diagram'(for an unfiltered raw signal) is obtained (see **SIGNAL 2b)**.

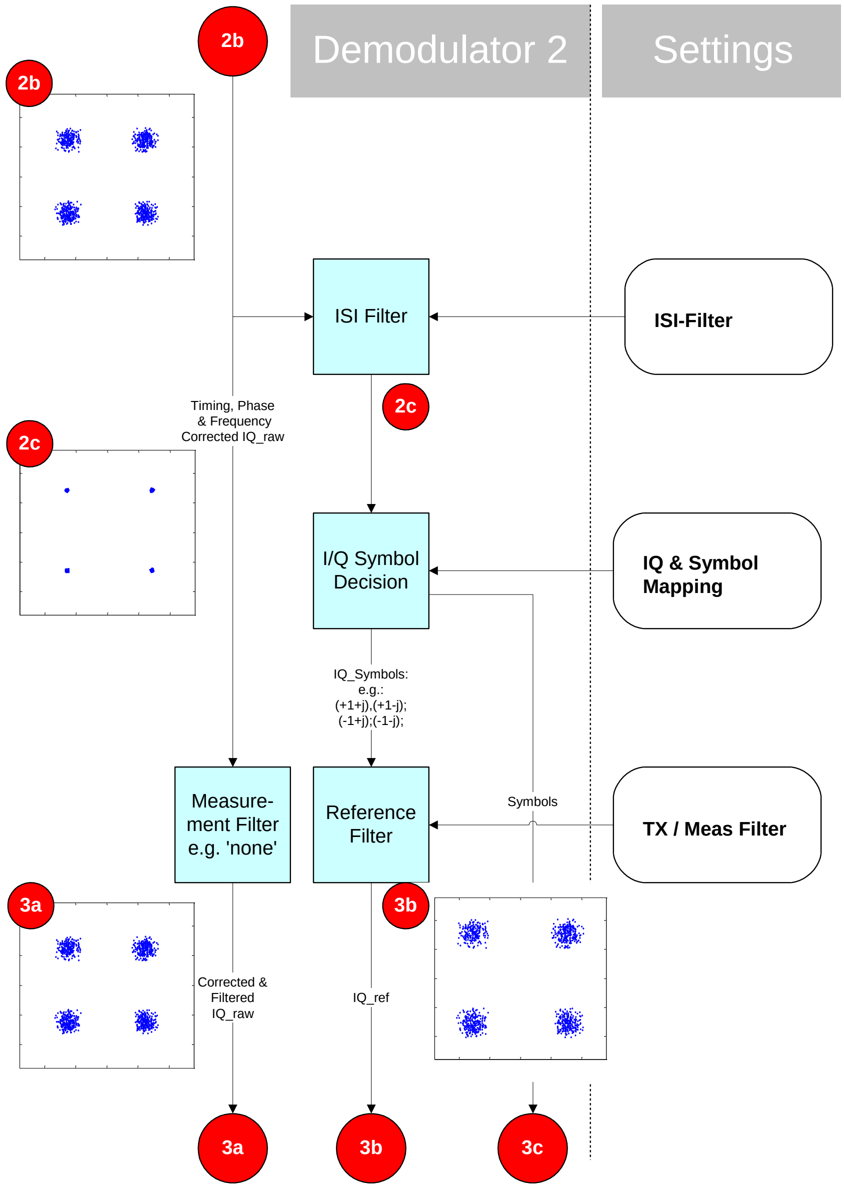


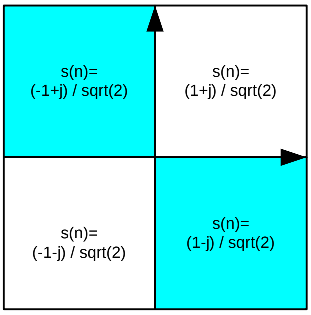
Fig. 87 Demodulator 2

3.3.3 Demodulator 2

The timing-, frequency- and phase-corrected data record (signal 2b) is forwarded to an **ISI FILTER** to eliminate the ISI of adjacent symbols (see section „System-Theoretical Modulation and Demodulation Filters")

I/Q symbols (signal 3c) and - if symbol mappings are taken into account - logical symbols are then produced in the **I/Q SYMBOL DECISION** block (for PSK).

In the case of QPSK, the segment decider is a simple quadrant decider which only affects the input signal phase.



$$\left\{\begin{array}{lcl} 0 \le \arg(x(n)) < \frac{\pi}{2} & \rightarrow & s(n) = \frac{1}{\sqrt{2}}(1+j) \\ 1\frac{\pi}{2} \le \arg(x(n)) < 2\frac{\pi}{2} & \rightarrow & s(n) = \frac{1}{\sqrt{2}}(-1+j) \\ 2\frac{\pi}{2} \le \arg(x(n)) < 3\frac{\pi}{2} & \rightarrow & s(n) = \frac{1}{\sqrt{2}}(-1-j) \\ 3\frac{\pi}{2} \le \arg(x(n)) < 4\frac{\pi}{2} & \rightarrow & s(n) = \frac{1}{\sqrt{2}}(1-j) \end{array}\right\}$$

arg(x(n)) = phase of I/Q input sample at the decision point

s(n) = decided I/Q symbol

Fig. 88 QPSK segment decider

The I/Q REF data record (signal 3b) is generated from the data record of the decided I/Q symbols after null stuffing (to attain the required oversampling rate) and filtering with the REFERENCE FILTER. After filtering with the MEASUREMENT FILTER, the measurement data record is forwarded as signal 3a to the subsequent processing stages. When MEASUREMENT FILTER = NONE is set, the data record is forwarded unchanged.

Phase ambiguity of demodulator

Up to now, the demodulator operated without knowing the transmitted signal. Since phase shifts may occur on the transmission path, the result of demodulation is ambiguous with respect to the phase position (because of the rotation symmetry in the PSK constellation). In the case of QPSK with static symbol mapping, this means that the I/Q measurement and I/Q reference signals as well as the decided symbols may have a constant phase offset of {0, pi/2, pi, or 3pi/2}. This offset can only be detected and eliminated in all 3 data records after sync pattern search in the data record.

If modulation types without static mapping are used, e.g. differential PSK or MSK, the information represented by the phase transition is encrypted so that static symbol mapping and the ambiguity of the starting phase are no longer a problem.

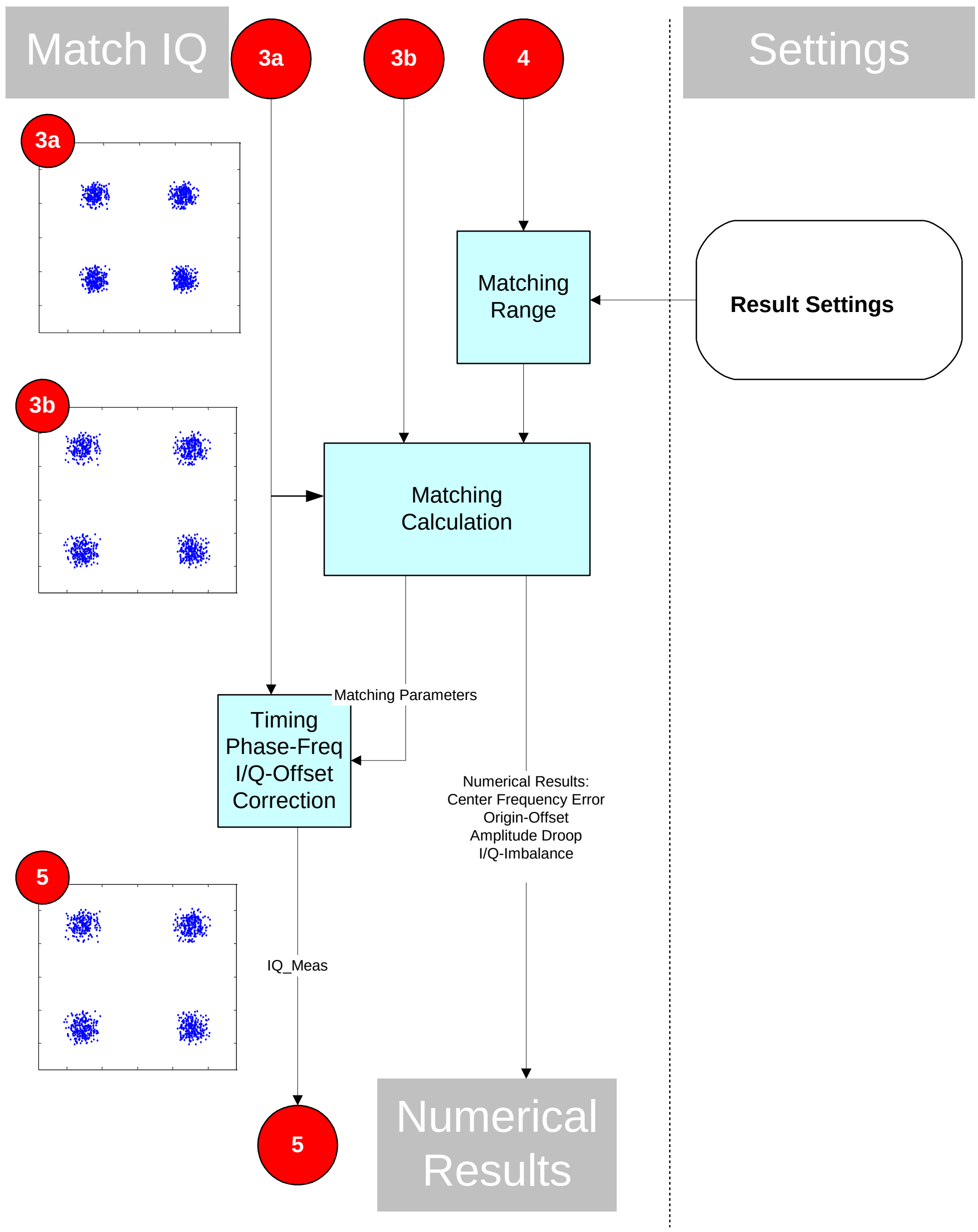


Fig. 89 Matching

3.3.4 Matching

The measurement signal was processed in the previous modulation stages so that error-free demodulation, symbol decision and reference signal generation could be performed.

In the **MATCHING** group, the error parameters (e.g. RMS EVM in case of PSK) are minimized.

With the aid of the following equation a transmit signal Y(t) in the time domain can be obtained in the baseband (all parameters used are complex):

$$Y(t) = C1 \cdot \left(REF_{tx}(t) + ERR_{tx}(t) + C0 \right) \cdot W;$$

- REF_{tx} is the ideal transmit signal,
- ERR_{tx} the error signal of the transmitter (linear and nonlinear distortions),
- C0 the I/Q offset (origin offset) and
- C1 a complex constant (phase and amplitude of transmitter)

$W = e^{\alpha t + j\omega_0 t};$ is a complex factor which represents the amplitude variations in the burst (α) and a center frequency offset (ω_0).

The parameter to be minimized (valid for EDGE, for formulae of other modulation types see chapter 10 is defined by

$$RMS\_EVM = \sqrt{\frac{\sum_{n \in N} |EV(n)|^2}{\sum_{n \in N} |REF(n)|^2}};$$

containing the error vector: $EV(n) = MEAS(n) - REF(n) - C0;$

where

- EV is the error vector after the prescribed measurement filtering,
- MEAS is the measured transmit signal (Y8t) after measurement filtering in the analyzer,
- REF is the reference signal and
- (n) the symbol points in the useful part (length N) of the demodulator range.

The RMS_EVM is minimized by means of a maximum likelihood function in the **MATCHING** block and the associated parameters (C0, C1, $\alpha;\omega_0$) are determined.

During minimizing, a residual time offset τ_0 is also determined to compensate for the estimation uncertainty of the non-data-aided demodulator.

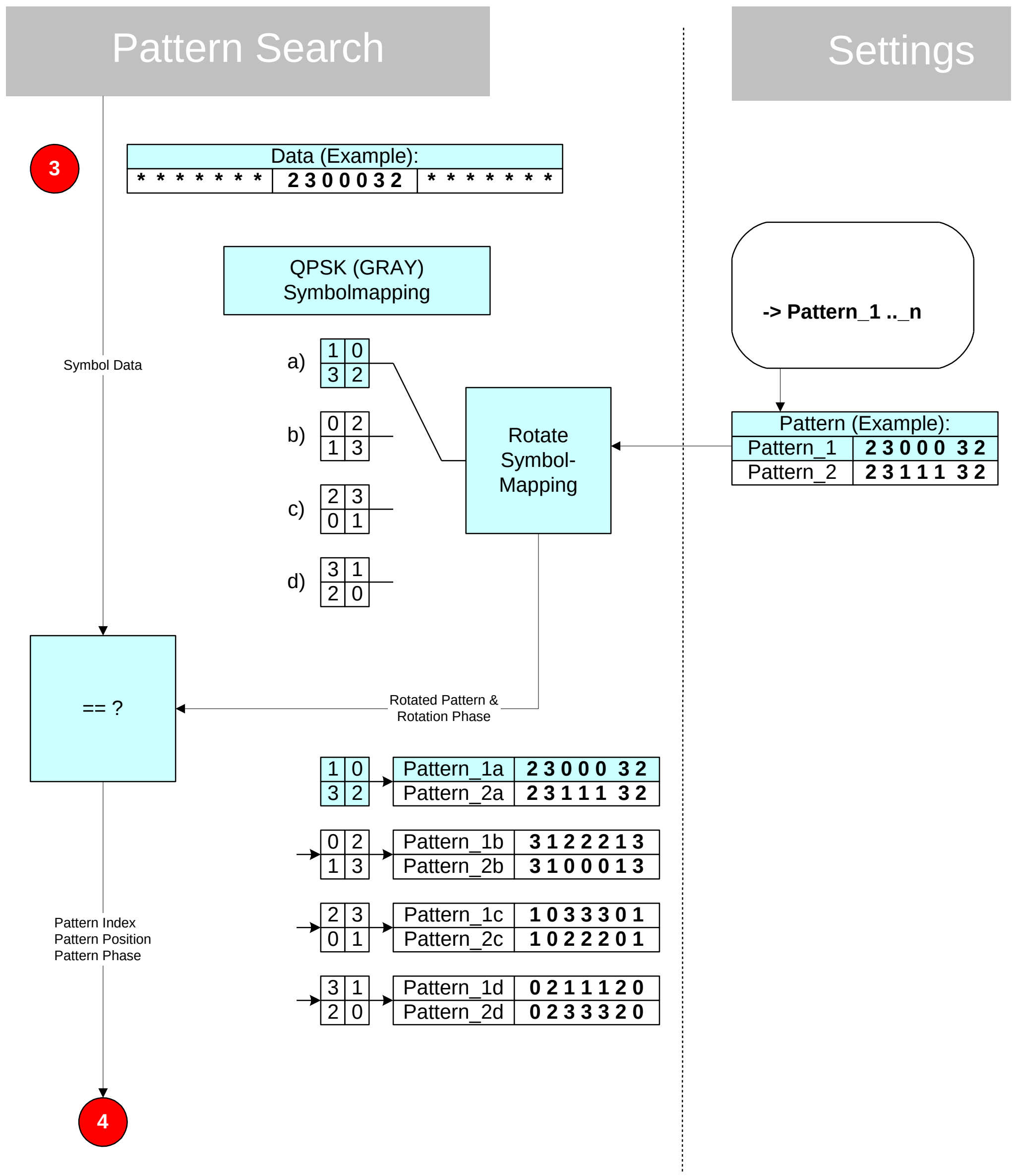


Fig. 90 Pattern search

3.3.5 Pattern Search

Many digital standards use constant symbol sequences (here called patterns) at defined positions in the burst, which are used in the mobile network for estimating transmission channel characteristics.

In the analyzer, the pattern position defined by the standard is used for scaling and for determining the standard-specific measurement range.

In pattern search, a distinction is made between static mappings and differential mappings:

In pattern search, a distinction is made between static mappings and differential mappings:

With **static mappings**, the symbol information is represented by the absolute position of the symbol in the I/Q plane. Examples are QPSK, 8PSK and regular QAM constellations (see section "*Symbol* Mapping"). Because of the rotation symmetry of these mappings, an unambiguous symbol decision is only possible after a pattern search.

When the pattern is found, the absolute phase position of the signal is also identified, the I/Q measurement data record and the I/Q reference data record are appropriately rotated and the symbol data record is corrected.

Fig. 91 illustrates the function principle for QPSK (GRAY mapping).

The user predefines 2 possible sync patterns (Pattern_1 and Pattern_2). With QPSK, 4 symmetry states (mapping a to d) are possible, which correspond to a rotation of coordinates by 0, pi/2, pi, 3pi/2, respectively.

Original	1 0 3 2	Pattern_1a **2 3 0 0 0 3 2** Pattern_2a **2 3 1 1 1 3 2**	
Hypotheses	**Mapping**	**Temporary Pattern**	**If pattern is found**
Hypothesis a) (phase = 0pi/2)	1 0 3 2	Pattern_1a **2 3 0 0 0 3 2** Pattern_2a **2 3 1 1 1 3 2**	- I/Q data records are unchanged - Symbol data record are unchanged
Hypothesis b) (phase = pi/2)	0 2 1 3	Pattern_1b **3 1 2 2 2 1 3** Pattern_2b **3 1 0 0 0 1 3**	- I/Q data records are rotated clockwise by pi/2 - The symbol data record is remapped (2->0, 0->1, 1->3, 3->2)
Hypothesis c) (phase = 2pi/2)	2 3 0 1	Pattern_1c **1 0 3 3 3 0 1** Pattern_2c **1 0 2 2 2 0 1**	- I/Q data records are rotated clockwise by 2pi/2 - The symbol data record is remapped->1, 0->3, 1->2)
Hypothesis c) (phase = 3pi/2)	3 1 2 0	Pattern_1d **0 2 1 1 1 2 0** Pattern_2d **0 2 3 3 3 2 0**	- I/Q data records are rotated clockwise by 3pi/2 - he symbol data record is remapped (1->0, 3->1, 2->3, 0->2)

Fig. 91 Pattern search for static QPSK mapping

The algorithm internally converts the predefined pattern by taking the symmetry states

into account (pattern 1a to d and pattern 2a to d) and searches in the symbol data record for this "rotating" search pattern. If the patterns exactly coincide, the search is successfully terminated and, if required, the I/Q data records and the symbol data record are corrected according to the hypothesis found.
With **differential** mappings, only a single-stage procedure is required because the symbol information is represented by the phase difference of two consecutive decision points. Correction of data records is therefore not required.

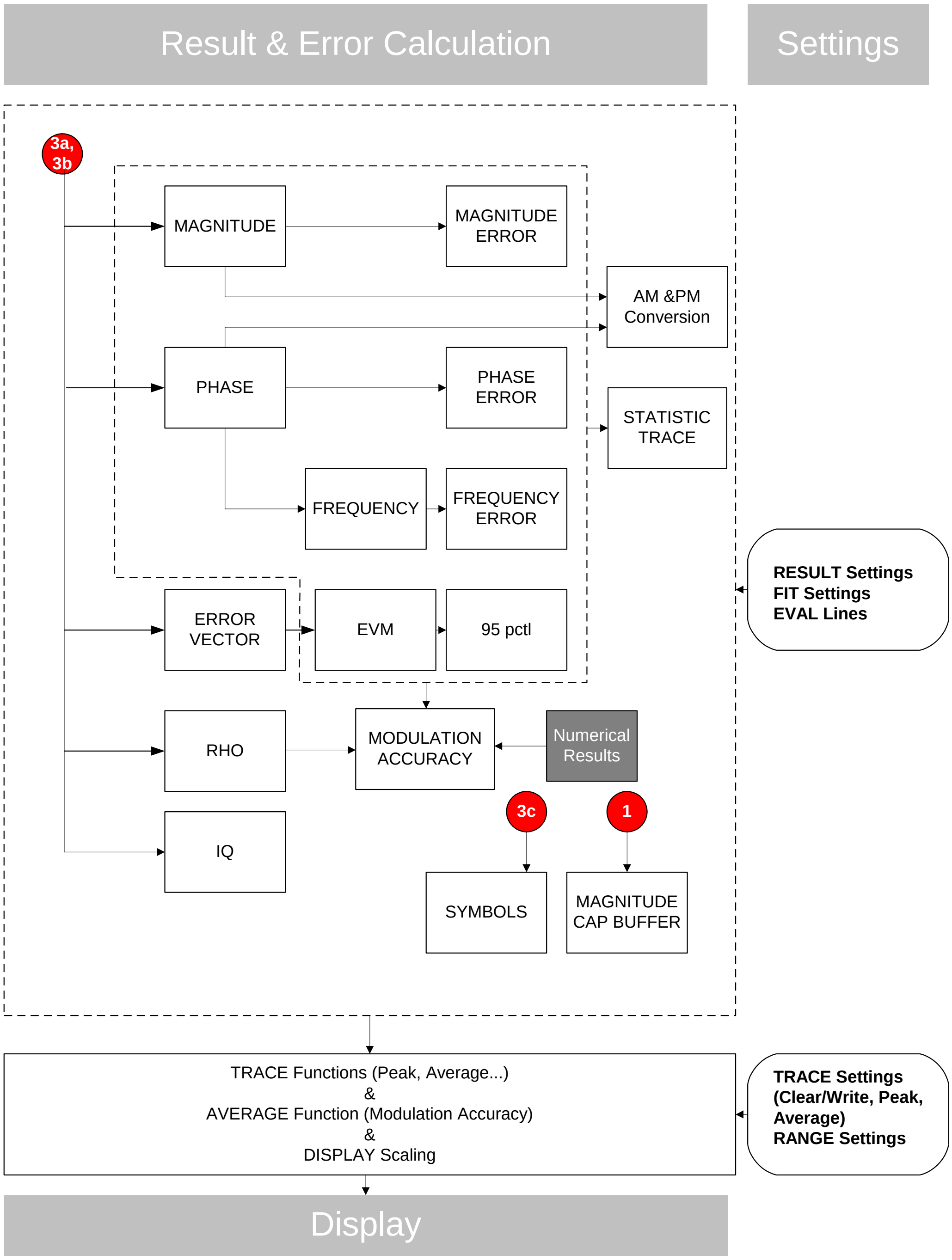


Fig. 92 Result & Error Calculation

3.3.6 Result & Error Calculation, Display

The result displays selected by the user are calculated and scaled in the two last processing stages.

Extreme values and average values over several measurements can be calculated for result display. This function can be switched on and off in the Trace menu.

The calculation formulae can be found in the description of the specific display modes and at the end of this manual (chapter 10").

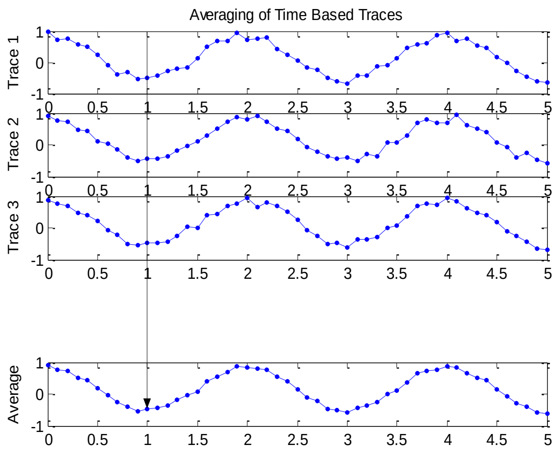


Fig. 93 Trace averaging

In the case of **trace display**, average and extreme values are calculated for each trace point derived from the measured value samples.

Fig. 93 illustrates this process of linear averaging over three measurements. The smoothed measurement trace (average) is also displayed.

$$\left.\begin{matrix} EVM\,(TRACE1) \\ EVM\,(TRACE2) \\ EVM\,(TRACE3) \end{matrix}\right\rangle \rightarrow RMS(EVM1..3);$$

Fig. 94 Averaging of scalar parameters

For **numeric (scalar) result** display, the results of all single measurements are considered. Square averaging of the scalar EVM parameter is shown as an example. The linear average and the standard deviation are calculated for these measurement parameters in addition to the square average value.

Average and extreme value functions are not available for display in the I/Q plane.

Fig. 95 shows the different result displays that can be calculated from the I/Q measurement and I/Q reference data records (PSK, MSK, QAM).

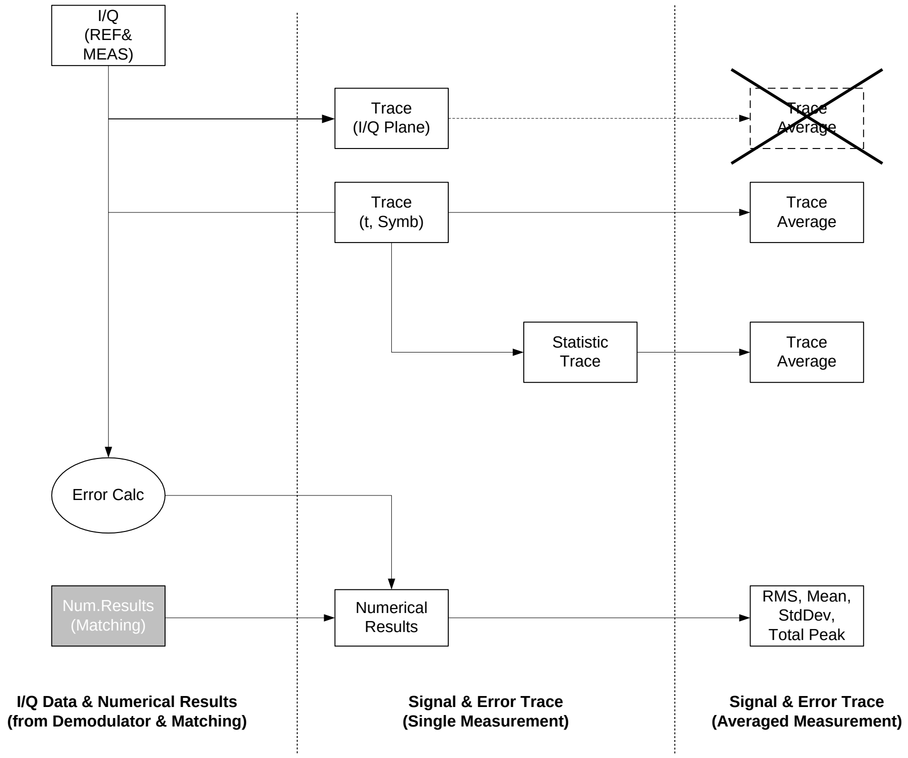


Fig. 95 Result display

3.3.7 Differences between Modulation Types

There are slight differences between the function blocks for QAM, VSB, MSK and FSK.

QAM Processing is very similar to that of PSK, but evaluation of amplitude statistics and signal scaling are performed in the first processing stages. As with PSK, the optimization criterion for the MATCHING stage is the minimization of RSM EVM.

VSB Processing is very similar to that of PSK, but evaluation of amplitude statistics and signal scaling are performed in the first processing stages (as with QAM). In addition the pilot carrier typical for VSB are removed from the signals. As with PSK, the optimization criterion for the MATCHING stage is the minimization of RSM EVM.

MSK Demodulation and matching are based on I/Q data records; the optimization criterion for the MATCHING stage is the minimization of RMS phase errors. All available samples are used, not only the decision points.

FSK Output data of the demodulator stage (and therefore the basis for all subsequent stages) comprises real data records with instantaneous frequencies.
Optimization criterion for the MATCHING stage is the minimization of the RMS frequency error between reference and measurement signal.

3.4 Vector and Scalar Modulation Errors

3.4.1 Error Model of Transmitter

The following error model is used for the examples below:

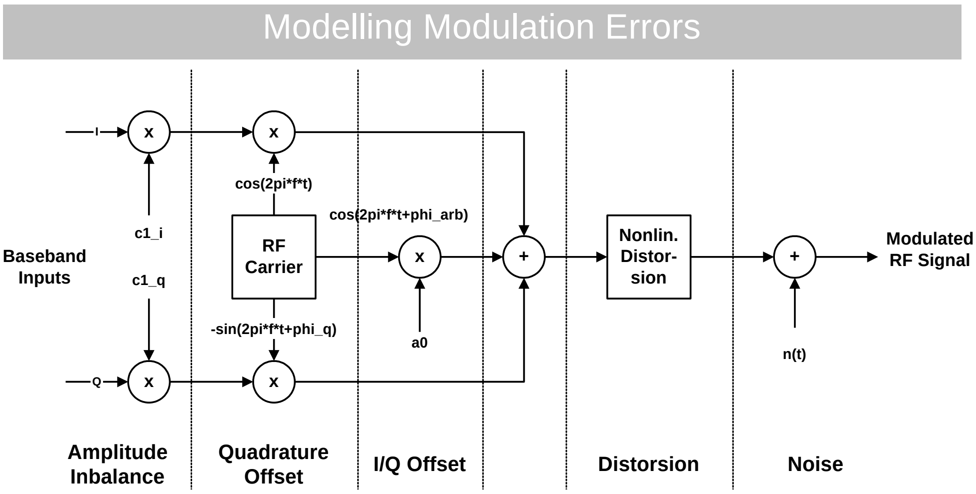


Fig. 96 The following error model is used for the examples below:

3.4.2 Modulation Error (PSK, MSK, QAM, VSB)

3.4.2.1 Error vector (EV)

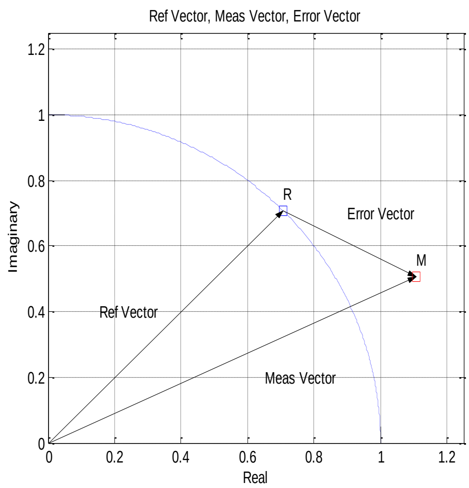


Fig. 97 Modulation error: error vector

Definition of error vector (EV)::

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

3.4.2.2 Error vector Magnitude (EVM)

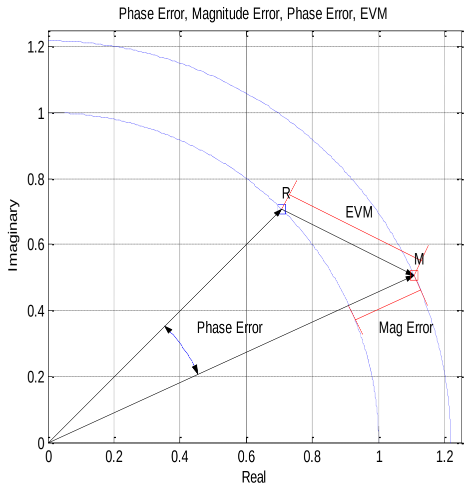


Fig. 98 Modulation error: EVM, magnitude error

The error vector in the diagram is specified as error vector magnitude (EVM). The difference between the reference vector magnitude and the measurement vector magnitude is referred to as magnitude error.

In some modern networks, the basic EVM definition is modified so that the calculation is weighted with half the average signal power in the observed period. This is sometimes referred to as modulation error ratio (MER). In the case of ISI-free demodulation and measurements, the two definitions are identical.

3.4.2.3 Phase Error

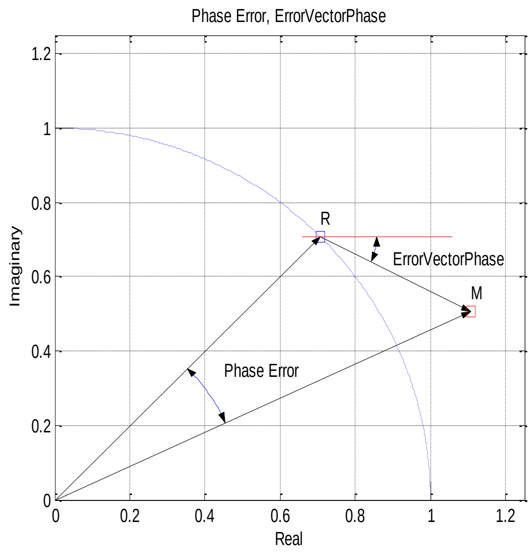


Fig. 99 Modulation error: EVM, magnitude error

Fig. 99 illustrates the definition of the phase error:

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

$$\varphi_{err} = \arg\left(MEAS \cdot REF^{*}\right);$$

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

In contrast, the error vector phase is defined as:

$$\varphi_{EV} = \arg(EV);$$

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. Errors for FSK are shown in the frequency/time diagram.

3.4.2.4 IQ-Offset (Origin Offset)

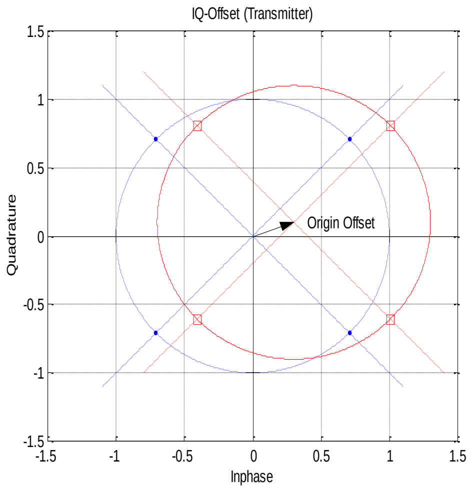


Fig. 100 Modulation error: origin offset (I/Q offset)

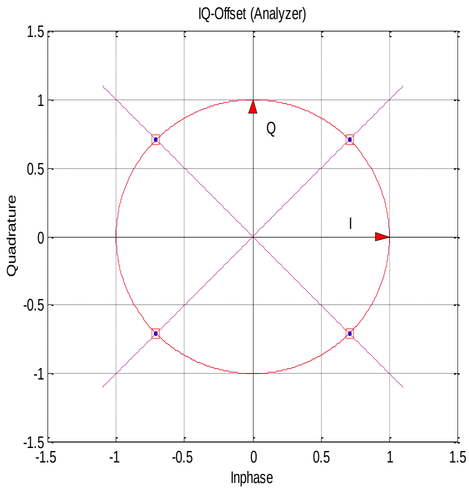


Fig. 101 Modulation error: compensation of origin offset

Fig. 100 and Fig. 101 show the effect of an I/Q offset or origin offset in the transmitter and in the analyzer after demodulation and error compensation.

The residual carrier of the amplitude C0 and any phase is superimposed on the ideal transmit signal. The result is a noise vector in the complex baseband that shifts the constellation diagram out of its complex 0 position. Fig. 100 shows an ideal constellation diagram and a diagram shifted by the I/Q offset.

This error parameter is determined during demodulation and deducted from the complex measurement data record.

The result after error compensation is shown in Fig. 101. The ideal constellation diagram is restored after demodulation. The unit circle around the constellation points remains unchanged.

3.4.2.5 Gain Imbalance

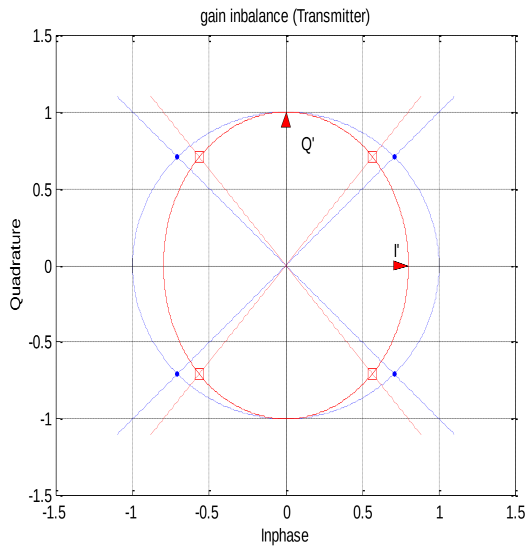


Fig. 102 Modulation error: gain imbalance (transmitter)

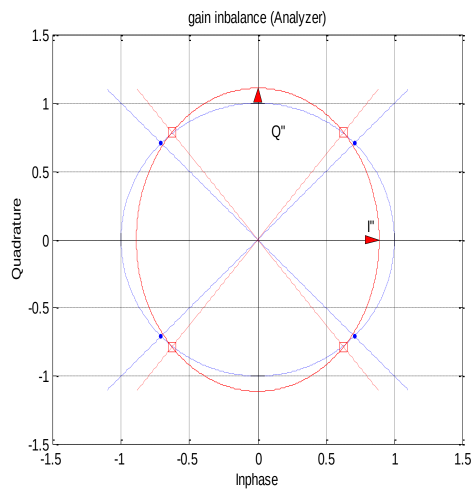


Fig. 103 Modulation error: gain imbalance (analyzer)

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 Fig. 102. 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.

This distortion is not corrected in the analyzer. It increases the EVM and is part of the displayed I/Q imbalance error. Fig. 103 shows that the analyzer chooses linear scaling for the measurement signal to minimize the RMS EVM. The elliptic shape of the unit circle remains unchanged.

3.4.2.6 Quadrature Imbalance

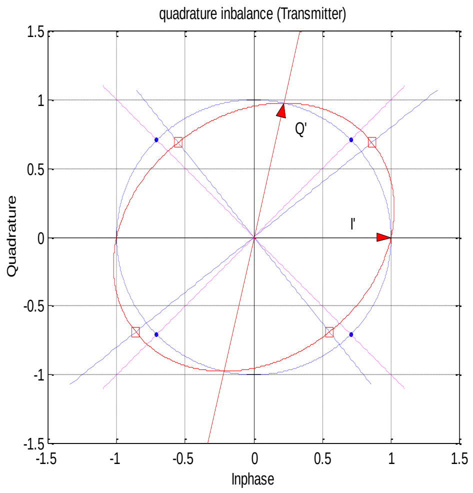


Fig. 104 Modulation error: quadrature imbalance (transmitter)

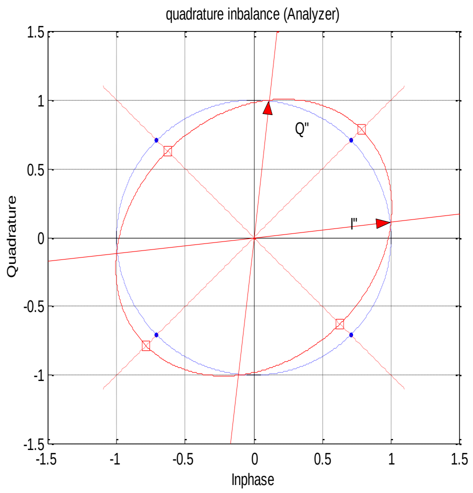


Fig. 105 Modulation error: quadrature imbalance (analyzer)

Quadrature imbalance is another modulation error which is shown in Fig. 104 and Fig. 105.

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 Fig. 104 the Q axis is shifted.

During demodulation in the analyzer, the phase is shifted in addition to linear amplitude scaling to minimize the RMS EVM. The elliptic shape of the unit circle remains unchanged.

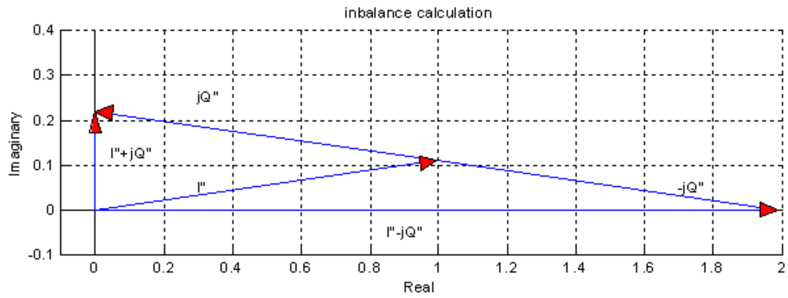


Fig. 106 Modulation error: I/Q imbalance

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

$$IQ\_Inbalance = \frac{|I''+jQ''|}{|I''-jQ''|};$$

Fig. 106 shows this measurement parameter for the quadrature imbalance.

3.4.2.7 Gain Distortion

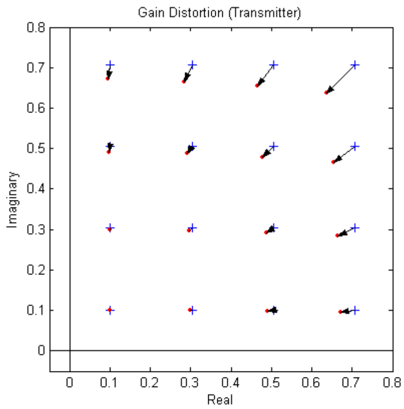


Fig. 107 Nonlinear distortions: amplitude distortion (transmitter)

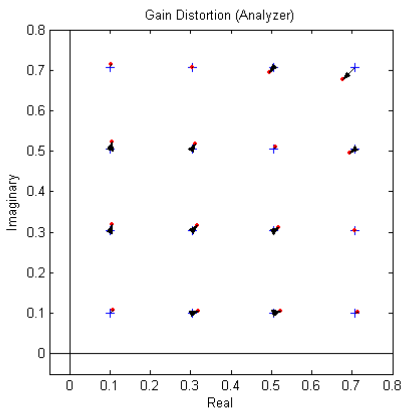


Fig. 108 Amplitude distortion (analyzer)

Fig. 107 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. Fig. 108 shows the signal after scaling.

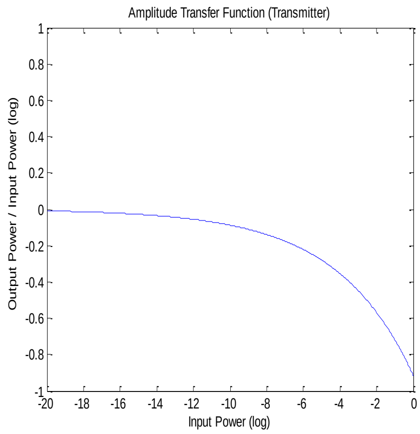


Fig. 109 Amplitude transfer function (transmitter)

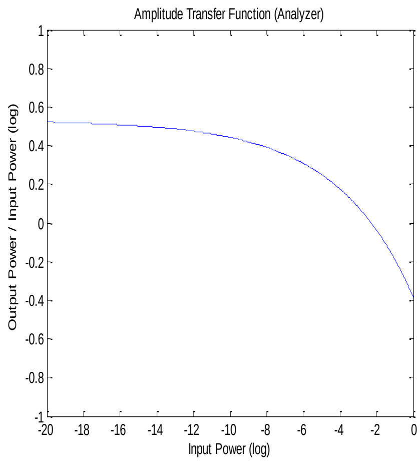


Fig. 110 Amplitude transfer function (analyzer)

Fig. 109 and Fig. 110 show a logarithmic display of the amplitude transfer functions. The analyzer trace is shifted against the transmitter trace by this scale factor.

3.4.2.8 Phase Distortion

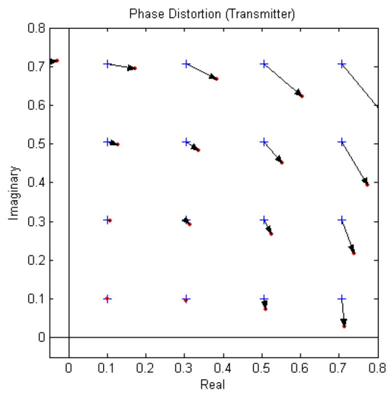


Fig. 111 Nonlinear distortions: phase distortion (transmitter)

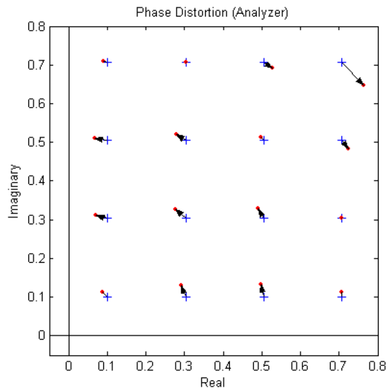


Fig. 112 Phase distortion (analyzer)

Fig. 111 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. Fig. 112 shows the signal after scaling.

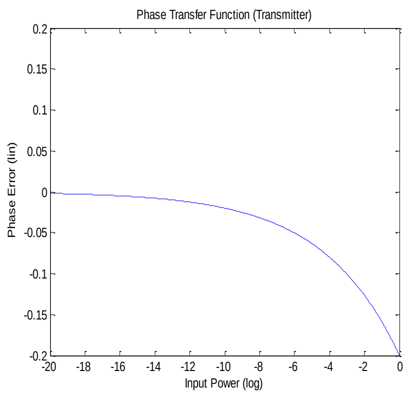


Fig. 113 Nonlinear distortions: phase distortion (transmitter)

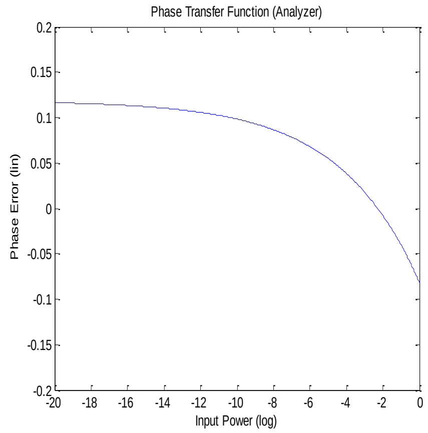


Fig. 114 Phase distortions (analyzer)

Fig. 113 and Fig. 114 show a logarithmic display of the phase transfer functions. The analyzer trace is shifted by the phase described above as against the transmitter trace.

3.4.2.9 Noise

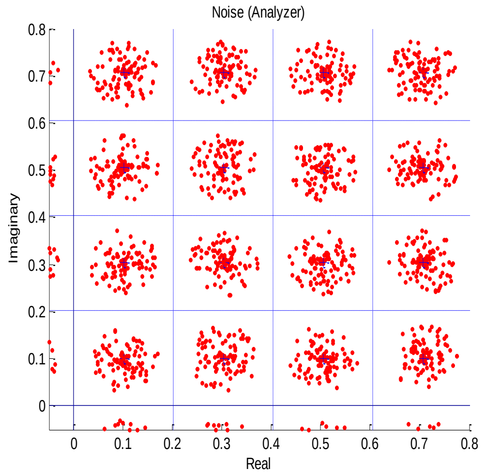


Fig. 115 Additive noise

Fig. 115 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 filter settings** (transmitter filter or corresponding receive filter in the analyzer). 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.

3.4.3 Modulation Error (FSK)

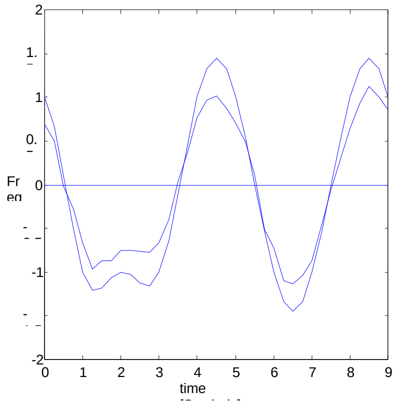


Fig. 116 Modulation error: reference signal (REFDEVCOMP = OFF) and measurement signal

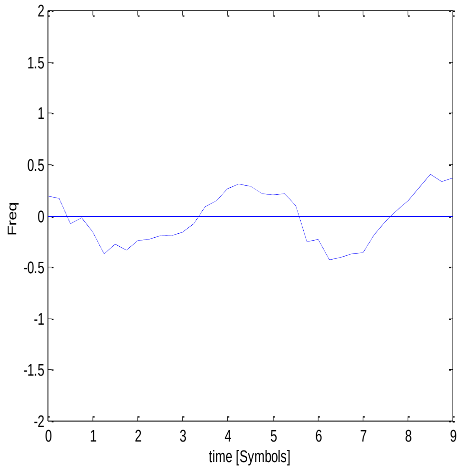


Fig. 117 Modulation error: frequency error, reference signal not normalized

Fig. 116 shows the instantaneous frequency characteristic of the MEAS signal and the REF signal characteristic.

The FSK demodulator demodulates the signal down to symbol level and generates the REF signal using the transmitter filter and the reference deviation set.

A center frequency error is automatically compensated for during demodulation (as with PSK, MSK and QAM) and has no effect on subsequent error calculations.

The following error parameters are calculated by correlation or simply by forming the difference:

Deviation error = numeric value for the entire measurement range

Frequency error = deviation from the instantaneous frequency of the two signals

Fig. 117 shows the frequency error calculated from the MEAS and REF signals in Fig. 116.

A striking feature is the modulation-dependent error signal variations.

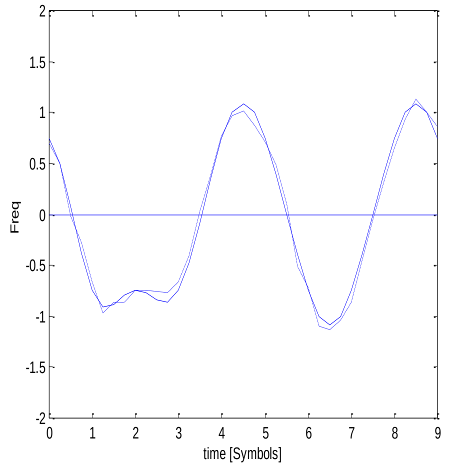


Fig. 118 Modulation error: reference signal normalized

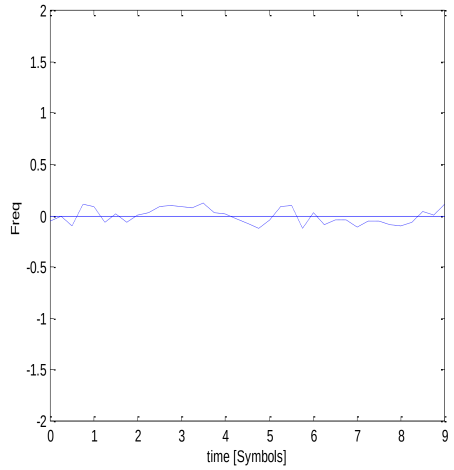


Fig. 119 Modulation error: frequency error, reference signal normalized

With FERDEVCOMP ON, the **reference signal is scaled** so that the RMS error between the scaled REF signal and the MEAS signal is minimized.

Fig. 118 shows the same MEAS signal as Fig. 119 and a REF signal with rescaled reference deviation.

The error plot (Fig. 119) no longer shows modulation-dependent variations; the errors are statistically distributed around the 0 frequency.

4 Operation and Menu Overview

4.1 Operation

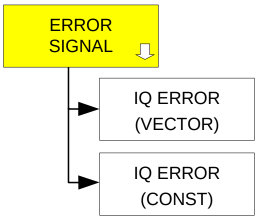
The R&S FSQ-K70/FSMR-B73/FSU-B73 option is menu-guided using keys, hotkeys and softkeys.

4.2 Special Features/Differences from the Basic Instrument

The standard unit is symbols.
In some cases (e.g. RECORD LENGTH), time can be selected as the basic unit. If so, the values are automatically rounded up to the next integer that expresses the number of symbols.

4.2.1 Display of States Within Softkeys

Error Signal



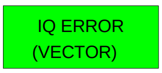
For softkeys that offer more than one setting, the softkey labelling indicates the current setting. For example, the following settings are possible for the measurement evaluation IQ Error:

- IQ ERROR VECTOR Display of I/Q error in the vector diagram
- IQ ERROR CONST. Display of I/Q error in the constellation diagram

The state of the softkey is indicated by its color:

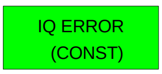
The measurement is switched off:

The softkey is grey



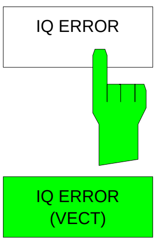
The measurement is switched on with the display mode VECTOR.

The softkey is highlighted in green, the setting VECTOR is indicated in brackets.

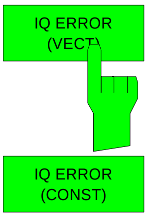


The measurement is switched on with the display mode CONSTELLATION

The softkey is highlighted in green, the setting CONST is indicated in brackets.

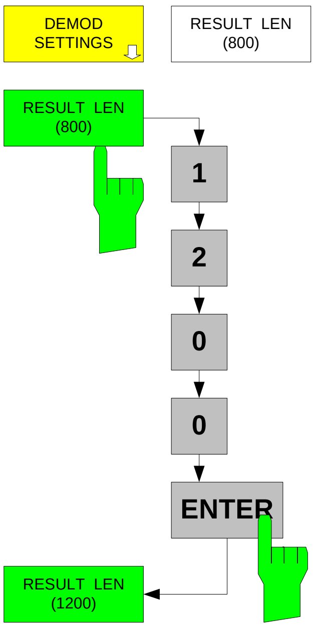


Pressing the inactive softkey re-activates the **measurement set last** and the softkey colour changes from grey to green.



Pressing the active softkey open the window for selecting the softkey setting.

4.2.2 Display of Setting Parameters Within Softkeys



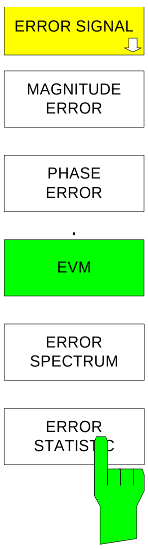
The current set value of some numeric entry parameters is displayed in the softkey labelling.

Examples:

RECORD LENGTH LENGTH (with unit)

RESULT LENGTH (without unit; SYMBOLS is used as the standard unit here)

The current set value can thus be immediately read off without opening the associated softkey menu. The selected unit is also displayed in the labelling of softkeys that enable parameters to be entered with different basic units (e.g. TIME or SYMBOLS).



The *ERROR STATISTIC* and *ERROR SPECTRUM* softkeys offer additional evaluation modes:

When the *ERROR STATISTIC* softkey is selected, not the error parameter itself but its statistical distribution is output in the selected display mode (e.g. EVM).

When the *ERROR SPECTRUM* softkey is selected, a fast Fourier transform (FFT) for determining the spectrum is carried out for the selected type of display (e.g. EVM).

The basic display mode is restored by again pressing (switching off) the *ERROR STATISTIC* or the *ERROR SPECTRUM* softkey.

When a new display mode is activated (e.g. *MAGNITUDE ERROR*, *PHASE ERROR*), the *ERROR STATISTIC* and *ERROR SPECTRUM* softkeys are automatically switched off.

Suitable evaluation modes are available for the record buffer and the measurement and reference signal (see section 5.8).

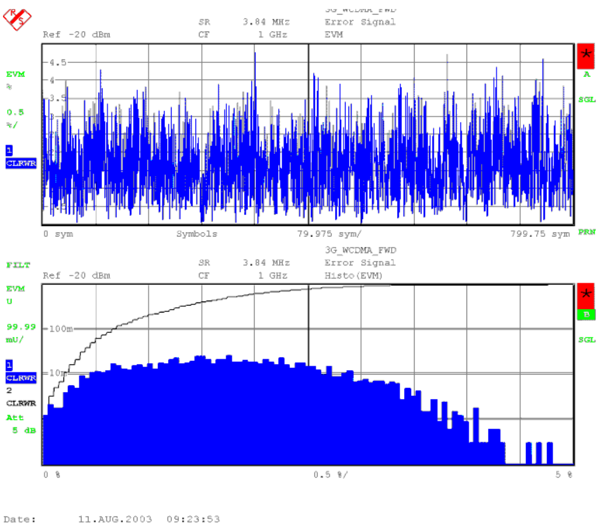


Fig. 120 Result display split screen *EVM* (upper diagram) *ERROR STATISTIC + EVM* (lower diagram)

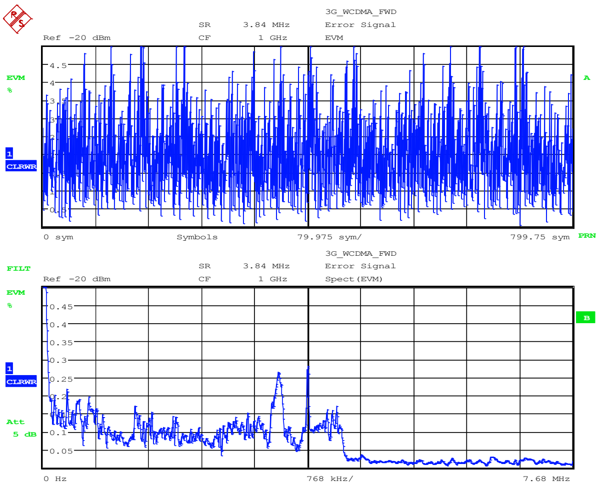


Fig. 121 Result display split screen *EVM* (upper diagram) *ERROR SPECTRUM + EVM* (lower diagram)

STATISTIC: The unit and the scaling of the y-axis of the basic diagram is also used for the x-axis of the statistic diagram.

SPECTRUM: The unit and the scaling of the y-axis of the basic diagram is also used for the y-axis of the spectrum diagram. The scaling of the x-axis depends on the I/Q bandwidth.

4.2.3 Measurement Window

The measurement window configuration is only slightly different from that of the basic instrument. Information on vector signal analysis has replaced the displays that are typical for the spectrum analyzer mode such as filter settings and sweep time (RBW, VBW, SWT). For displays of the measurement window that are not described here, refer to the documentation for the basic instrument.

The new fields **above the measurement curve** are provided to display the following:

- Digital standard or modulation mode
- Symbol rate
- Designation of the result display

The following status information is displayed **in the curve**:

Warnings and status information on the current measurement (e.g. BURST NOT FOUND)

Consecutive number and number of measurements for averaging measurements

Additional information on the type of filtering in signal processing is provided **to the left of the curve**:

RAW or FILT for measurements on non-filtered or measurement-filtered signals

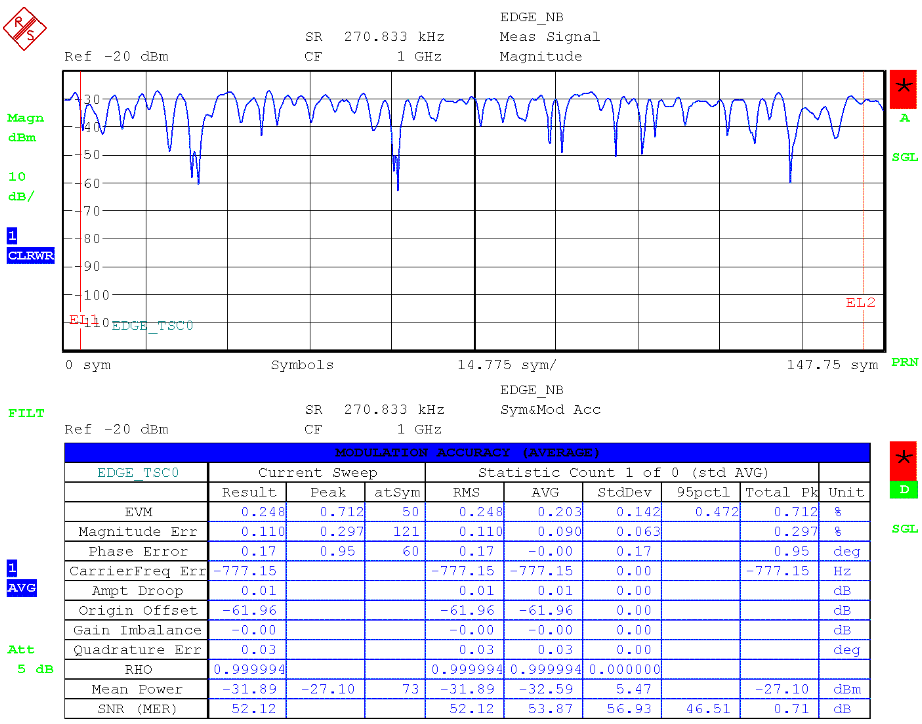


Fig. 122 Measurement window of the R&S FSQ-K70/FSMR-B73/FSU-B73 option

4.2.3.1 Warnings and Messages of Signal Processing Stages

Depending on the type of input signal, various errors may occur during demodulation.

BURST NOT FOUND
The analyzer was parameterized with BURST SRCH ON (search for bursts = ON) but no burst was found in the signal.

PATTERN NOT FOUND
The analyzer was parameterized with PAT SRCH ON (search for patterns = ON) but no set synchronization pattern was found.

END OF BUFFER
The analyzer has reached the end of the captured data record. No more data for demodulation and measurement is present. This message occurs only if multiple evaluation mode (MULTI) as well as SINGLE SWEEP are active and no new data is captured automatically (AUTO CAPTURE = OFF).

NO VALID SIGNAL
The analyzer cannot demodulate the input signal. This message may occur if noise, an unmodulated carrier, or a signal with noncompliant modulation parameters is present at the input.

In the signal and modulation error traces, such measurements are marked with a warning on the function panel. If several warnings occur at the same time, only the warning with the highest priority is displayed on this panel and further ones are suppressed.

Table 9 Warnings displayed in the order of priority

Priority	Warning	Cause	Message suppressed in the presence of a warning with a higher priority
Very High	NO VALID SIGNAL	Demodulation not possible	
High	END OF BUFFER	End of the recorded data set reached	
Medium	BURST NOT FOUND	No burst in the signal, but BURST SRCH ON	
Low	PATTERN NOT FOUND	No pattern in the signal, but PAT SRCH ON	BURST NOT FOUND

With an error-free measurement, the name of the pattern found (e.g. GSM_TSC0) is displayed on this function panel. If a pattern search is not active, the panel remains blank.

4.2.3.2 Discarding a Measurement

With MEAS ONLY ON BURST and MEAS ONLY ON PATT, the analyzer only performs and displays measurements with a valid burst signal or pattern. Otherwise, both measurement is suppressed and status Message SEARCHING BURST or SEARCHING PATTER is indicated on the display. For averaged measurements with the setting BURST SRCH=ON, MEAS ONLY ON BURST should also be activated so that erroneous measurements do not affect the result of averaging. The same applies to pattern searches.

4.3 Menu Overview

4.3.1 Hotkeys

4.3.1.1 Assignment of the Hotkey Bar of the Basic Instrument

The position of the VSA hotkey varies depending on the type and number of installed options.

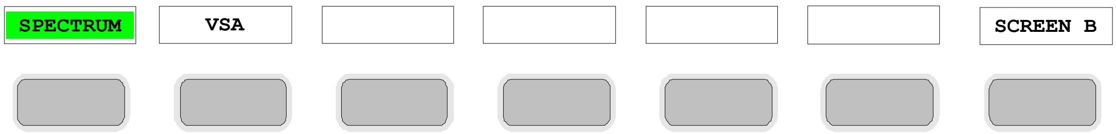


Fig. 123 Hotkey bar of the basic instrument with the R&S FSQ-K70/FSMR-B73/FSU-B73 option installed

4.3.1.2 Assignment of the Hotkey Bar of the Option

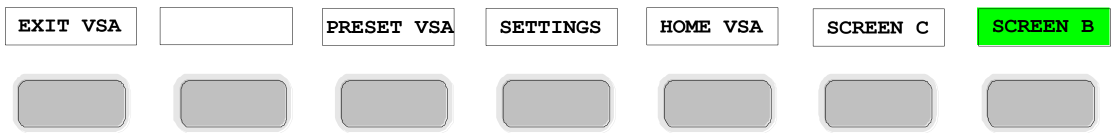
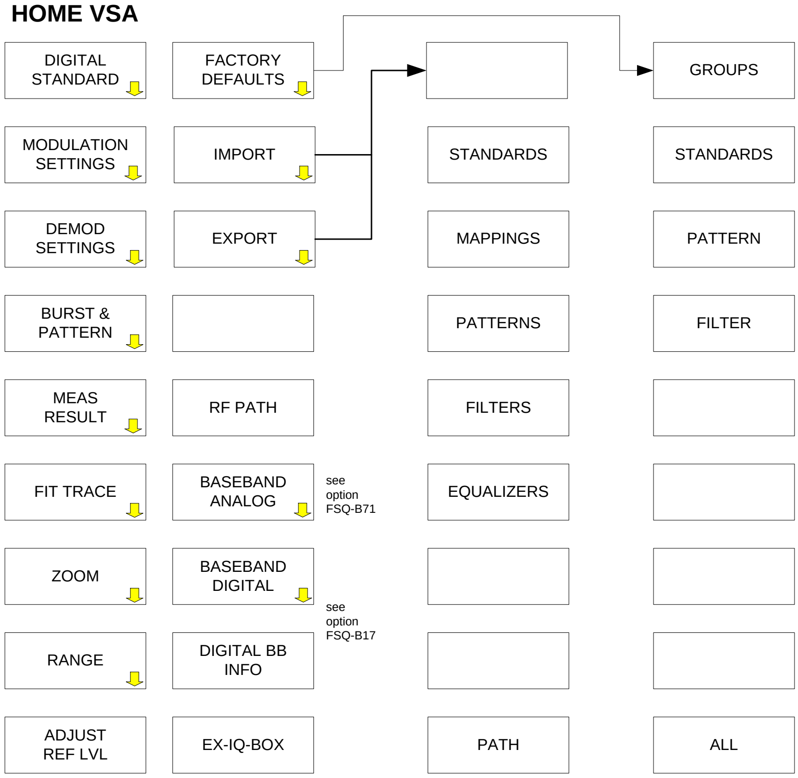


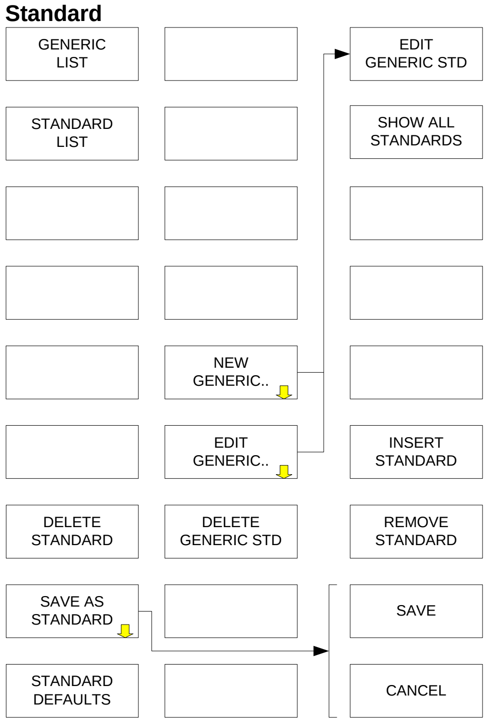
Fig. 124 Hotkey bar with the R&S FSQ-K70/FSMR-B73/FSU-B73 option switched on

4.3.2 Softkeys

HOME VSA



Digital Standard



Meas Result

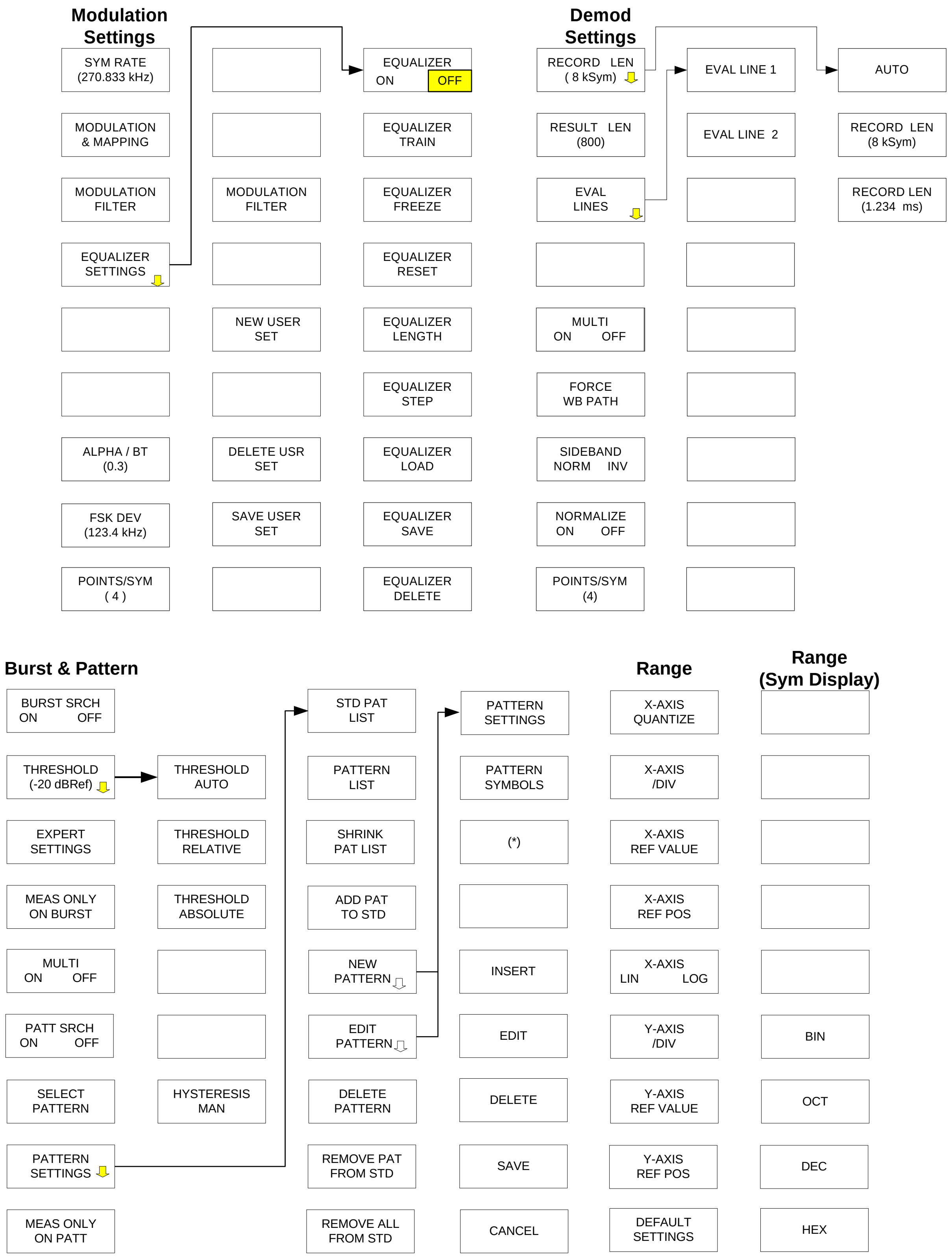
RESULT RAW FILT		MAGNITUDE (LIN)	EQUALIZER ON OFF	MAG CAP BUFFER	MAGNITUDE ERROR	MAGNITUDE (RELATIVE)
MEAS SIGNAL		PHASE (WRAP)	EQALIZER TRAIN		PHASE ERR	PHASE (WRAP)
REF SIGNAL	OFFSET EMV ON OFF		EQALIZER FREEZE	FREQUENCY	FREQ ERR (RELATIVE)	FREQUENCY (RELATIVE)
ERROR SIGNAL	HIGHLIGHT	REAL / IMAG	EQALIZER RESET	REAL / IMAG	REAL / IMAG	REAL / IMAG
CAPTURE BUFFER	NORMALIZE ON OFF		EQALIZER LANGTH		AM & PM CONVERSION	EYE (I)
SYMBOLS & MOD ACC	MAGER ABS ON OFF	GROUP DELAY	EQALIZER STEP		EVM	
EQUALIZER	MAGER CALC (|MAX|)	PHASE RESP (WRAP)	EQALIZER LOAD	ZOOM	IQ (VECT)	IQ (VECT)
RESULT LEN (800 Sym)	EVM CALC (|MAX|)	FREQ RESP (LIN)	EQALIZER SAVE	SPECTRUM	ERROR SPECTRUM	SPECTRUM
POINTS/SYM (4)	REFDEVCOMP ON OFF	CHAN RESP (LIN)	EQALIZER DELETE	SIGNAL STATISTIC	ERROR STATISTIC	SIGNAL STATISTIC

Fit Trace

	RECORD LEN AUTO
FIT TRIGGER	RECORD LEN (800 SYM)
FIT BURST	RECORD LEN (1.579 us)
FIT PATTERN	
FIT ALIGN LEFT	
FIT ALIGN CENTER	PAT POS (123SYM)
FIT ALIGN RIGHT	
FIT ALIGN (20%)	RESULT LEN (456SYM)
SET SYMB # (58SYM)	FIT OFFSET (-10SYM)

ZOOM

ZOOM START
ZOOM LENGTH
DEMOD NEXT RIGHT
DEMOD RESTART
DEMOD @ ZOOM START
CAPTURE AUTO OFF
MULTI ON OFF


Modulation Settings
SYM RATE (270.833 kHz)
MODULATION & MAPPING
MODULATION FILTER
EQUALIZER SETTINGS
ALPHA / BT (0.3)
FSK DEV (123.4 kHz)
POINTS/SYM (4)
MODULATION FILTER
NEW USER SET
DELETE USR SET
SAVE USER SET
EQUALIZER ON OFF
EQUALIZER TRAIN
EQUALIZER FREEZE
EQUALIZER RESET
EQUALIZER LENGTH
EQUALIZER STEP
EQUALIZER LOAD
EQUALIZER SAVE
EQUALIZER DELETE
Demod Settings
RECORD LEN (8 kSym)
RESULT LEN (800)
EVAL LINES
MULTI ON OFF
FORCE WB PATH
SIDEBAND NORM INV
NORMALIZE ON OFF
POINTS/SYM (4)
EVAL LINE 1
EVAL LINE 2
AUTO
RECORD LEN (8 kSym)
RECORD LEN (1.234 ms)
Burst & Pattern
BURST SRCH ON OFF
THRESHOLD (-20 dBRef)
EXPERT SETTINGS
MEAS ONLY ON BURST
MULTI ON OFF
PATT SRCH ON OFF
SELECT PATTERN
PATTERN SETTINGS
MEAS ONLY ON PATT
THRESHOLD AUTO
THRESHOLD RELATIVE
THRESHOLD ABSOLUTE
HYSTERESIS MAN
STD PAT LIST
PATTERN LIST
SHRINK PAT LIST
ADD PAT TO STD
NEW PATTERN
EDIT PATTERN
DELETE PATTERN
REMOVE PAT FROM STD
REMOVE ALL FROM STD
PATTERN SETTINGS
PATTERN SYMBOLS
(*)
INSERT
EDIT
DELETE
SAVE
CANCEL
Range
X-AXIS QUANTIZE
X-AXIS /DIV
X-AXIS REF VALUE
X-AXIS REF POS
X-AXIS LIN LOG
Y-AXIS /DIV
Y-AXIS REF VALUE
Y-AXIS REF POS
DEFAULT SETTINGS
Range (Sym Display)
BIN
OCT
DEC
HEX

CAL

CAL TOTAL
CAL ABORT
CAL CORR ON OFF
CAL RESULTS
PAGE UP
PAGE DOWN

SETUP

REFERENCE INT EXT	YIG FILTER ON OFF
NOISE SRC ON OFF	
SIGNAL SOURCE	
PREAMP	RF PATH
	BASEBAND ANALOG
GENERAL SETUP	IQ INPUT 50Ω 1kΩ
SYSTEM INFO	BALANCED ON OFF
SERVICE	LOWPASS 36 MHZ
	DITHER ON OFF

HARDCOPY

PRINT SCREEN
PRINT TRACE
PRINT TABLE
HARDCOPY ABORT
SETUP
DEVICE 1 2
COLORS
COMMENT SCREEN A
COMMENT SCREEN B

FREQUENCY

CENTER
CF STEP AUTO MAN
CF STEP SIZE
FREQUENCY OFFSET

TRACE

SELECT TRACE	MIN HOLD
CLEAR / WRITE	AVG MODE (LOG)
MAX HOLD	FILE EXPORT
AVERAGE	FILE IMPORT
VIEW	DATA TRACE
BLANK	DATA RAW
SWEEP COUNT	HEADER ON OFF
RMS	DECIM SEP . ,

DISPLAY

FULL SCREEN
SPLIT SCREEN
CONFIG DISPLAY

FILE

SAVE	
RECALL	
EDIT COMMENT	
ITEMS TO SAVE / RCL	
DATA SET LIST	DATA SET CLEAR ALL
DATA SET CLEAR	
STARTUP RECALL	
FILE MANAGER	

AMPT			BW	SWEEP	TRIGGER
REF LEVEL			RES BW MANUAL	CONTINUOUS SWEEP	FREE RUN
	REF LEVEL OFFSET		RES BW AUTO	SINGLE SWEEP	
		Y UNIT LOG DB		DEMOD NEXT RIGHT	EXTERN
RANGE		Y UNIT LINEAR		DEMOD RESTART	IF POWER
DISPLAY UNIT		Y UNIT DEG		DEMOD @ ZOOM START	IQ LEVEL
RF INPUT AC DC		Y UNIT RAD		SWEEP COUNT	TRIGGER OFFSET
RF ATTEN MANUAL				CAPTURE AUTO OFF	POLARITY POS NEG
RF ATTEN AUTO		X UNIT TIME		MULTI ON OFF	MEAS ONLY ON PATT
ADJUST REF LVL	MIXER	X UNIT SYMBOL			MEAS ONLY ON BURST

MARKER		MKR ->	MKR FCT	LINES
MARKER 1	MKR -> TRACE	SELECT MARKER	COMP PT (1 dB)	SELECT LIMIT LINES
MARKER 2		MAX PEAK		NEW LIMIT LINE
MARKER 3		MIN PEAK		EDIT LIMIT LINE
MARKER 4		MAX |PEAK|		COPY LIMIT LINE
MARKER NORM DELTA				DELETE LIMIT LINE
				X OFFSET
				Y OFFSET
ALL MARKER OFF		MKR -> TRACE		

5 Instrument Settings and Measurements

5.1 Resetting the Option - PRESET VSA Hotkey

The *PRESET VSA* hotkey resets the R&S FSQ-K70/FSMR-B73/FSU-B73 option to the initial state (3G_WCDMA_FWD).

The settings of other applications such as frequency, level and trigger values remain unchanged.

Remote: - (IEC/IEEE bus command *RST resets all instrument settings in contrast to the hotkey.

5.2 Overview of Current Settings - SETTINGS Hotkey

The *SETTINGS* hotkey opens a table containing the most important settings of the option (see Fig. 125). The window provides an overview but it cannot be used to set parameters.

Remote: –

VSA SETTINGS			
DIGITAL STANDARD	DECT_FP	INSTR SETTINGS	
		Input	RF
MOD SETTINGS		Center Frequency	1 GHz
Symbol Rate	1.152 MHz	Reference Level	-20 dBm
Modulation	2FSK	RF Attenuator	AUTO
Mapping	NATURAL	Sweep	continuous
Transmit Filter	GAUSS	Trigger	free run
Receive Filter	NONE	Trigger Offset	0 s
Weighting Filter	NONE		
BURST & PATTERN	SETTINGS	RESULT SETTINGS	
Burst Search	ON	Sweep Count	0
Burst Threshold	AUTO	Fit	pattern to left
Pattern Search	ON	Fit Offset	-4 Symbols
Pattern	DECT_FP,...	SCREEN A/C	A
Meas Only	all	Range X	-4 to 419.75 Symb
		Range Y	-0.15 to 0.15 U
		Trace 1	Frequ CLRWR
DEMOD SETTINGS		Trace 2	-
Record Length	12000 Symbols	Trace 3	-
Result Length	424 Symbols	SCREEN B/D	B
Eval Size	0 419 Symbols	Range X	-
Sideband	NORM	Range Y	B
Points / Symbol	4	Trace 1	-
		Trace 2	-
		Trace 3	-

Fig. 125 Overview of vector analysis settings

5.3 Configuration of Measurements - HOME VSA Hotkey

The measurement is configured in the *HOME VSA* menu:

The *HOME VS*A hotkey opens the menu of the R&S FSQ-K70/FSMR-B73/FSU-B73 option with the following settings:

- *DIGITAL STANDARD* opens a submenu for selecting measurements to be performed on digital standards.
- *MODULATION SETTINGS* opens a submenu containing the settings used to define the modulation mode.
- *DEMOD SETTINGS* opens a submenu with the settings relevant for demodulation.
- *BURST & PATTERN* opens a submenu for parameterizing the burst search and the search for synchronization patterns that may be contained in the symbol stream.
- *MEAS RESULT* opens a submenu with the settings for the demodulation result and the type of result display.
- *ZOOM* opens a submenu with for selecting the displayed section of the capture buffer and for controlling the demodulation
- *FIT TRACE* opens a submenu for positioning the measurement result on the display.
- *RANGE* opens a submenu with the scaling parameters for the display format.
- *ADJUST REF LVL* automatically sets the level of the measuring instrument.

The right side menu offers the following settings:

- *FACTORY DEFAULTS* opens a submenu for restoring the factory-set default state.
- *IMPORT* opens a submenu for recalling filter, pattern, standards and mappings.
- *EXPORT* opens a submenu for saving filter, pattern, standards and mappings to an external floppy.

5.4 Measurements on Dig. Standards - DIG. STANDARD Softkey

5.4.1 Predefined Standards and Standard Groups

In the **Digital Standards** menu, predefined basic settings for standards can be selected and user-defined standards stored.

An export and import function is provided for transferring predefined and user-defined standards between different instruments (see HOME VSA menu).

The most usual measurements are predefined as standard settings for a large number of mobile radio networks. The instrument comes ready with the following settings in these **standard settings**:

- Symbol rate
- Modulation mode and modulation filter
- Recording length
- Search for burst signals
- Synchronization to fixed signal patterns
- Measurement results
- Display range and scalings

The standard settings are grouped in a *GENERIC STANDARD* to facilitate selecting a standard. A *GENERIC STANDARD* is an organization criterion for standards with similar measurement tasks.

As an example, the settings for the following measurements are grouped under the predefined *GENERIC STANDARD* GSM_EDGE:

- GSM Normal Burst,
- Access Burst,
- Synchronization Burst,
- Frequency Correction Burst
- Edge Normal Burst

Grouping itself is not subject to limitations or rules. Especially standards with different types of modulation and synchronization sequences can also be grouped in one group.

Users can easily define their own standards.

The *SAVE AS STANDARD* softkey is used to accept the current instrument setting with the above parameters including the synchronization patterns but **without frequency and level settings** of the basic instrument and to store them with user-defined names. The assignment of the new standard to a *GENERIC STANDARD* can be entered into the menu. Defining new groups is also easy.

The use of standards in several groups is possible. The user can thus generate a group shortcut with the preferred standard measurement settings.

Individual standards can be grouped and selected without any limitation, i.e. the parameters may even belong to different mobile radio networks with completely different default setups.

A *GENERIC STANDARD Y* is only an **organization criterion** for the individual standards it contains.

Fig. 126 shows

- assignments of standards to groups of standards
- the multiple use of standards in various groups
- the use of user-defined standards and groups

The only restriction for defining a user-standard name is that it must be **unique**. This means that storing a new standard under an existing name is not possible for security reasons. The existing standard must be deleted before a standard can be stored under this name.

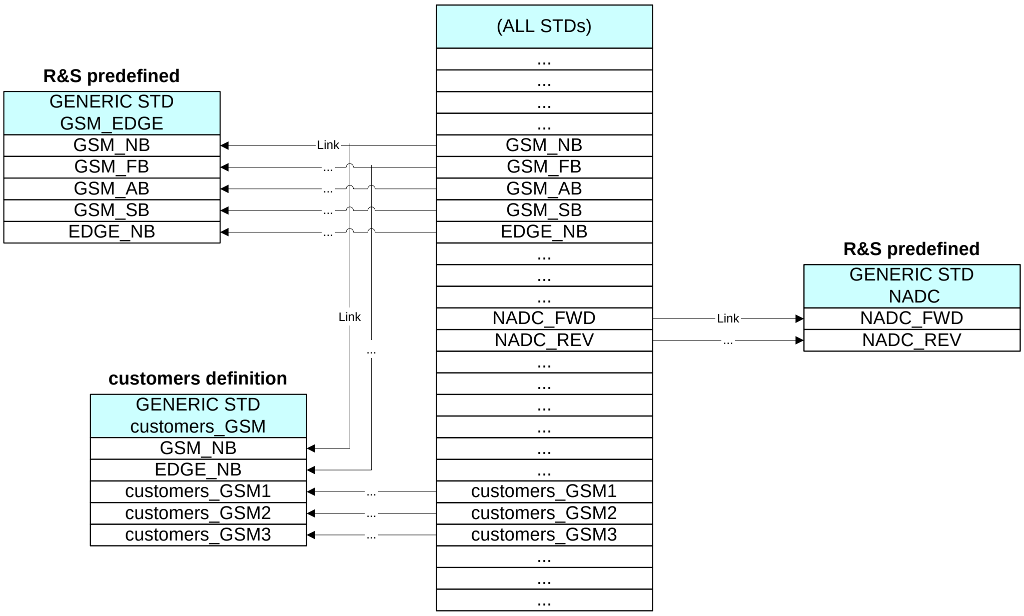


Fig. 126 Standard definition and grouping in groups

Example of operation:

The setting is performed in two steps: **selecting a standard group** and **selecting the standard measurement**.

After selection of a *GENERIC STANDARD* and acknowledgement, the focus is automatically set to the right-hand table (*STANDARDS*) for further selection.

The table below contains predefined standards and their default settings.

5.4.2 List of Predefined Standards and Standard Groups

Modulation/ GENERIC STANDARD	Standard	Modulation	Symbol rate	Filter & Mapping Transmit Filter Receive Filter Measure. Filter	Alfa BT	REF Deviation (FSK)	Search for Burst	Search for Pattern	Pattern Position	Pattern	Record length	Result length	Eval Lin 1	Eval Lin2	Fit	Fit Offset	Set Symb #	Points/symb	RESULT RAW/ FILT	ScreenA/B
APCO25	APCO25_C4FM	4FSK	4.8 kHz	APCO25_C4FM_TX APCO25_C4FM_ISI APCO25_C4FM_ISI Mapping: APCO25_C4FM	-	1.8 kHz						200			Trigger to Left			4	FIL T	Freq Error / Modu. Acc
	APCO25_CQPSK	Pi4-DQPSK	4.8 kHz	RRC NONE NONE Mapping: APCO25	0.2	-						200			Trigger to Left			4	FIL T	Meas Const / Modu. Acc
	APCO25_F4FM	4FSK	4.8 kHz	APCO25_F4FM_TX APCO25_F4FM_ISI APCO25_F4FM_ISI Mapping: APCO25_F4FM	0.22	4 kHz						200			Trigger to Left			4	FIL T	Freq Error / Modu. Acc
GSM-EDGE	GSM_NB	DMSK	270.833 kHz	GAUSS NONE NONE Mapping: GSM	0.3	-	X	X		GSM_TSC0 .... GSM_TSC7		148	3		Pattern to Center			4	FIL T	Phase Error / Modu. Acc
	GSM_SB	DMSK	270.833 kHz	GAUSS NONE NONE Mapping: GSM	0.3	-	X	X		GSM_SB0 .... GSM_SB2		148	42		Pattern to Center			4	FIL T	Phase Error / Modu. Acc
	GSM_FB	DMSK	270.833 kHz	GAUSS NONE NONE Mapping: GSM	0.3	-	X	X		GSM_FB0 GSM_FB01		148	3		Pattern to Center			4	FIL T	Phase Error / Modu. Acc
	GSM_AB	DMSK	270.833 kHz	GAUSS NONE NONE Mapping: GSM	0.3	-	X	X		GSM_AB0 .... GSM_AB2		88	8		Pattern to Center			4	FIL T	Phase Error / Modu. Acc
	EDGE_NB	3pi-8PSK	270.833 kHz	GAUSS_LINEARIZED EDGE_ISI EDGE_MEAS Mapping: WCDMA	-	-				EDGE_TSC0 .... EDGE_TSC7		148	3		Pattern to Center			4	FIL T	EVM/ Modu. Acc

Modulation/ GENERIC STANDARD	Standard	Modulation	Symbol rate	Filter & Mapping Transmit Filter Receive Filter Measure. Filter	Alfa BT	REF Deviation (FSK)	Search for Burst	Search for Pattern	Pattern Position	Pattern	Record length	Result length	Eval Lin 1	Eval Lin2	Fit	Fit Offset	Set Symb #	Points/symb	RESULT RAW/ FILT	ScreenA/B
3G_WCDMA	3G_WCDMA_FWD	QPSK	3.84 MHz	RRC RRC RRC Mapping: WCDMA	0.22	-						800	0		Trigger to Left			4	FIL T	Meas Const/ Modu. Acc
	3G_WCDMA_REV	QPSK	3.84 MHz	RRC RRC RRC Mapping: WCDMA	0.22	-						800			Trigger to Left			4	FIL T	Meas Const/ Modu. Acc
CDMA2K	CDMA2K_1x_FWD	QPSK	1.2288 MHz	CDMA2K_1X_FWD_TX CDMA2K_1X_FWD_ISI CDMA2K_1X_FWD_ISI Mapping: CDMA2K_FWD	-	-						800	0		Trigger to Left			4	FIL T	Meas Const/ Modu. Acc
	CDMA2K_1x_REV	QPSK	1.2288 MHz	CDMA2K_1X_REV_TX CDMA2K_1X_REV _ISI CDMA2K_1X_REV _ISI Mapping: CDMA2K_REV	-	-						800	0		Trigger to Left			4	FIL T	Meas Const/ Modu. Acc
	IS95_FWD	QPSK	1.2288 MHz	CDMA2K_1X_FWD_TX CDMA2K_1X_FWD_ISI CDMA2K_1X_FWD_ISI Mapping: CDMA_FWD	-							800	0		Trigger to Left			4	FIL T	Meas Const/ Modu. Acc
	IS95_REV	Pi4-DQPSK	24.3 kHz	CDMA2K_1X_REV_TX CDMA2K_1X_REV _ISI CDMA2K_1X_REV _ISI Mapping: CDMA2K_REV	-					NADC_S1 ... NADC_S6		162	0		Pattern to Center			4	FIL T	Meas Const/ Modu. Acc
NADC	NADC_FWD	Pi4-DQPSK	24.3 kHz	RRC RRC RRC Mapping: NADC	0.35			X		NADC_S1 ... NADC_S6		162	0		Pattern to Center			4	FIL T	Meas Const/ Modu. Acc
	NADC_REV	Pi4-DQPSK	24.3 kHz	RRC RRC RRC Mapping: NADC	0.35		X			NADC_S1 ... NADC_S6		156	6		Burst to Center			4	FIL T	Meas Const/ Modu. Acc
PDC	PDC_DOWN	Pi4-DQPSK	21 kHz	RRC RRC RRC Mapping: PDC	0.35		X	X		PDC_S1 ... PDC_S12		138			Pattern to Center			4	FIL T	Meas Const/ Modu. Acc

Modulation/ GENERIC STANDARD	Standard	Modulation	Symbol rate	Filter & Mapping Transmit Filter Receive Filter Measure. Filter	Alfa BT	REF Deviation (FSK)	Search for Burst	Search for Pattern	Pattern Position	Pattern	Record length	Result length	Eval Lin 1	Eval Lin2	Fit	Fit Offset	Set Symb #	Points/symb	RESULT RAW/ FILT	ScreenA/B
	PDC_UP	Pi4-DQPSK	21 kHz	RRC RRC RRC Mapping: PDC	0.5		X			PDC_S1 ... PDC_S12		135	3		Burst to Center			4	FIL T	Meas Const/ Modu. Acc
PHS	PHS_UPDN	Pi4-DQPSK	192 kHz	RRC RRC RRC Mapping: PHS	0.5		X			PHS_DO1 PHS_DO2 PHS_UP1 PHS_UP2		110	2		Burst to Center			4	FIL T	Meas Const/ Modu. Acc
	TETRA_NDDOWN	Pi4-DQPSK	18 kHz	RRC RRC RRC Mapping: TETRA	0.5		X			TETRA_S1 ... TETRA_S3		246	2		Burst to Center			4	FIL T	Meas Const/ Modu. Acc
	TETRA_NCDOWN	Pi4-DQPSK	18 kHz	RRC RRC RRC Mapping: TETRA	0.5		X			TETRA_E TETRA_S		255	7		Burst to Center			4	FIL T	Meas Const/ Modu. Acc
DECT	DECT_FP	2FSK	1152 kHz	GAUSS NONE NONE Mapping: DECT	0.5	288 kHz	X			DECT_FP DECT_PP		424	16		Burst to Center			4	RA W	Freq Error/ Modu. Acc
BLUETOOTH	BLUETOOTH1	2FSK	1000 kHz	GAUSS NONE NONE Mapping: BLUETOOTH	0.5	160 kHz -	X			BLUETH_AA BLUETH_FO		625	0		Burst to Left			4	RA W	Freq Error/ Modu. Acc
	BLUETOOTH3	2FSK	1000 kHz	GAUSS NONE NONE Mapping: BLUETOOTH	0.5	160 kHz	X			BLUETH_AA BLUETH_FO		1875	0		Burst to Left			4	RA W	Freq Error/ Modu. Acc
	BLUETOOTH_DH5	2FSK	1000 kHz	GAUSS NONE NONE Mapping: BLUETOOTH	0.5	160 kHz	X			BLUETH_AA BLUETH_FO		3125	0		Burst toLeft			4	RA W	Freq Error/ Modu. Acc

5.4.3 DIGITAL STANDARD Menu

GENERIC LIST and STANDARD LIST
DELETE STANDARD
STANDARD DEFAULTS
SAVE AS STANDARD
NEW GENERIC STD and EDIT GENERIC STD
NEW GENERIC STD

The *DIGITAL STANDARDS* softkey opens the submenu for selecting predefined measurement settings for conventional mobile radio standards.

In addition, the menu has setting items for **defining** and **deleting** digital standards as well as for configuring, modifying and deleting standard groups.

There is no item for editing a digital standard since the current device setup can be stored as user-specific standard with the *SAVE AS STANDARD* softkey.

After the *DIGITAL STANDARD* softkey is pressed, a window split in three parts is displayed:

- The currently set standard is displayed in the **upper window** (STANDARD DEFINITION).
- The predefined standard groups are displayed in the **bottom left window** (GENERIC STANDARD).
- The standards assigned to the currently selected group are displayed in the **bottom right window** (STANDARD).

A predefined measurement setting can be selected by marking the desired setting in the right column and then confirming the selection with ENTER.

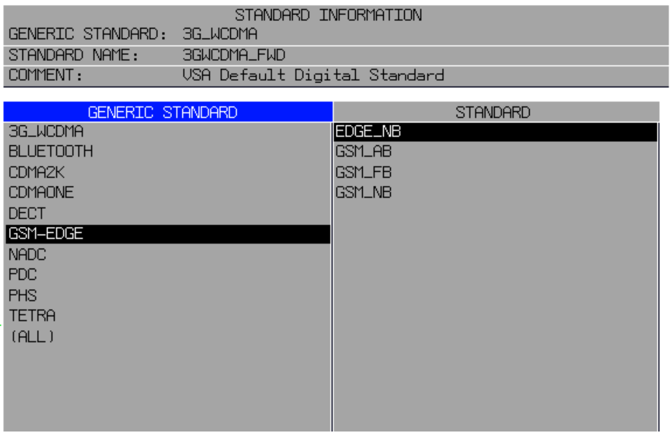


Fig. 127 Standard window

An entry (*ALL*) is contained in the list of standard groups. All standards defined in the instrument are provided under this entry on the right side.

```
Remote: SENS:DDEM:STAN:CAT?
        SENS:DDEM:PRES..<standard>|<file_name>
```

GENERIC LIST and STANDARD LIST

The *GENERIC LIST* and *STANDARD LIST* softkeys toggle the focus between the left and right column of the table. Some softkeys are only available if the table column has been correctly selected.

DELETE STANDARD

The *DELETE STANDARD* softkey deletes the marked standard. Standards predefined by Rohde & Schwarz can also be deleted. The softkey can be operated only if the entry focus is in the right table (*STANDARD LIST* softkey).

A confirmation query is displayed to avoid unintentional deletion of the standard.

The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the FACTORY DEFAULTS softkey (HOME VSA menu).

`Remote: SENS:DDEM:STAN:DEL <file_name>`

STANDARD DEFAULTS

The *STANDARD DEFAULTS* softkey resets the R&S FSQ-K70/FSMR-B73/FSU-B73 option to the default setting of the standard last used.

`Remote: SENS:DDEM:STAN:PRES`

SAVE AS STANDARD

The *SAVE AS STANDARD* softkey stores the current instrument setting as a user-defined standard.

A window is opened for entering the following parameters:

NAME	Name of the new standard. If a standard with the same name is available, overwriting is prohibited and the standard available must first be deleted. Each new standard is automatically stored in the list of all standards known (ALL Standards).
COMMENT	Comment
GENERIC STD	First assignment to a standard group. The newly defined standard can be entered into other groups later on. It is thus possible to group predefined standards with user-defined new standards to form a new group so that the work environment can be accessed rapidly.
PATTERN PREFIX	Prefix file for synchronization patterns. Patterns with this prefix are automatically entered into a selection list (PREFERRED PATTERN) for fast selection and are available for the pattern search without further configuration (see section "Pattern Search List")

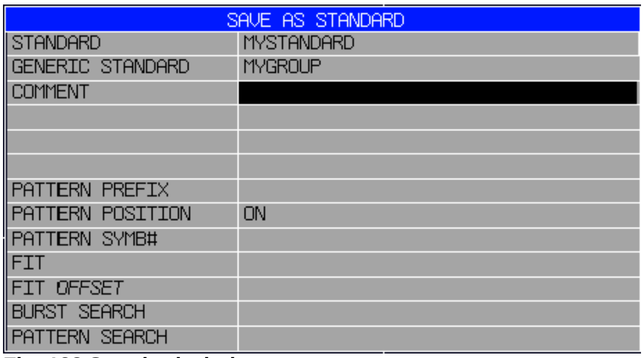


Fig. 128 Standard window

SAVE

The *SAVE* softkey stores the current setting as standard; the standard is then displayed in the standard selection list. The patterns, filters and mappings for the standard are also saved.

The softkey then returns to the calling menu.

```
Remote: SENS:DDEM:STAN:GRO 'GSM'
        SENS:DDEM:STAN:COMM 'FOR TEST'
        SENS:DDEM:STAN:PREF 'GSM_NB'
        SENS:DDEM:STAN:SAVE 'XG_2000'
        SENS:DDEM:STAN:SYNC:OFFS 10
```

CANNEL

The *CANCEL* softkey refuses the entries and does not store them as a new standard.

The softkey then returns to the calling menu.

`Remote: -`

DELETE GENERIC STD

The *DELETE GENERIC STD* softkey deletes the currently selected standard group without deleting the associated individual standard in the overall list (ALL). The softkey can be operated only if the entry focus is in the left table (*STANDARD GROUP* softkey).

`Remote: -`

NEW GENERIC STD and EDIT GENERIC STD

The *NEW GENERIC* and *EDIT GENERIC* softkeys open a submenu for defining and editing standard groups.

EDIT GENERIC STD and SHOW ALL STANDARDS
INSERT STANDARD
REMOVE STANDARD
SAVE
CANCEL

`Remote: -`

NEW GENERIC STD

The *NEW GENERIC* softkey is used to define new standard groups and *EDIT GENERIC* to adapt available groups. For this purpose, a table that is divided into two parts is opened:
The left part of the table contains an entry mask for the name of the new group and a comment. In addition, all standards already entered in the group are listed.

The right part of the table contains a list of all digital standards available.

After a name and, if required, a comment for the new standard group have been entered, *SHOW ALL STANDARDS* is used to change to the right table. Associated standards in the list are then consecutively selected and entered into the group with the INSERT STANDARD softkey.

The definition of the standard group is terminated with the *SAVE* softkey.

Fig. 129 Definition of a standard group

EDIT GENERIC STD and SHOW ALL STANDARDS

The *EDIT GENERIC STD* and *SHOW ALL STANDARDS* softkeys toggle the entry focus between the left and right table.
The left table shows the standard group and the assigned standards and the right table contains all standard definitions known (ALL STANDARDS).

`Remote: -`

INSERT STANDARD

The *REMOVE STANDARD* softkey deletes the highlighted standard from the list of the standard group without deleting the standard.

REMOVE STANDARD

The *REMOVE STANDARD* softkey deletes the highlighted standard from the list of the standard group without deleting the standard.

`Remote: -`

SAVE

The *SAVE* softkey saves the current standard assignment to the current group under the set name.

CANCEL

The *CANCEL* softkey is used to cancel editing without storing any data. In both cases, the softkey returns to the calling menu.

`Remote: -`

5.4.3.2 Exiting a Standard

If **standard instrument settings** are changed, the analyzer displays the **modulation mode** instead of the digital standard in the function panel "Standard / Modulation". This prevents the analyzer from signalling standard-conforming measurements even if standard settings were made changed.

The following parameter changes cause a digital standard to be exited:

- modulation mode (PSK; MSK; FSK; QAM)
- symbol rate (SYMBOL RATE)
- filter and filter parameters
- EVM calculation formula (EVM CALC)

Resetting the corresponding setting parameter to standard-conforming values does **NOT** result in a return to the standard. To return to the standard, either select the corresponding standard again (via DIGITAL STANDARDS) or select the STANDARD DEFAULTS softkey to return to the standard last selected.

The following settings do not cause the standard to be exited:

- modification of display formats
- modification of display scaling
- pattern

5.5 BURST& PATTERN Softkey

The settings for the sync pattern and for the burst are combined in the *BURST & PATTERN* menu.

5.5.1 Burst and Search Parameters

The basic operation of the algorithm has already been described in section 3. The present section describes the effects of the operating parameters on the burst search.

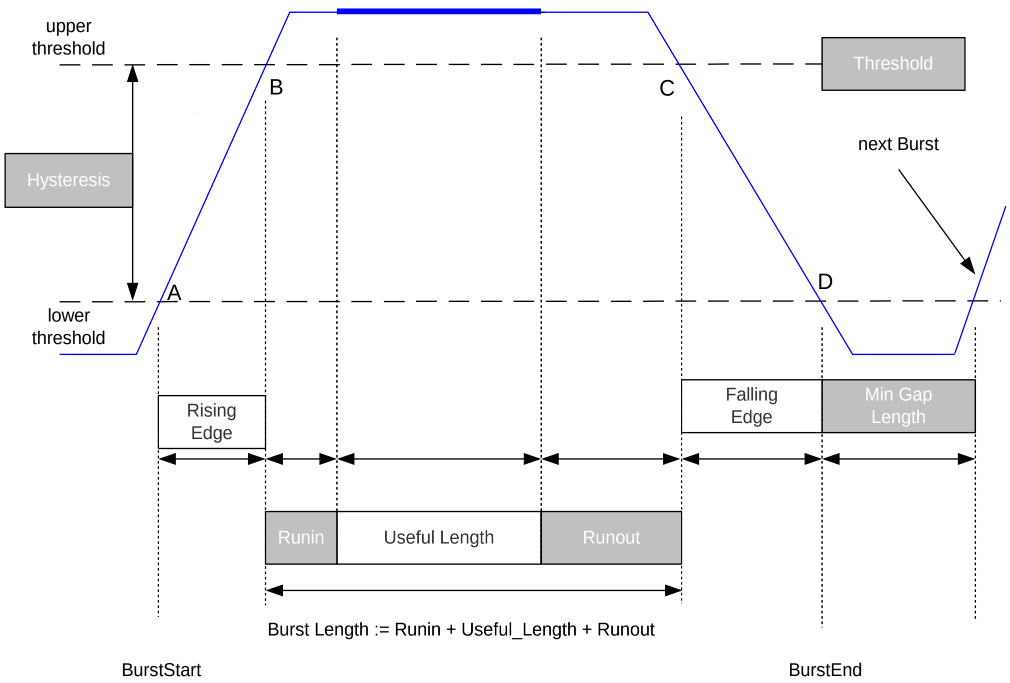


Fig. 130 Burst model of analyzer, where grey fields are operating parameters

Fig. 130 shows a burst with the operating parameters that are required for manual burst search. The figure shows points A and D when the burst level exceeds or falls below the lower threshold and points B and C for the upper level threshold.

The inner burst range (USEFUL RANGE) plays a decisive role for further demodulation. After detection of the burst edges, the range (B,C) is further limited via parameters RUNIN or RUNOUT. In this inner range, the analyzer assumes stable and settled signal ratios.

- The demodulation range of the demodulator as well as the search range for sync patterns are limited to this range.
- The operating range of the matching algorithm is also limited to this range unless standard-specific definitions have priority.

The following parameters are evaluated and corrected in the Useful Length:

- Center Frequency Error
- Symbol Timing

- Symbol Phase
- Origin Offset
- Amplitude Droop (only evaluation, no correction)

These parameters are then applied to the complete Demodulation Range, ie also to the range outside the burst.

Other test parameters such as the following are determined by the *EVAL RANGE* (see section "*Evaluation Lines / Limiting the Measurement Range*").

- EVM
- PhaseError
- Frequency Error (MSK, FSK)

This ensures a stable demodulation and measurement even if the user extends the measurement range to a burst range (by means of EVAL LINES) or ranges outside the burst.

The burst search can be performed in three different ways depending on the operating mode "Digital Standard" or "Digital Demodulation" (no standard is active).:

	Digital standard	**No standard**
Fully automatic burst search	All burst search parameters are determined by the analyzer. The useful length definition is **implemented by the standard** (Useful Part).	All burst search parameters are determined by the analyzer. The following settings are defined: Useful length = 100 symbols Max burst length = 1600 symbols
Manual search	All parameters can be set by the user.	All parameters can be set by the user.

The following distinctions are made:

- In the case of **"Standard active"**, the nominal burst length of the standard definition determines the minimum and maximum values for the search range.
- In the case of **"No standard"**, the useful length and maximum burst lengths determine the search range. In this special case, the burst search recognizes all bursts in this tolerance range and modifies the USEFUL BURST LENGTH for every measurement.
- If **SweepCount > 1** and the AVERAGE function are additionally activated (averaging over several measurements), averaging over bursts of different lengths is avoided by limiting the USEFUL BURST RANGE and the demodulation range of the NDA demodulator to the minimum burst length.

5.5.2 Multiple Evaluation of a Captured Data Record (MULTI)

Signal processing with MULTI OFF carries out exactly one demodulation per measured data capture and displays the results.

MULTI ON enables you to carry out multiple evaluations from a single data record. This mode greatly simplifies searching for modulation signal errors that occur infrequently.

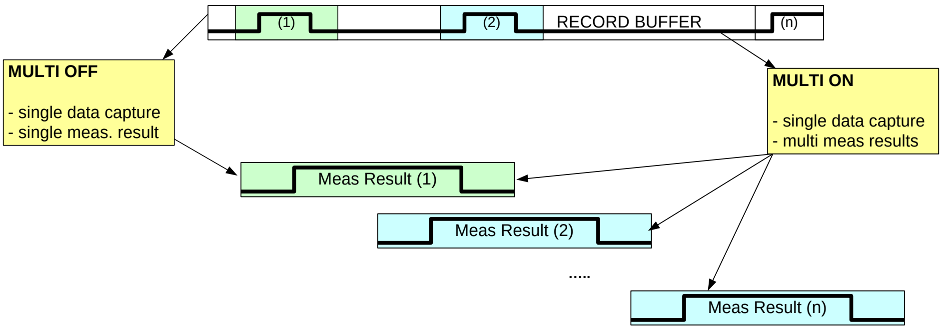


Fig. 131 ***MULTI ON/MULTI OFF*****: Multiple measurement evaluations per data capture**

Although the record length can be set as small as possible for normal measurement demodulation in order to keep the measurement time short, increase the record buffer to its maximum value of 16 Msamples in this case. Use the ZOOM or SWEEP menu to control demodulation.
Fig. 131 shows a result display when multi-processing is active. The top diagram shows the magnitude of the record buffer. The lower diagram shows the magnitude of the demodulated signal. In the example, the size of the record buffer is 100000 samples per buffer.
The section of the record buffer that is displayed is determined by the ***ZOOM LENGTH*** parameter. The maximum size is 32000 samples. To provide better orientation, the entire record buffer is symbolized as a grey bar at the top of the diagram and the area of the capture buffer that is actually being displayed is indicated in red within the bar. The demodulated range (result range) is indicated with a green bar. The navigation bars are visible only when MULTI = ON.

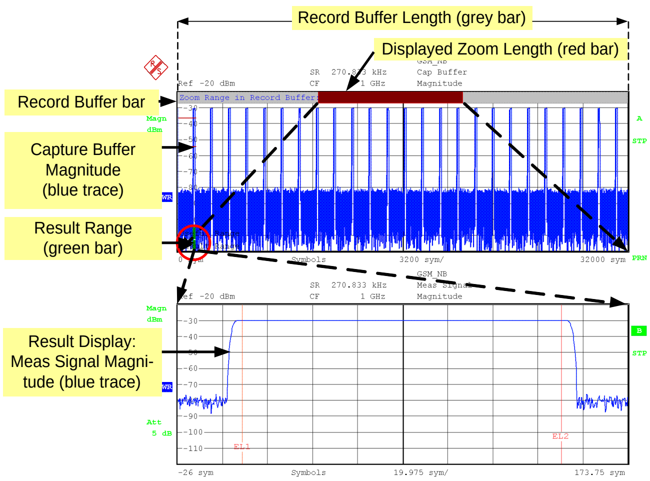


Fig. 132 Screenshot of multiple processing.
Upper trace: Capture buffer magnitude (zoomed view),
Lower trace: Measurement signal magnitude

5.5.2.1 Controlling the Evaluation

Use the softkeys *DEMOD NEXT RIGHT*, *DEMOD RESTART* and *DEMOD @ ZOOM START* to control multiple evaluation.

Use *DEMOD NEXT RIGHT* to demodulate the next block. If burst search is active, the next burst will be demodulated (Fig. 134). If burst search is inactive, the immediately following block will be measured (Fig. 133).

If the demodulation area exceeds the displayed ZOOM area, the ZOOM area will automatically shift accordingly (Fig. 135).

DEMOD @ ZOOM STA*RT* resets the demodulation area to the start of the current ZOOM area (Fig. 136), *DEMOD RESTART* resets the demodulation area to the start of the captured data (Fig. 137). Each time capture of measured data is restarted, ***ZOOM START*** resets to 0.

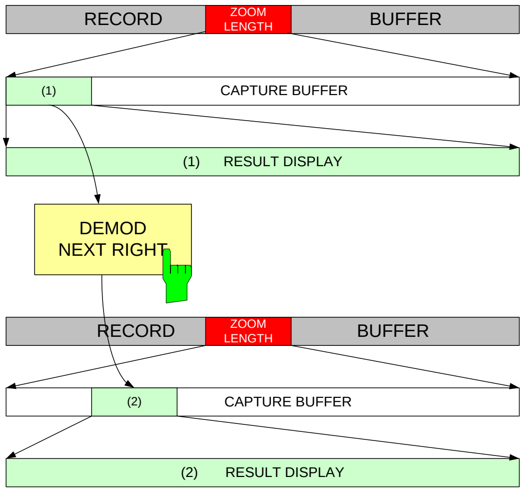


Fig. 133 DEMOD NEXT RIGHT: Demodulation of the adjacent signal section

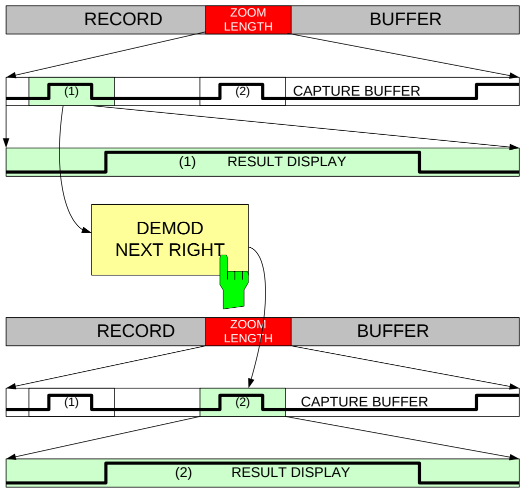


Fig. 134 DEMOD NEXT RIGHT Burst signal, demodulation of the next burst signal

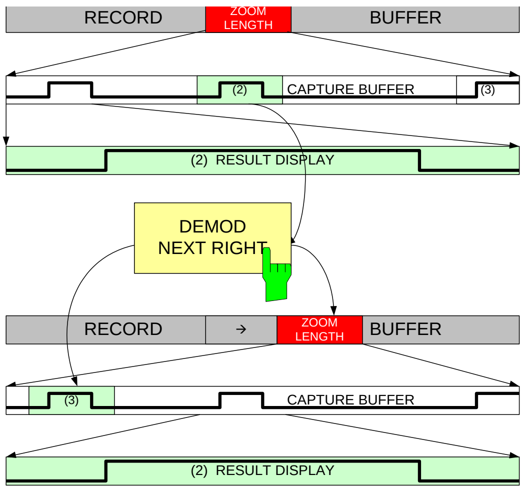


Fig. 135 DEMOD NEXT RIGHT: Automatic shifting of the ZOOM area

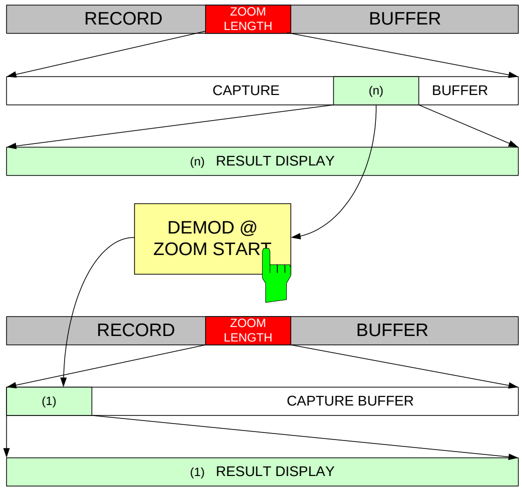


Fig. 136 DEMOD @ ZOOM START: Reset to the start of the zoom window

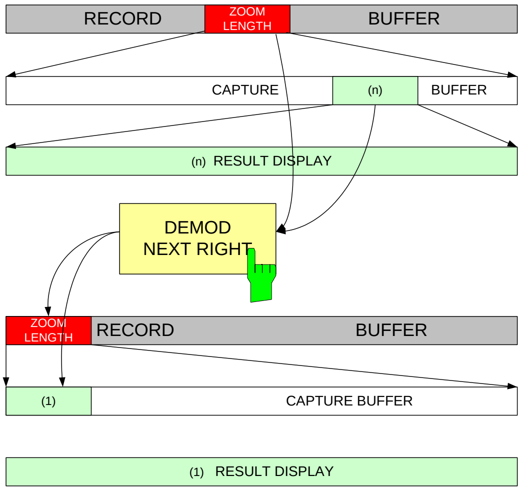


Fig. 137 DEMOD RESTART: Reset to the start of the record buffer

5.5.2.2 Controlling Data Capture

In both cases (MULTI = ON and MULTI = OFF), the capture of new measured data is controlled with the *CONTINUOUS SWEEP* and *SINGLE SWEEP* softkeys. In continuous sweep mode, data is automatically captured after each measurement. In single sweep mode, new data capture and the first evaluation are performed each time the *SINGLE SWEEP* softkey is pressed. You can then perform additional measurement evaluations by pressing *DEMOD NEXT RIGHT*. If no more data is present for evaluation, the message "End of Buffer" will appear. In this case, you can use *CAPTURE = AUTO* (and thus avoid having to enter data) to perform a new data capture, suppress the message and start the next evaluation.

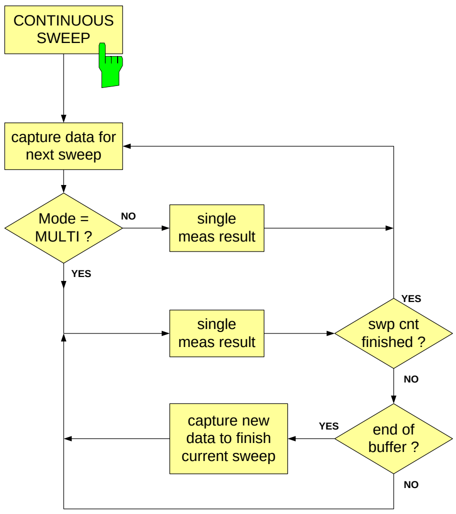


Fig. 138 COUNTINUOUS SWEEP: Automatic data capture

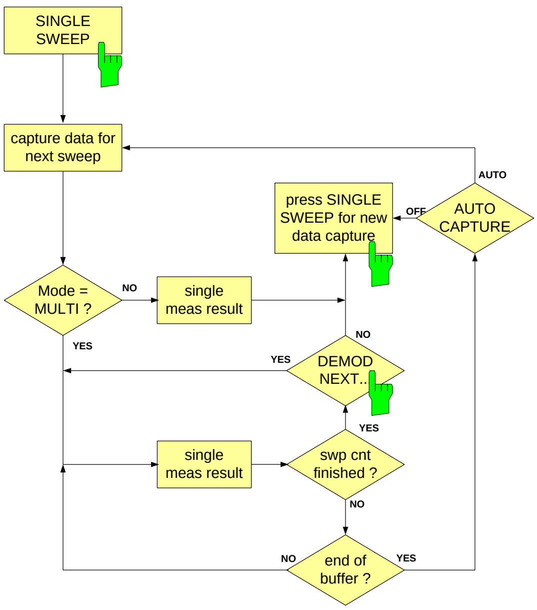


Fig. 139 SINGLE SWEEP: Automatic data capture at end of the record buffer if CAPTURE = AUTO

5.5.3 Burst and Search Parameters for Predefined Standards

Standards				**Burst Settings**			**Expert Burst Settings**				
Standard group	**Standard**	**Nominal Framelength (Standard)**	**Result Length**	**Search Burst ON**	**Search Mode (Level)**	**Hysteresis**	**USEFUL LENGTH**	**MAX LENGTH**	**RUNIN**	**RUNOUT**	**MIN GAP LENGTH**
GSM-EDGE	GSM_NB	147	148	X	Auto	9dB	142	166	2	2	1
	GSM _SB	147	148	X	Auto	9dB	142	166	2	2	1
	GSM _FB	**147**	**148**	**X**	**Auto**	**9dB**	**142**	**166**	**2**	**2**	**1**
	GSM _AB	87	88	X	Auto	9dB	77	106	7	2	1
	EDGE_NB	147	148	X	Auto	9dB	142	166	2	2	1
NADC	NADC_FWD	162	163		Auto	9dB	146	160	2	2	0
	NADC _REV	162	163	X	Auto	9dB	146	160	2	2	0
PDC	PDC_DOWN	140	140		Auto	9dB	129	172	3	3	0
	PDC _UP	140	139	X	Auto	9dB	129	172	2	2	1
PHS	PHS_CTRL	120	113	X	Auto	9dB	110	120	1	1	1
	PHS_COMM	120	114	X	Auto	9dB	110	120	1	1	1
TETRA	TETRA_NDDOWN		255	X	Auto	9dB	243	246	1	7	1
	TETRA _NCDOWN		255	X	Auto	9dB	263	266	1	7	1
DECT	DECT_FP	436	424	X	Auto	9dB	420	484	2	2	1
BLUETOOTH	BLUETOOTH_DH1	366	625	X	Auto	9dB	357	625 (1 Slot)	2	2	312 (1/2 Slot)
	BLUETOOTH_DH3	1622	1875	X	Auto	9dB	1613	1875 (3 Slots)	2	2	312 (1/2 Slot)
	BLUETOOTH_DH5	2870	3125	X	Auto	9dB	2861	3125 (5 Slots)	25	2	312 (1/2 Slot)

All numeric values are given in symbols.

5.5.4 Pattern and Pattern Lists

Since sync patterns provide a fixed symbol pattern 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.

After demodulation down to the symbol level, the R&S FSQ-K70/FSMR-B73/FSU-B73 option can synchronize to a pattern and adapt its result range to this pattern. In the case of a digital standard, several patterns to be searched for during the measurement can be selected from a list.

In a GSM burst, for example, all specific patterns TSC0...7 can be searched for. The recorded and demodulated symbol stream is searched in the given sequence of patterns. The search is stopped after the first stream has been found. The result range is adapted to the known position of the pattern in the burst and the set measurement parameters are determined for this limited measurement range.

In the case of a multiple search, only patterns of the same length and same pattern position in the data stream are useful. A simultaneous activation of patterns that do not comply with these criteria is not accepted by the system.

5.5.4.1 Predefined Patterns and List Structures

Common standards usually have predefined pattern lists (*PATTERN STANDARD LIST*) with standard-specific patterns. Sync patterns required for the current measurement can only be selected from this list. This list can be extended by patterns that are already available in the analyzer. Or newly edited patterns can be added to the list.

An export and import function is provided for transferring predefined and user-defined standards between different instruments (see HOME VSA menu).

5.5.4.2 Extending the Pattern List

The following selections are offered to extend the pattern standard list:

- The first selection level **(***PREFERRED PATTERN***)** only offers those patterns with a common (defined in the digital standard) PREFIX (e.g. GSM_).
- The second selection level **(***COMPATIBLE PATTERN***)** also offers those patterns that are compatible with the selected degree of modulation. This includes those patterns with a deviating prefix, e.g. due to deviating customer-specific sorting criteria. Patterns of different standards are also displayed at this level.
- The third selection level **(***ALL PATTERN***)** displays all patterns. This level is primarily used to define and change patterns.

5.5.4.3 Creating a New Pattern

A **new entry** of a pattern is made in the *ALL PATTERN* list. Derived lists such as *COMPATIBLE PATTERN* and *PREFERRED PATTERN* are automatically adapted, if required. A pattern can be entered into the standard list only by means of a user command or by loading data from a floppy disk or by an IEC/IEEE bus command.

5.5.4.4 Deleting and Removing a Pattern

Patterns can be **removed** very easily from predefined or user-defined standard lists *(REMOVE PATTERN FROM LIST).*

Predefined R&S patterns cannot be **deleted** from the list *(ALL PATTERN)* whereas the deletion of customer-specific patterns is possible. Derived lists are adapted automatically.

5.5.4.5 Pattern Search List

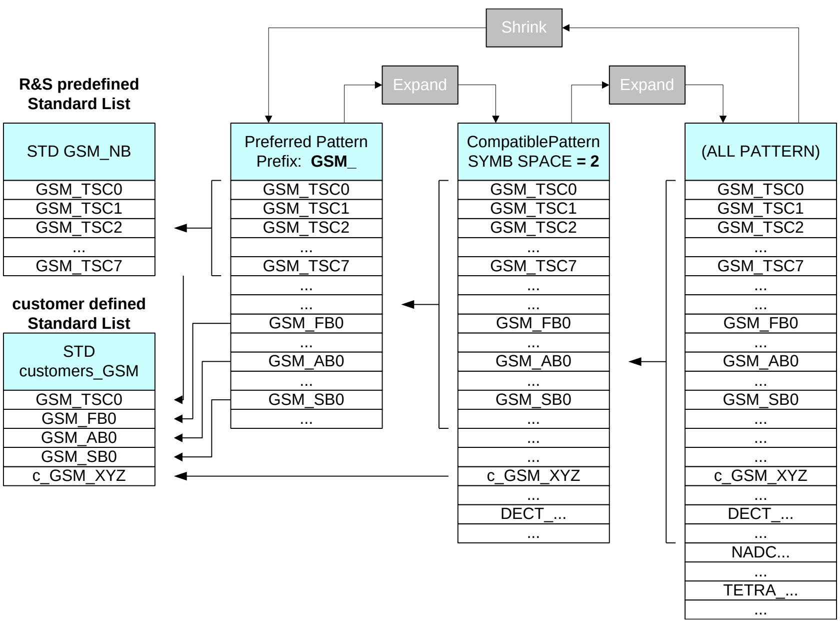


Fig. 140 Pattern lists

Fig. 140 gives an **overview** of how sync patterns are grouped to form digital standards.

Example:

The user defines a custom standard named “customers_GSM” and selects the *PREFERRED PATTERN* prefix “GSM” in the standard definition.

The user selects the patterns GSM_TSC0, GSM_FB0, GSM_AB0 and GSM_SB0 one after the other from the PREFERRED list and enters these patterns into the custom standard list.

The next pattern c_GSM_XYZ is not contained in this list. Therefore, the search is continued in the next selection list of *COMPATIBLE PATTERN*, where this pattern is selected and again saved in the standard list.

In particular, this COMPATIBLE list contains patterns that are suitable for the selected standard but have a different prefix such as customer-specific definitions ‘c_GSM’.

The *EXPAND* softkey is used to **switch** from the *PREFERRED PATTERN* list to the *COMPATIBLE PATTERN* list*.* This softkey is also used to switch to the *ALL PATTERN* list. In the list last mentioned, the labelling and function of the EXPAND softkey is modified and becomes a *SHRINK* softkey. If this softkey is pressed, the *PREFERRED* list will again be displayed.

5.5.5 BURST& PATTERN Menu

BURST SRCH ON/OFF
THRESHOLD
EXPERT SETTINGS
MEAS ONLY ON BURST
PAT SRCH ON/OFF
PATTERN SELECT
MEAS ONLY ON PAT

The *BURST & PATTERN* softkey opens a submenu for setting and parameterizing the search for bursts and sync patterns.

When a digital standard is selected, all parameters - including the SETS of the patterns - are set to default values.

BURST SRCH	Switches the burst search on or off.
THRESHOLD	Sets a level threshold for the burst search.
EXPERT SETTINGS	Opens a submenu to manually set the burst search parameters.
MEAS ONLY ON BURST	Measurement results are only displayed if a valid burst has been found. For averaged measurements of burst signals (BURST SRCH=ON), MEAS ONLY ON BURST should be activated so that erroneous measurements do not affect the result of averaging.
PAT SRCH	Switches the search for a sync pattern on or off.
SELECT PATTERN	Selects one or more patterns for the measurement.
PATTERN SETTINGS	Opens a submenu to control the pattern selection list and to edit the patterns.
MEAS ONLY ON PATT	Measurement results are displayed only if a valid burst has been found. For averaged measurements with active pattern search, MEAS ONLY ON PATT should be activated so that erroneous measurements do not affect the result of averaging.

BURST SRCH ON/OFF

The *BURST SRCH ON/OFF* softkey switches the burst search for the measurement signal on or off.

Measurements on burst input signals should be performed with the setting *BURST SRCH ON*:

In the first processing stage, the rising and falling burst edges are recognized and the internal processing lengths, which are used to find the modulation parameters, are adapted to the recognized burst length.

Measurements on unburst signals should normally be performed with the setting *BURST SRCH OFF* to avoid any erroneous detection due to the dynamic range of the signal.

The error message *BURST NOT FOUND* is displayed if an evaluation of the recorded *RECORD MEMORY* does not reveal any burst structure that meets the following requirements at the same time:

- level threshold is exceeded
- useful length
- maximum burst length

If an applied burst signal is detected unreliably due to difficult receiving conditions, it is useful to support automatic burst search with *EXPERT SETTINGS* and to use the external trigger input of the measuring instrument together with a trigger offset setting.

After activating the burst search or pattern search, the **positioning of the measurement result** on the screen should also be adapted using FIT TRACE, in order to achieve a stable display.

If the burst search is activated without a simultaneously activated pattern search, the best setting to use is FIT BURST.

If the pattern search is active, the display of the measurement result should be adjusted to the found pattern (section "Positioning of Displays on Screen - FIT TRACE Softkey").

The page menu associated with *FIT TRACE* also contains the operating parameter PAT POS (pattern position), which specifies the expected position of the pattern from the start of the USEFUL LENGTH.

`Remote: SENS:DDEM:SEAR:BURS:STAT ON`

THRESHOLD

The *THRESHOLD* softkey opens a submenu to set a **level threshold and the hysteresis for burst search**.

THRESHOLD AUTO
THRESHOLD RELATIVE
THRESHOLD ABSOLUTE
HYSTERESIS MAN

For numeric settings, the current threshold (dB or dBm) is displayed in the softkey. For automatic settings, (AUTO) will be displayed.

Three options are available for the level threshold:

- THRESHOLD AUTO
- THRESHOLD RELATIVE
- THRESHOLD ABSOLUTE

The hysteresis is set with the *HYSTERESIS MAN* softkey.

The set modulation mode (PSK, MSK, QAM, FSK) determines the hysteresis of the burst search and makes the burst search insensitive to the modulation-specific dynamic range of the corresponding modulation mode.

The burst (starting at the beginning of the *RECORD MEMORY*) meeting the level and hysteresis requirement and the minimum requirement for the burst length of the level is used for further demodulation (see also *EXPERT SETTINGS*).
The setting *AUTO* is normally used for normal demodulation settings.

If the burst search was not successful, the message *BURST NOT FOUND* would be output. However, a measurement will be performed in any case.

THRESHOLD AUTO

The *THRESHOLD AUTO* softkey activates the automatic setting of the threshold required for the burst search.

The analyzer classifies its *RECORD BUFFER* according to the maximum level occurring and derives the burst search thresholds from the maximum level and the set modulation mode.

```
Remote: SENS:DDEM:SEAR:BURS:THR:AUTO ON
```

THRESHOLD RELATIVE

The *THRESHOLD RELATIVE* softkey activates the entry of a relative threshold required for the burst search.
A numeric threshold (with reference to the set reference level (see *REFERENCE LEVEL* softkey) must be entered. The setting value is maintained even if the reference level is modified. An absolute threshold is internally calculated based on this relative threshold and the reference level setting. The absolute threshold is then adapted to the reference level setting.

```
Remote: SENS:DDEM:SEAR:BURS:THR:AUTO OFF
        SENS:DDEM:SEAR:BURS:THR:MODE REL
        SENS:DDEM:SEAR:BURS:THR:LEV <num>
```

THRESHOLD ABSOLUTE

The *THRESHOLD ABSOLUTE* softkey activates the entry of a fixed threshold required for the burst search.

A numeric threshold also has to be entered which is interpreted as an absolute setting value. A modification of the reference level does not have any effect on this absolute threshold.

```
Remote: SENS:DDEM:SEAR:BURS:THR:AUTO OFF
        SENS:DDEM:SEAR:BURS:THR:MODE ABS
        SENS:DDEM:SEAR:BURS:THR:LEV <num>
```

HYSTERESIS MAN

The *HYSTERESIS MAN* softkey activates the entry of a fixed hysteresis required for the burst search.
The hysteresis setting is referenced to the upper threshold (Threshold).

```
Remote: SENS:DDEM:SEAR:BURS:HYST:LEV 9 dB
```

EXPERT SETTINGS

The *EXPERT SETTINGS* softkey opens a table for settings that are used to accurately control the behaviour of the burst search even under difficult measurement conditions.

EXPERT SEARCH SETTINGS		
	Symbols	Time
Useful Length	142	524.3083 µs
Max Length	166	612.9238 µs
Runin	2	7.384624 µs
Runout	2	7.384624 µs
Min Gaplen	1	3.692312 µs

Fig. 141 Settings of burst search

Useful Length Setting value for minimum burst length (see Fig. 130, USEFUL LENGTH)
Max Length Setting value for maximum burst length.
Runin Setting value for the cut after the rising burst edge for the first demodulation.
Runout Setting value for the cut prior to the falling burst edge for the first demodulation.
Min Gaplen Setting value for the size of the gap between two successive bursts.

For predefined R&S standards, these values are **explicitly set** to default values. For user-defined standards, the current device settings are stored in the standard definition and are also set to default values.
The corresponding parameters can be entered both in time and symbols. They are rounded up to complete symbols or to times that correspond to complete symbols.

```
Remote: SENS:DDEM:SEAR:BURS:LENG:MIN <num_value>
        SENS:DDEM:SEAR:BURS:LENG:MAX <num_value>
        SENS:DDEM:SEAR:BURS:SKIP:RIS <num_value>
        SENS:DDEM:SEAR:BURS:SKIP:FALL <num_value>
        SENS:DDEM:SEAR:BURS:GLEN:MINimum <num_value>
```

MEAS ONLY ON BURST

The *MEAS ONLY ON BURST* softkey ensures that complete measurements are performed only if a burst complying with the above criteria has been found.
If no burst was found, processing in the demodulator is stopped at an early stage **without further measurement results or a screen display being available**.

The analyzer will immediately be ready for a new data recording and evaluation.

For averaged measurements of burst signals (BURST SRCH=ON), MEAS ONLY ON BURST should be activated so that erroneous measurements do not affect the result of averaging.

```
Remote: SENS:DDEM:SEAR:BURS:MODE BURS
```

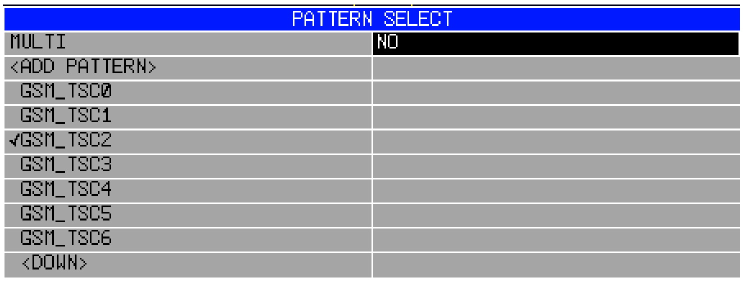
PAT SRCH ON/OFF

The *PAT SRCH ON/OFF* softkey switches the search for sync patterns in the sync data set on or off. If the sync pattern is found, the zero point of axial scaling is adapted according to the definition of the standard.

```
Remote: SENS:DDEM:SEAR:SYNC:STAT ON | OFF
        SENS:DDEM:SEAR:SYNC:FOUN?
```

PATTERN SELECT

The *PATTERN SELECT* softkey opens a table to select a pattern.
This selection list offers only those patterns that are defined for this standard.
The first line of the table can also be used to set whether the burst search is to be performed for a single pattern (**MULTI OFF**) or for several patterns (**MULTI ON**). With **MULTI ON** selected, several patterns of the list can be selected. With **MULTI OFF** selected, only one pattern can be selected from the list.



PATTERN SELECT	
MULTI	NO
<ADD PATTERN>	
GSM_TSC0	
GSM_TSC1	
✓GSM_TSC2	
GSM_TSC3	
GSM_TSC4	
GSM_TSC5	
GSM_TSC6	
<DOWN>	

Fig. 142 Pattern Select

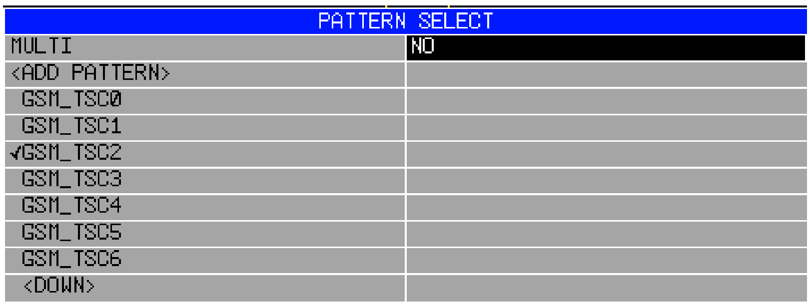
For extension or new creation of a pattern set, see next section.

```
Remote: SENS:DDEM:SEAR:SYNC:SEL "GSM_TSC2", 3
```

Selection of sync patterns without standard being set

If no digital standard is set, the *PATTERN SELECT* softkey will open a list of all patterns that are compatible with the selected degree of modulation instead of the standard-specific pattern list.

With the modulation mode MSK set, all GSM, DECT, 2FSK and other patterns with two-state modulation will be displayed. The list is displayed in alphabetical order.



PATTERN SELECT	
MULTI	NO
<ADD PATTERN>	
GSM_TSC0	
GSM_TSC1	
✓GSM_TSC2	
GSM_TSC3	
GSM_TSC4	
GSM_TSC5	
GSM_TSC6	
<DOWN>	

Fig. 143 Pattern Select

```
Remote: SENS:DDEM:SEAR:SYNC:SEL GSM_TSC2, 3
```

MEAS ONLY ON PAT

The *MEAS ONLY ON PATT* softkey is used to set complete measurements only if a suitable sync pattern was found.
If no burst was found, processing in the demodulator is stopped at an early stage **without further measurement results or a screen display being available**.

The analyzer is immediately ready for a new data recording and evaluation.

For averaged measurements of burst signals (BURST SRCH=ON), MEAS ONLY ON BURST should be activated so that erroneous measurements do not affect the result of averaging.

`Remote: SENS:DDEM:SEAR:SYNC:MODE SYNC`

5.5.5.2 Sync Patterns and Pattern Lists

STD PAT LIST and PATTERN LIST
SHRINK / EXPAND PAT LIST
ADD PAT TO STD
DELETE PATTERN
REMOVE PAT FROM STD
REMOVE ALL FROM STD

The *PATTERN SETTINGS* softkey opens a submenu for doing the following:

- managing standard-specific patterns
- creating new patterns
- editing and deleting available patterns

A table with two columns is opened at the same time

The patterns assigned to the current standard are listed in the **left** column of the table. The **right** column of the table shows an extended selection list for patterns. This selection list is used to add patterns to a digital standard and to create, edit and delete a pattern. The SHRINK / EXPAND PAT LIST softkey is used to switch between several selection levels.

PATTERN	
STANDARD: GSM_NB	ALL PATTERN
GSM_TSC0	DECT_FP
GSM_TSC1	DECT_PP
GSM_TSC2	EDGE_TSC0
GSM_TSC3	EDGE_TSC1
GSM_TSC4	EDGE_TSC2
GSM_TSC5	EDGE_TSC3
GSM_TSC6	EDGE_TSC4
GSM_TSC7	EDGE_TSC5
	EDGE_TSC6
	EDGE_TSC7
	GSM_AB0
	GSM_AB1
	GSM_AB2
	GSM_DB0
	GSM_FB0
	GSM_FB1
	GSM_SB0
	GSM_SB1
	GSM_SB2
	<DOWN>

Fig. 144 Pattern selection tables

STD PAT LIST and PATTERN LIST

Softkeys *STD PAT LIST* and *PATTERN LIST* are used to switch the focus between the left and right column of the table.

With the entry focus in the left column of the table, patterns can be edited, created or deleted from this standard list.

In the right column of the table, patterns can be added to the standard list or can be deleted from the list of patterns known throughout the system.

```
Remote: SENS:DDEM:SEAR:SYNC:CAT? CURR
        SENS:DDEM:SEAR:SYNC:CAT? ALL
```

SHRINK / EXPAND PAT LIST

The *SHRINK* ***/*** *EXPAND PAT LIST* softkeys modify the right column of the PATTERN LIST table.

Three different tables are available:

- table of patterns with pattern prefix suitable for selected standard setting (PREFERRED PATTERN)
- table of patterns with degree of modulation suitable for current device settings (COMPATIBLE PATTERN)
- table of all available patterns in the device (ALL PATTERN)

The labelling and function of the softkey changes when the table is modified. To **expand** the PREFERRED PATTERN and COMPATIBLE PATTERN table, the labelling changes to EXPAND PAT LIST; when the ALL PAT table is displayed, the softkey labelling changes to SHRINK PAT LIST.

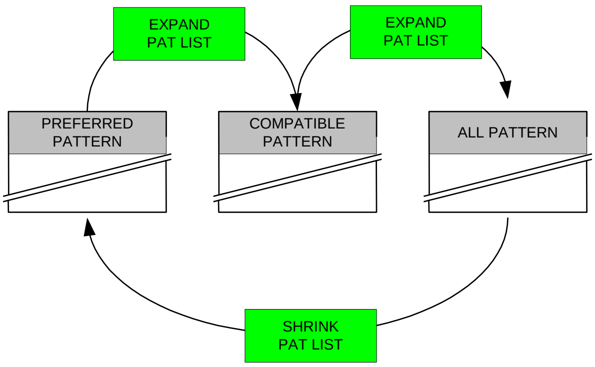


Fig. 145 Expanding pattern lists

```
Remote: -
```

ADD PAT TO STD

The *ADD PAT TO STD* softkey assigns the selected pattern of the PATTERN list (right table) to a digital standard and adds it to its list.

```
Remote: SENS:DDEM:SEAR:SYNC:PATT:ADD PATT_GSM
```

DELETE PATTERN

The *DELETE PATTERN* softkey deletes the selected pattern from the PATTERN list (right table). Any references of digital standards to this pattern are deleted as well.

```
Remote: SENS:DDEM:SEAR:SYNC:NAME SYNC_GSM
        SENS:DDEM:SEAR:SYNC:DEL
```

REMOVE PAT FROM STD

The *REMOVE PAT FROM STD* softkey removes the selected pattern from the STANDARD list (left table). However, the pattern remains in the ALL PATTERN list and can be used again at a later time.

REMOVE ALL FROM STD

The *REMOVE ALL FROM STD* softkey removes all patterns assigned so far to the standard from the *STANDARD PATTERN* list.

```
Remote: SENS:DDEM:SEAR:SYNC:PATT:REM PATT_GSM
        SENS:DDEM:SEAR:SYNC:PATT:REM ALL
```

5.5.5.3 Creating and Editing Sync Patterns

INSERT
EDIT
DELETE
SAVE >
CANCEL

The *EDIT PATTERN* and *NEW PATTERN* softkeys open a table divided into two parts to edit and create sync patterns. The upper part of the table is used to define the pattern information. The lower part of the table is used to define the actual sync pattern.

Switching between the two parts of the table is performed with the *PATTERN SETTINGS* (upper part of table) or *PATTERN SYMBOLS* (lower part of table).

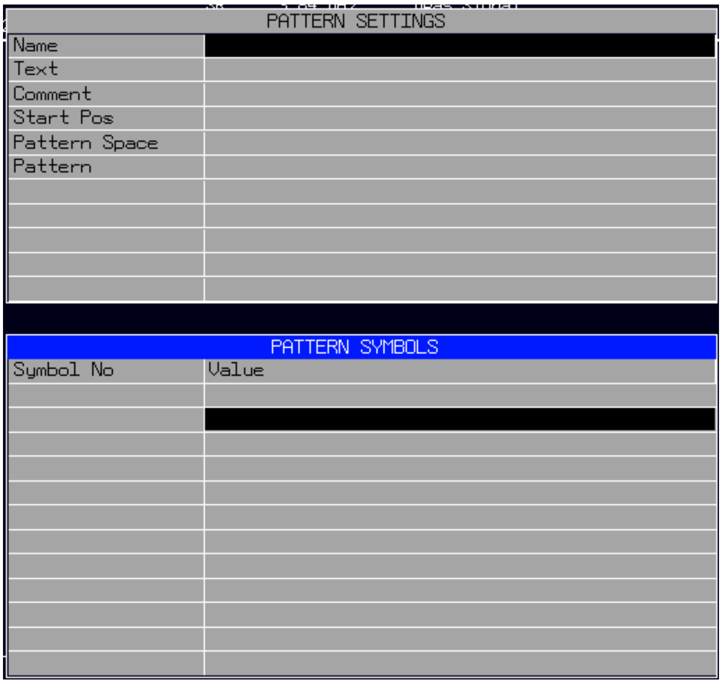


Fig. 146 Entry fields for *EDIT PATTERN*

The entries in the *PATTERN SETTINGS* table (upper part) have the following meaning:

NAME	(File) name of pattern
TEXT	Description (is displayed in the selection list)
COMMENT	Comment (is not displayed in the selection lists)
START POS	Expected position of the pattern in the burst
SYMBOL SPACE	Logical value range of modulation. **(degree of modulation** = number of constellation points in the mapping diagram, see *"Symbol Mapping"*)
PATTERN	Pattern defined so far

```
Remote: SENS:DDEM:SEAR:SYNC:NAME SYNC_GSM
        SENS:DDEM:SEAR:SYNC:TEXT SYNC for GSM
        SENS:DDEM:SEAR:SYNC:COMM version 2
        SENS:DDEM:SEAR:SYNC:NST 2|4|8|16|32|64|128|256|512|1024
```

0 ... 9

. + 0 ... . + 5

"A" "F"

(*)

The pattern is entered into the *PATTERN SYMBOLS* table (lower part):
Before entering a pattern, you must set the logical modulation value range in the PATTERN SETTINGS table (SYMBOL SPACE). For example, the value range is 4 for QPSK, 2 for GMSK, or 32 for 32QAM.
The pattern is entered in hexadecimal notation.

After each symbol the entry has to be confirmed by pressing <ENTER> key. The numbers 0 to 9 can be found in the usual place on the key pad. The alphanumeric characters A to F are entered by pressing the following keys:

"."+ "0" -> A
"."+ "1" -> B
"."+ "2" -> C
"."+ "3" -> D
"."+ "4" -> E
"."+ "5" -> F.

The (*) softkey is the wild card character for a "don’t care" symbol:

This symbol is not considered when comparing the symbol data stream with the predefined patterns.

Example:

The pattern 00011011 is to be entered for a GMSK modulation.

1. in table PATTERN SETTINGS
   set parameter SYMBOL SPACE to 2 for the GMSK modulation
2. in table PATTERN SYMBOLS enter the sync patterm:
   "0" <Enter>
   "0" <Enter>
   "0" <Enter>
   "1" <Enter>
   "1" <Enter>
   "0" <Enter>
   "1" <Enter>
   "1" <Enter>
3. in table PATTERN SETTINGS enter name (NAME) and start position (START POS) of pattern
4. save pattern using the SAVE softkey
5. include the new pattern in the standard pattern list using the ADD PAT TO STD softkey.

```
Remote: SENS:DDEM:SEAR:SYNC:NAME SYNC_GSM
        SENS:DDEM:SEAR:SYNC:DATA FFFF
```

INSERT

The *INSERT* softkey shifts the following symbols by one position and adds a "don't care" symbol to the current position.

```
Remote: -
```

EDIT

The *EDIT* softkey activates the overwriting mode and is used to change the symbol entries.

`Remote: -`

DELETE

The *DELETE* softkey deletes the symbol from the selected position and moves the following symbols one position up in the list.

`Remote: -`

SAVE

The *SAVE* softkey stores the open pattern definition under the given name and returns to the calling menu. A warning will be displayed prior to overwriting a definition with the same name.

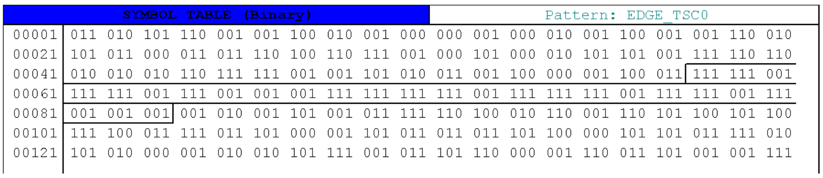
`Remote:` (is performed automatically for the IEC/IEEE-bus)

CANCEL

The *CANCEL* softkey stops editing without storing any data and returns to the calling menu.

`Remote: -`

5.5.5.4 Display of Pattern in Data Stream



SYMBOL TABLE (Binary) Pattern: EDGE_TSC0

00001	011	010	101	110	001	001	100	010	001	000	000	001	000	010	001	100	001	001	110	010
00021	101	011	000	011	011	110	100	110	111	001	000	101	000	010	101	101	001	111	110	110
00041	010	010	010	110	111	111	001	001	101	010	011	001	100	000	001	100	011	111	111	001
00061	111	111	001	111	001	001	001	111	111	111	111	001	111	111	111	001	111	111	001	111
00081	001	001	001	001	010	001	101	001	011	111	110	100	010	110	001	110	101	100	101	100
00101	111	100	011	111	011	101	000	001	101	011	011	011	101	100	000	101	101	011	111	010
00121	101	010	000	001	010	010	101	111	001	011	101	110	000	001	110	011	101	001	001	111

Fig. 147 Display of pattern in the table of decoded symbols

In the result display Symbols & Accuracy, the pattern in the symbol stream is highlighted in color on the display. On the print-out, the spattern is framed. The highlighted pattern/frame can only be seen if it is within the displayed result range. Don't care symbols are NOT highlighted in the result display. Only the **fixed components** of the sync patterns are highlighted.

Display of pattern name in function panel

A successful pattern search is additionally displayed in the function panel (PATTERN) and the name of the pattern found is displayed (e.g. GSM_TSC0). An unsuccessful search is indicated by the message “PATTERN NOT FOUND”.
This also applies if several patterns are searched for. If several measurements are averaged and if no update is performed, the pattern name of the last measurement will be displayed.

5.6 Setting Parameters - MODULATION SETTINGS Softkey

The *MODULATION SETTINGS* softkey opens a menu for setting the modulation parameters:

- Symbol rate (*SYM RATE)*
- roll-off (*ALFA BT*)
- filter (transmitter + receiver side)
  MODULATION FILTER opens a table to select the standard filter setting. If a user-specific setting is available, the selection USER will be provided.
  NEW USER SET opens a table that permits a user-specific selection of a filter set.
  DELETE USER SET stores a user-defined filter set.
  SAVE USER SET deletes a user-defined filter set.
- Settings for adaptive equalizer (EQUALIZER SETTINGS)
- Nominal deviation for FSK (*FSK DEV*)
- Modulation mode and mapping (*MODULATION & MAPPING*)
- Oversampling rate (*POINTS/SYM*)

SYM RATE
MODULATION & MAPPING
MODULATION FILTER
EQUALIZER SETTINGS
ALFA/BT
FSK DEV
POINTS/SYM

SYM RATE

The *SYM RATE* softkey opens a window for entering the symbol rate.

Together with the setting *POINTS/SYM*, the symbol rate determines the IQ bandwidth of the data recording and demodulation (see chapter 3.1.2.2).

```
Remote: SENS:DDEM:SRAT <num_value>
```

MODULATION & MAPPING

The *MODULATION & MAPPING* softkey opens a table for setting the

- modulation group (FSK, MSK, PSK, QAM)
- modulation group (FSK, MSK, PSK, QAM)
- modulation mode or degree of modulation (number of modulation states)
- symbol mapping (position of logical symbol at the IQ or frequency level)

An export and import function is provided for transferring predefined and user-defined standards between different instruments (see HOME VSA menu).

```
Remote: SENS:DDEM:FORM  <modulation>
        SENS:DDEM:<modulation>:FORM  <format>
        SENS:DDEM:<modulation >:NST  <num_value>
```

```
SENS:DDEM:MAPP <mapping_name>
SENS:DDEM:MAPP:CAT?
```

The following figures show the possible modulation groups and the predefined mappings for the selected modulation mode.

MODULATION & MAPPING		
Modulation	FSK	Mapping
PSK	√2FSK ※	√NATURAL
MSK	4FSK ※	
QAM		
√FSK		
USER-QAM		
VSB		

Fig. 148 Modulation mode FSK,-> 2FSK, 4FSK

MODULATION & MAPPING		
Modulation	MSK	Mapping
PSK	√MSK ※	√NATURAL
√MSK	DMSK ※	
QAM		
FSK		
USER-QAM		
VSB		

Fig. 149 Modulation mode MSK,-> DMSK,MSK

MODULATION & MAPPING		
Modulation	PSK	Mapping
√PSK	BPSK ※	CDMA2K_FWD
MSK	√QPSK	NATURAL
QAM	OQPSK ※	√WCDMA
FSK	DQPSK ※	
USER-QAM	PI/4-DQPSK	
VSB	8PSK ※	
	D8PSK ※	
	3PI/8-8PSK ※	

Fig. 150 Modulation mode PSK,-> BPSK,QPSK, OQPSK, 8PSK, DQPSK, D8PSK, pi/4 DQPSK, 3pi/8-8PSK

DIGITAL DEMODULATION		
Modulation	QAM	Mapping
PSK	16QAM ※	
MSK	D16QAM ※	
√QAM	32QAM ※	
FSK	D32QAM ※	
	64QAM ※	
	D64QAM ※	
	128QAM ※	
	D128QAM ※	
	256QAM ※	
	D256QAM ※	

Fig. 151 Modulation mode QAM,-> 16QAM ... 256 QAM (regular, and cross structure)

MODULATION FILTER

The *MODULATION FILTER* softkey opens a table for selecting the standard filter settings.

For detailed information on these system-theoretical filters and designs for individual filters, see chapter 3, section 3.1.2.4.

MODULATION FILTER SET			
TRANSMIT FILTER	RECEIVE FILTER	MEAS FILTER	SET
RC	NONE	NONE	RC
RRC	RRC	RRC	RRC
GAUSS	NONE	NONE	GAUSS
GAUSS_LINEARIZED	EDGE_ISI	EDGE_MEAS	EDGE
CDMA2K_1X_FWD_TX	CDMA2K_1X_FWD_ISI	CDMA2K_1X_FWD_ISI	CDMA2K 1F
CDMA2K_1X_REV_TX	CDMA2K_1X_REV_ISI	CDMA2K_1X_REV_ISI	CDMA2K 1R
APCO25_C4FM_TX	APCO25_C4FM_ISI	APCO25_C4FM_ISI	APCO25C4FM
APCO25_F4FM_TX	APCO25_F4FM_ISI	APCO25_F4FM_ISI	APCO25F4FM
HALF_SINE	NONE	NONE	HALF SINE

Fig. 152 Filter selection list

Only **complete filter sets** can be set for digital demodulation. These sets are a **combination of**:

- TRANSMIT filter (= transmit filter)
- RECEIVE filter (= receive filter for an ISI-free demodulation)
- MEAS filter (=filter that is used for the measurement).
- HALF SINE filter (=user filter set). This filter set is reqired for ZigBee (IEEE 802.15.4) measurements.
  For details please refer to application note "*1EF55: EVM Measurements for ZigBee signals in the 2.4 GHz band*" available on the R&S download area.

In many applications, the MEAS filter is identical with the RECEIVE filter. A MEAS filter is stipulated for some digital standards (e.g. EDGE).

Such a filter set is displayed in one line of the selection menu. The filter set is selected by highlighting the desired line and by pressing the ENTER key or by pressing the rollkey. The selection window will then be cleared again.

If analytic filters (RC = Raised Cosine, RRC = Root Raised Cosine, Gauss = Gaussian filter) are used, also the roll-off factor ALPHA or the bandwidth factor BT have to be given (see ALPHA/BT softkey).

The user can define, modify and delete user-specific filter sets. This will be described on the following pages.

An export and import function is provided for transferring predefined and user-defined standards between different instruments (see HOME VSA menu).

```
Remote: SENS:DDEM:FILT <TX filt>, <ISI filt>,<MEAS filt>
        SENS:DDEM:FILT:CAT?
```

EQUALIZER SETTINGS

The softkey *EQUALIZER SETTINGS* opens a menu for setting the parameters of an adaptive equalizer filter.

A more detailed explanation of the functionality and the position in the demodulation chain can be found in the section 3.1.2.6.

EQUALIZER ON/OFF	The Equalizer of the measurement demodulator is activated (ON) or deactivated (OFF).
EQUALIZER TRAIN	The Equalizer is set to the learning (training) mode (TRAIN)
EQUALIZER FREEZE	The Equalizer is set to the freeze mode.
EQUALIZER RESET	The equalizer's coefficients are preset to a neutral filter.
EQUALIZER LENGTH	Selects the filter length if the adaptive equalizer
EQUALIZER STEP	Selects the equalizer's learning rate
EQUALIZER LOAD	Loads a previously saved filter into the workspace
EQUALIZER SAVE	Saves the current filter coefficients to a file.
EQUALIZER DELETE	A saved coefficient file is removed from the file list and the file is erased.

EQUALIZER ON/OFF
EQUALIZER TRAIN and EQUALIZER FREEZE
EQUALIZER RESET
EQUALIZER LENGTH
EQUALIZER STEP
EQUALIZER LOAD
EQUALIZER SAVE
EQUALIZER DELETE

EQUALIZER ON/OFF

The softkey *EQUALIZER ON/OFF* activates the adaptive equalizer filter in the signal chain. The mode of operation is controlled by the softkeys *EQUALIZER TRAIN* (learning mode on) and *EQUALIZER FREEZE* respectively (learning mode off, freeze coefficients).

If EQUALIZER = OFF is set, a neutral filter is displayed in any equalizer result display and switched in the demodulation chain (regardless of the equalizer was activated, trained or frozen before).

By switching on and off a frozen equalizer the instrument activates and deactivates the filter without destroying the trained filter coefficients. So the user can observe the impact of the equalizer on the modulation error displays without the need to train the equalizer again.

`Remote: SENS:DDEM:EQU:STAT ON | OFF`

EQUALIZER TRAIN and EQUALIZER FREEZE

The softkeys *EQUALIZER TRAIN* and *EQUALIZER FREEZE* control the operating mode of the equalizer.

With EQUALIZER TRAIN the learning phase is started (based on the currently active filter coefficients) and –depending on the measured error vector- the filter coefficients are optimized. Due to the additional time consuming calculations the measurement rate decreases.

With *EQUALIZER FREEZE* the learning phase is stopped and the coefficients are frozen. The measurement rate increases again.

EQUALIZER RESET

With *EQUALIZER RESET* the filter coefficients are preset to a neutral filter regardless of the TRAIN or FREEZE state

The softkeys are available only when the equalizer is switched on (EQUALIZER ON).

```
Remote: Train     SENS:DDEM:EQU:ADAP  ON
        Freeze    SENS:DDEM:EQU:ADAP  OFF
        Reset     SENS:DDEM:EQU:RESEQUALIZER LENGTH
```

EQUALIZER LENGTH

The softkey *EQUALIZER LENGTH* activates the input of the filter length.
Changing the length during operation of the equalizer is possible in principle. However, it is recommended to preset the coefficients to a neutral filter (EQUALIZER RESET) after changing the length followed by a new learning phase (EQUALIZER TRAIN). So the equalizers learning process can restart with a defined setting.

```
Remote: SENS:DDEM:EQU:LENG  <num>
```

EQUALIZER STEP

The softkey *EQUALIZER STEP* controls the equalizer’s learning rate.
The parameter can be altered during operation.
The equalizer control unit calculates update coefficients for each block of measurement results. The currently operative coefficients are calculated with the relation:

$$coeffs(n+1) = coeffs(n)\cdot(1-step) + update(n)\cdot step;$$

As a rule of thumb for the step settings a value of STEP = 0.1 (when started) is favourable for quick improvements of the EVM display. Later on (when improvements of the modulation error display are noticeable) a value of STEP = 0.01 or less can be used in order to get an even lower error display. When lowering the STEP values the learning rate decreases but the accuracy of the compensation increases.

```
Remote: SENS:DDEM:EQU:CNVR <num>
```

EQUALIZER LOAD

The softkey *EQUALIZER LOAD* loads a previous saved or imported equalizer filter in the working range. The existing internal files of the selected type are listed in a table. The cursor keys or rotary knob are used to make a selection. Pressing the ENTER key as confirmation copies the file to the diskette (or to another data medium that is connected). If no matching files are found in the instrument, a blank table will be displayed. It can be exited with ESC.

```
Remote: SENS:DDEM:EQU:LOAD  'name'
```

EQUALIZER SAVE

The softkey EQUALIZER SAVE allows storing of the actual equalizer coefficients in a file. A window for entering the filename is opened. Pressing the ENTER key as confirmation saves the file.

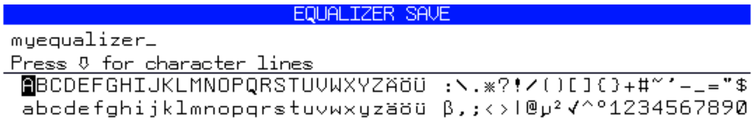


Fig. 153 Filename input

`Remote: SENS:DDEM:EQU:SAVE 'name'`

EQUALIZER DELETE

The softkey *EQUALIZER DELETE* deletes a previously saved or imported equalizer filter. The existing internal files of the selected type are listed in a table. The cursor keys or rotary knob are used to make a selection. Pressing the ENTER key as confirmation deletes the file. If no matching files are found in the instrument, a blank table will be displayed. It can be exited with ESC.

`Remote: SENS:DDEM:EQU:DEL 'name'`

NEW USER SET

The *NEW USER SET* softkey opens an entry window for defining a user-specific filter set. User-specific filters already available in the analyzer are offered in a selection menu. During the import or use of individual filters, the analyzer does **NOT** check whether the filters meet the system-theoretical requirements of an ISI-free demodulation. This may be checked by the user.
If a SET is newly defined, the TX, ISI and MEAS filters must be determined one after the other from a list of all filter files.
The following figure illustrates how such a SET is created and the TX filter selected (example).

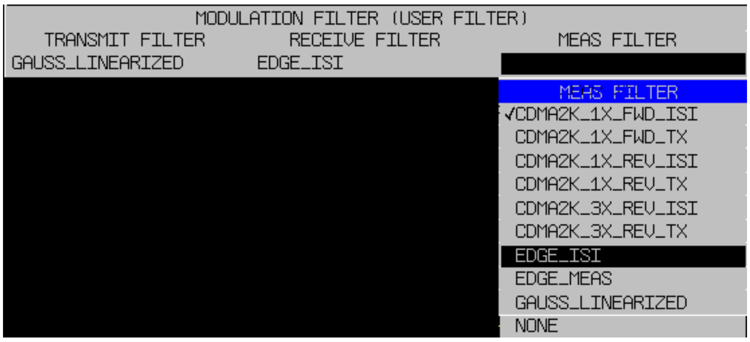


Fig. 154 Definition of a new filter set

Filter files cannot be mixed with analytical filters (RC, RRC, GAUSSIAN filters). In this case, the coefficients in the time domain must be designed for a corresponding filter and have to be imported as user-specific filters. The setting NONE is also permissible for the RECEIVE filter.

`Remote: -`

SAVE USER SET

The *SAVE USER SET* softkey adds the newly defined *USER SET* to the modulation filter table and marks the entry as (USER) to distinguish it from the factory-set filters. If user-specific SETs are already available, new SETS are added to the end of the list. It is then returned to the *MODULATION FILTER* table.

DELETE USER SET

The *DELETE USER SET* softkey is used to delete the selected *USER SET* from the modulation filter table. If a factory-set filter set is deleted, the following error message will be displayed.

`Remote: -`

ALFA/BT

The *ALFA/BT* softkey opens an entry window for the roll-off factor (PSK, QAM) or the bandwidth factor (MSK, FSK) for analytical filters**.**

The value range for ALFA and BT is 0.1 to 1.0.

The factor is limited for very large sampling rates. Modulation bandwidths > 28 MHz cannot occur (compensated resolution bandwidth= Comp_RBW); .(R&S FSU Modulation bandwidths > 7 MHz) cannot occur; compensated RBW 7 MHz).

$$Comp\_RBW \geq Symbolrate * (1 + ALFA);$$

`Remote: SENS:DDEM:FILT:ALPH <num_value>`

FSK DEV

The *FSK DEV* softkey opens a window for entering the reference deviation for FSK signals.

For FSK DEV values above the set symbol rate a POINTS/PER SYMBOL value of at least eight is recommended.

The value range is from 1 kHz (min) to the set symbol rate (max).

`Remote: CALC:FSK:DEV:REF <num_value>`

POINTS/SYM

The *POINTS/SYM* softkey indicates the number of samples between 2 successive symbols. The softkey also determines the signal bandwidth available for the demodulation.

Possible setting values: 1,2,4,8,16

For setting values *POINTS/SYM* <4, the internal data recording and demodulation is performed by setting "4

`Remote: SENS:DDEM:PRAT 4`

5.7 Setting Demodulation - DEMOD SETTINGS Softkey

The *DEMOD SETTINGS* softkey opens a submenu with the settings that are important for the demodulation and the display of measurement results.

RECORD LEN	Indicates the size of the IQ buffer for data recording.
RESULT LEN	Indicates the size of the result display.

EVAL LINES	Determines the evaluation range for numeric measurement results.
MULTI	Switches multiple evaluation mode on and off (see section 5.5.2).
FORCE WB PATH	Activates use of option “Bandwidth Extension R&S FSQ-B72” signal path below 100 MHz.
SIDEBAND	Switches between spectral non-inverted and inverted position.
NORMALIZE	Controls the conversion of the IQ offset (origin offset) into numeric results and the display format.
POINTS/SYM	Indicates the number of samples between two successive symbols.

RECORD LEN
RESULT LEN
MULTI ON/OFF
FORCE WB PATH (R&S FSQ only)
SIDEBAND NORM/INV
NORMALIZE ON/OFF
POINTS/SYM

RECORD LEN

The *RECORD LEN* softkey opens a submenu for setting the size of the IQ buffer for data recording.

Time entries are internally converted into the unit symbol and are rounded to integer symbols.

The screen display range of the MAG CAP BUFFERS is exclusively determined by the setting of the RECORD LEN.

The upper limit of the record length is 4194104 symbols.

RECORD LEN (AUTO)
RECORD LEN (x SYM)
RECORD LEN (x sec)

RECORD LEN (AUTO)

The *RECORD LEN (AUTO*) softkey automatically selects the optimum setting of the record length for the corresponding device setting.

A value of 10 times the burst length is set for a digital standard. If no bursts are defined in the standard, a value of 10 times the *RESULT LEN* is set.

`Remote: SENS:DDEM:RLEN:AUTO ON`

RECORD LEN (x SYM)

The *RECORD LEN (x SYM)* softkey activates the entry of the record length in symbols.

At least double the value of RESULT LEN should be set.

`Remote: SENS:DDEM:RLEN <num>SYM`

RECORD LEN (x sec)

The *RECORD LEN (x sec)* softkey activates the entry of the record length in seconds.

At least double the value of RESULT LEN should be set.

`Remote: SENS:DDEM:RLEN <num>S`

RESULT LEN

The *RESULT LEN* softkey opens a window for entering the maximum display range on the display of the analyzer. This display range is principally valid for all result displays.

The result range will be limited to the range determined by *EVAL LINES* only for the results in

- *MODULATION ACCURACY*
- *STATISTIC* or *ERROR STATISTIC und*
- *SPECTRUM* or *ERROR SPECTRUM*

See section "*Multiple Evaluation of a Captured Data Record (MULTI)*"

`Remote: SENS:DDEM:TIME <num_value>`

MULTI ON/OFF

The *MULTI ON/OFF* softkey switches **multiple evaluation mode** on and off ("*Multiple Evaluation of a Captured Data Record (MULTI)*"). If MULTI ON is selected, a new capture is performed once the end of the record buffer has been reached. Otherwise, the message '**End of Buffer'**will be output.

`Remote: SENS:DDEM:SEAR:MBUR ON`

FORCE WB PATH (R&S FSQ only)

The *FORCE WB PATH* softkey activates the use of signal path of option “Bandwidth Extension R&S FSQ-B72” for symbol rates below 25 MHz.

This softkey is only available, if option “Bandwidth Extension R&S FSQ-B72” is installed. This option is automatically activated when using sample rates above 100 MHz (= symbol rate 25 MHz * 5 points/symbol).

If function *FORCE WB PATH* is switched on the B72 signal path is also used for sample rate below 25 MHz.

The softkey is available down to symbol rate 5.1 MHz (at 4 points/symbol). Reducing the symbol rate below 5.1 MHz will automatically switch off this function.

`Remote: SENS:DDEM:WBAN:STAT ON|OFF`

SIDEBAND NORM/INV

The *SIDEBAND NORM/INV* softkey switches between spectral non-inverted and inverted position.

NORM The demodulator operates in non-inverted position.

INV The demodulator expects the spectral inverted position at the input.

`Remote: SENS:DDEM:SBAN NORM | INV`

NORMALIZE ON/OFF

The *NORMALIZE ON/OFF* softkey activates/deactivates the normalization.

ON The measured value evaluated for the IQ offset (origin Offset), for the display format and further error calculations (EVM, phase error ...) is subtracted from the IQ measurement data record.

OFF The error calculations are performed using the uncorrected data record. This setting is useful for the measurement of non-linear distortion.

`Remote: SENS:DDEM:NORM ON | OFF`

POINTS/SYM

The *POINTS/SYM* softkey sets the number of reference points between two symbol points in time.

The setting range is 1;2;4;8;16.

The IQ data recording is always performed with a minimum of 4 *POINTS/SYM* and does not depend on the setting range. For setting values 1;2, data is reduced only if the results are displayed.

The parameter has a special effect on the bandwidth of the data in the RECORD BUFFER (IQ bandwidth); for further examples, see "*Bandwidths for Signal Processing*".

`Remote: SENS:DDEM:PRAT 4`

5.7.2 Evaluation Lines / Limiting the Measurement Range

The evaluation lines limit the evaluation range of numeric error displays in the *MODULATION ERRORS* mode.

For modulation modes PSK, MSK and QAM, this applies to:

- EVM
- phase error
- RHO
- frequency error (only MSK)

For the modulation mode FSK, this applies to error displays for:

- magnitude error
- frequency error

To obtain stable demodulation, the analyzer uses - irrespective of the very tightly set evaluation lines - a large demodulation range. For burst signals, this corresponds to the "Useful Length". For unburst signals, it corresponds to the "Result Length". Within this extended range, further numeric error displays such as the following are determined:

- center frequency error
- IQ offset (origin offset)
- IQ imbalance

The following figure shows different predefined setting options using a burst signal as an example. The *EVAL RANGE* can also be determined by manually positioning *EVAL LINE 1* or *EVAL LINE 2*.

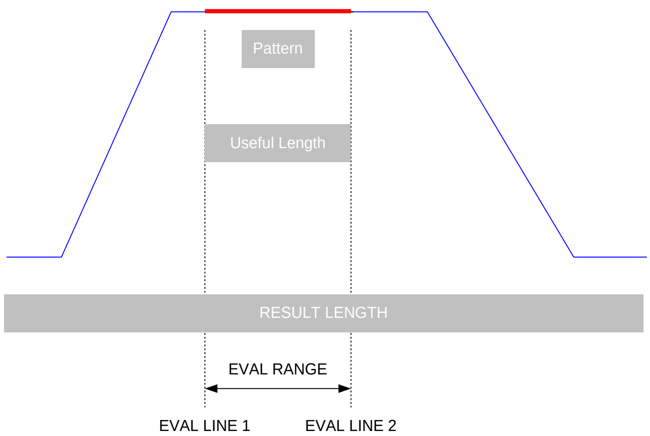


Fig. 155 Setting the *EVAL RANGE*

EVAL LINES

The *EVAL LINES* softkey opens a submenu for setting the evaluation ranges for a measurement.

EVAL LINE 1 /2 Selects the left and right margin of the range.

```
Remote: CALC:ELIN1 2SYMB
        CALC:ELIN2 12SYMB
        CALC:ELIN:STAT ON | OFF
```

5.7.3 Record Buffer, Demodulation Range and Display Range

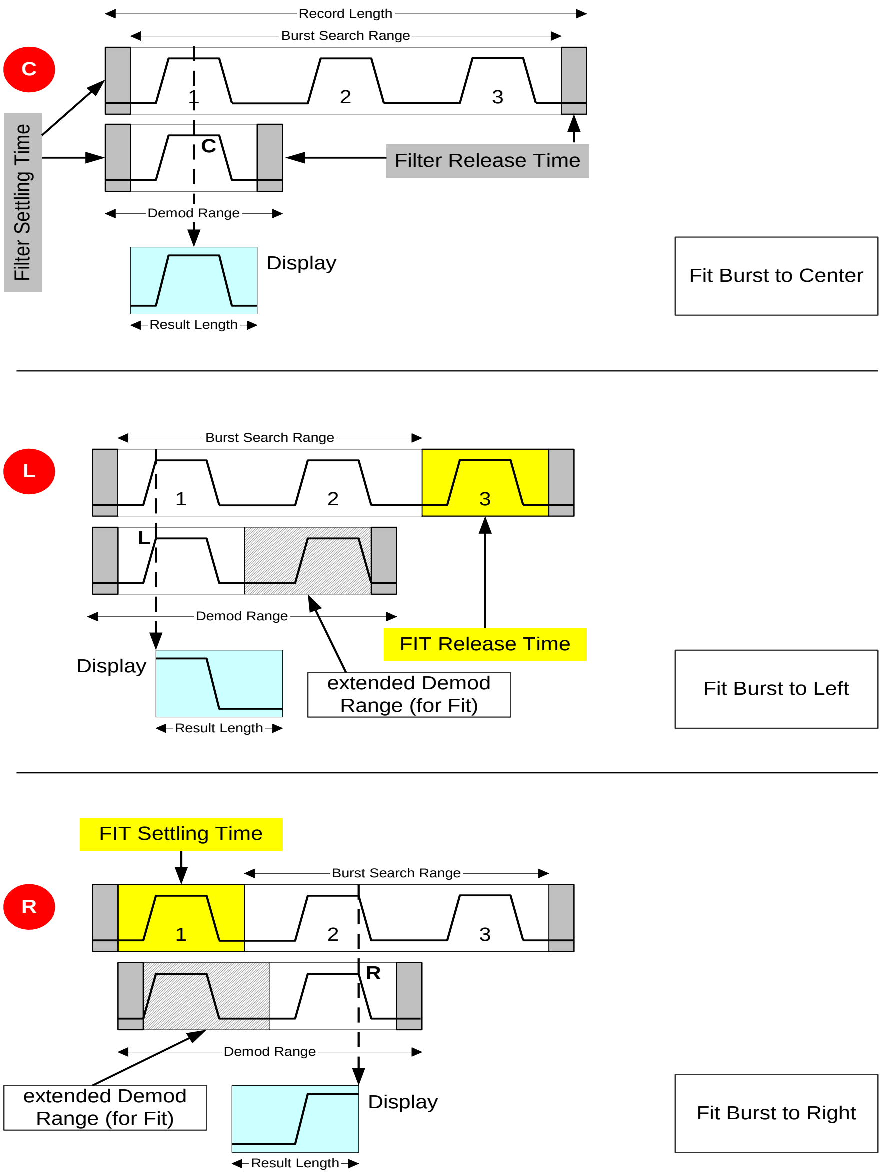


Fig. 156 Record buffer burst search range and result display

The operating settings for screen positioning (section "***Positioning of Display on Screen - FIT TRACE Softkey***") also determine internal processing lengths and search ranges within the record buffer. The analyzer may limit search ranges since the operating settings for screen positioning have priority.

Fig. 156 shows three examples of different screen positioning that display

- record buffer
- demodulation range in signal processing and
- the result display with the set display positioning

The operating parameter *RESULT LENGTH* determines the length of the result display. The operating parameter *FIT BURST* is used to control the position of the burst on the screen.

The evaluation range of the modulation parameters (see section Burst and Search Parameters) is, in every example, limited to the burst length (the inner burst range). The parameters evaluated there (center frequency error, symbol timing) are applied to the complete data record of signal processing (in this case designated as DSP_Demod_Range).

The data range of the record buffer considered in this DSP_Demod_Range is evaluated by the analyzer based on the burst length and the operating parameters *RESULT LEN* and *FIT*. In addition to the actual processing length, settling ranges are required for filtering and demodulation. They are displayed in grey. Further settling times (*FIT* Settling / Release Time) are required for correct representation and are displayed in light grey.

C **FIT BURST to CENTER**

Burst_1 is recognized with this setting. It is positioned in the center of the burst representation.

The simple *RESULT LENGTH* which is extended at the margin of the screen by settling ranges is sufficient as the processing range (DSP_Demod Range). FIT BURST to CENTER shows the typical default setup for digital standards.

L **FIT BURST to LEFT**

This setting is used to recognize Burst_1, and the left edge of the burst is positioned to the left margin of the screen.

The processing range (DSP_Demod Range) is extended towards the right since an **extended right edge** is required for burst representation. In Fig. 156 this is shown by a doubled DSP-Demod_Range. The analyzer calculates the actually required length itself.

R **FIT BURST to RIGHT**

This setting is used to position the right edge of the burst to the right margin of the screen.

The processing range (DSP_Demod Range) starts at a later time since an **extended left edge** is required for the representation.

As a result of the limitation of the search range, the measurement is performed only with the second burst in the record buffer. When an external trigger is used, a modification of the FIT settings must be compensated for by adapting the trigger delay setting. This is done to record data prior to burst_1.

For further positioning options, see section *FIT TRACE.* The same interdependencies apply.

5.8 Display of Measurement Results

5.8.1 Spectral Displays

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

Meas and Reference Signal:	Magnitude, Phase, Frequency, Real/Imag
Error Signal:	Error Magnitude, Error Phase, Error Frequency, Error Real/Imag, EVM
Capture Buffer:	Magnitude Capture Buffer, Frequency, Real/Imag.

An I/Q mapper maps logic symbols onto real Dirac pulses. For real input signals, the spectrum between the frequencies 0 and (symbol rate*points/symbol/2) is displayed; for complex input signals (REAL/IMAG and Error REAL/IMAG), the spectrum between +/- (symbol rate*points/symbol/2) is displayed.

The input signal is subjected to a fast Fourier transform (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 TimeLines for restricting the evaluation area are active, the FLATTOP window is also restricted to the area inside the TimeLines. Following the FFT, the spectrum magnitude is calculated and displayed.

Fig. 157 and Fig. 158 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 Fig. 157 shows EVM versus time; the FFT magnitude versus the EVM signal is shown at the bottom. In Fig. 158, the FFT is applied to the complex signal (REAL/IMAG, top). The bottom diagram shows the FFT magnitude. Since the input signal was complex, a two-sided spectrum is shown. In both cases, the time range for the FFT is restricted by the activated TimeLines so that, for example, burst edges will not be included.

When activating the spectral display, the measurement evaluation must first be set in the time range in order to then switch the display over by pressing the SPECTRUM softkey. The scaling and the unit of the x axis of the basic diagram are also used on the y axis of the spectrum display but they can be changed via the RANGE menu. The LIN/LOG softkey in this menu can be used to switch between linear and logarithmic scaling of the y axis.

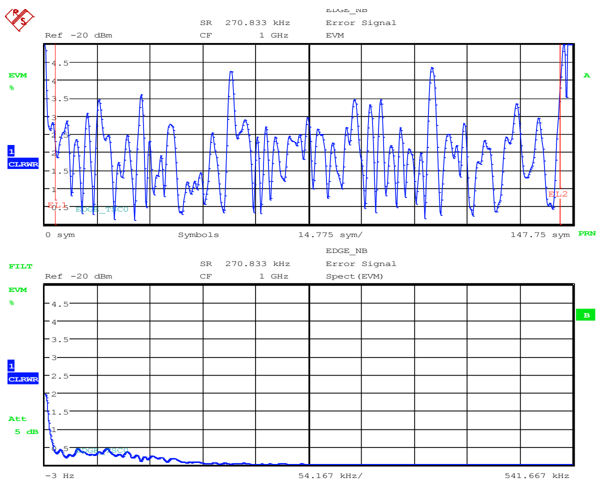


Fig. 157 Spectrum diagram: Single-sided display for real input signals

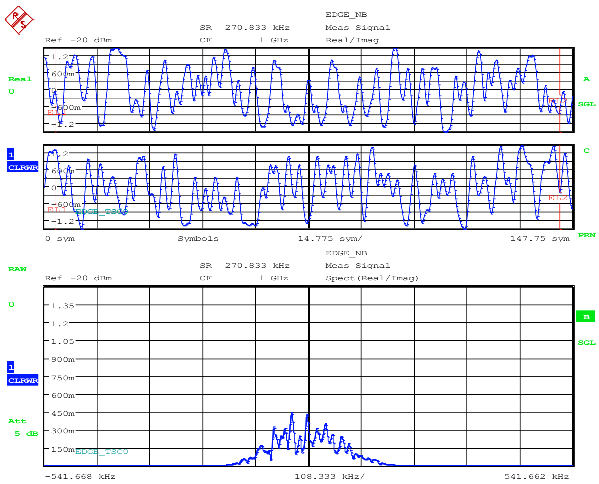


Fig. 158 Spectrum diagram: Two-sided display for complex input signals

5.8.2 Statistical Displays

Statistical evaluations can be carried out for all result displays that show the time or symbols on the x axis:

Measurement and Reference Signal:	Magnitude, Phase, Frequency, Real/Imag
Error Signal:	Error Magnitude, Error Phase, Error Frequency, Error Real/Imag, EVM
Capture Buffer:	Magnitude Capture Buffer, Frequency, Real/Imag.

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. Probabilities of occurrence located outside the display area are applied to the bars at the left or right borders of the display. The quantization can be set via the number of bars in the display area by using the RANGE -> QUANTIZE parameter. In the basic setting, 101 bars are used.

Fig. 159 shows an example of a statistical evaluation. The upper trace shows the basic diagram (EVM), while the lower trace shows the associated distribution of the EVM.

As with spectral displays, the time range for evaluation is also restricted by means of the activated TimeLines so that, for example, burst edges will not be included.

When activating statistical evaluation, the measurement evaluation must first be set in the time range in order to then switch the display over by pressing the STATISTIC or ERROR STATISTIC softkey. The scaling and the unit of the y axis of the basic diagram are also used on the x axis of the statistics display but they can be changed via the RANGE menu. The RANGE -> LIN/LOG softkey in this menu can be used to switch between linear and logarithmic scaling of the y axis.

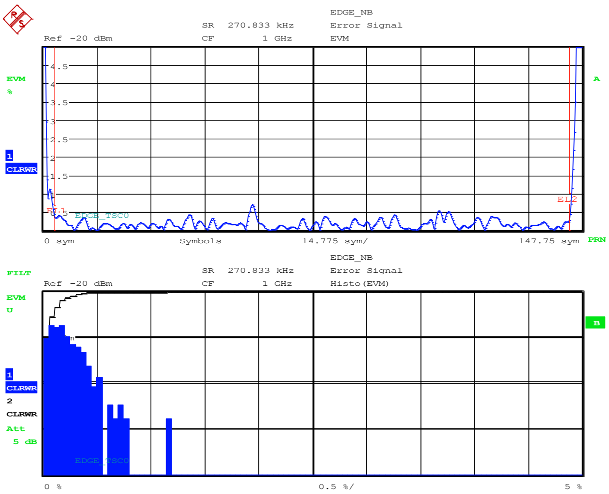


Fig. 159 Error vector magnitude (top) EVM frequency distribution (bottom)

5.8.3 MEAS RESULT Softkey

RESULT RAW/FILT
MEAS SINAL and REF SIGNAL
ERROR SIGNAL
CAPTURE BUFFER
EQUALIZER
SYMBOLS & MOD ACC
RESULT LEN; NORMALIZE ON/OFF and POINTS/SYM
OFFSET EVM ON/OFF
HIGHLIGHT
MAGER ABS
MAGER CALC
EVM CALC
REFDEVCOMP ON/OFF

The *MEAS RESULT* softkey opens a menu for selecting result displays.

RESULT RAW/ FILT Selects the measurement on an unfiltered raw signal or a filtered signal.

MEAS SIGNAL Opens a submenu for selecting the measurement signal (MEASUREMENT SIGNAL).

REF SIGNAL Opens a submenu for selecting the reference signal (REFERENCE SIGNAL)

ERROR SIGNAL Opens a submenu for selecting the modulation error display.

CAPTURE BUFFER Opens a submenu for selecting the recorded raw signal.

SYMBOLS & MOD ACC Outputs the decoded symbols as well as numeric modulation errors. (MODULATION ACCURACY)

EQUALIZER Opens a submenu for selecting the filter coefficient display or related displays of the adaptive equalizer

OFFSET EVM ON/OFF Influences the calculation of the error vector magnitude trace for Offset-QPSK only.

HIGHLIGHT Highlights the symbol decision instants in many diagrams.

REVDEVCOMP Controls the normalization of the FSK reference signal to the measurement signal.

EVM CALC Selects the calculation method for error calculation and display of error vector magnitude.

MAGER ABS Switches the calculation formula for Magnitude Error.

MAGER CALC Switches the calculation formula for Magnitude Error.

The function and operation of the following softkeys are identical to the softkeys in the *DEMOD SETTINGS* menu:

RESULT LEN

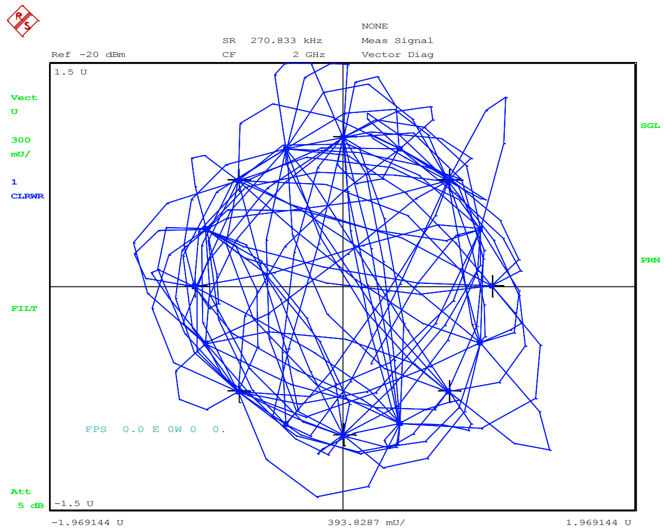
NORMALIZE

POINTS/SYM

RESULT RAW/FILT

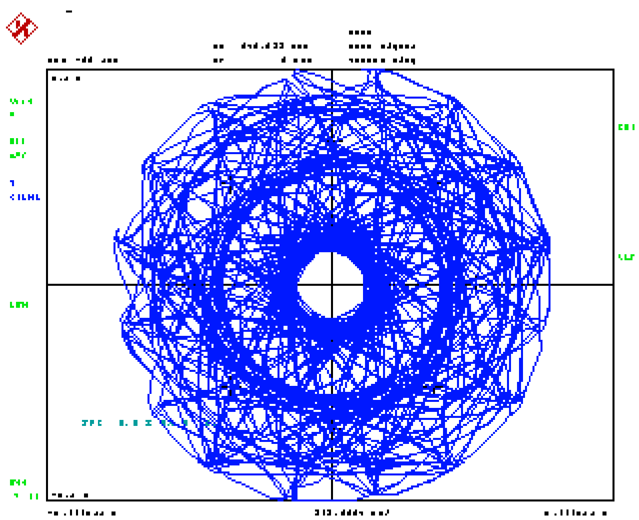
The *RESULT RAW/FILT* softkey selects between filtered and unfiltered signals.

FILT In many mobile radio systems, the filtering between the transmitter and the receiver is defined in such a way that intersymbol interference-free sampling times are available in the receiver. This operating mode is attained with the setting *RESULT FILT*.



RAW For further applications (e.g. distortion measurement on transmitter output stages), demodulated but unfiltered measurement signals that are not falsified by filtering in the receiver are required.

With the setting *RESULT RAW*, demodulation is continued down to the symbol level. Then, a reference signal is generated again. This signal corresponds to an **unfiltered raw signal** and further evaluations are performed with these raw signals.



Constellation diagrams for which the measurement points are concentrated at the ideal symbol points of the I/Q diagram normally do not occur in display modes that are derived from RESULT RAW. This is due to the fact that filtering in the receiver resulting in intersymbol interference-free (ISI-free) times is not performed.

This softkey **is not available** in MSK and FSK systems since the demodulation is always carried out with unfiltered signals.

Remote: `SENS:DDEM:FILT:STAT ON | OFF`

MEAS SINAL and REF SIGNAL

See section "Selection of Displayed Measurement and Reference Signal - MEAS SIGNAL / REF SIGNAL Softkey"

ERROR SIGNAL

See section " Selection of Error Display - ERROR SIGNAL Softkey"

CAPTURE BUFFER

See section "Selection of the Raw Signal - CAPTURE BUFFER Softkey"

EQUALIZER

See section "Selection of Adaptive Equalizer Display - EQUALIZER Softkey"

SYMBOLS & MOD ACC

The *SYMBOLS & MOD ACC* softkey activates the display of numeric results (MODULATION ACCURACY) and the table of decoded symbols.

In the display mode **Single Screen**, the decoded symbols are displayed in the upper part and the numeric result values in the lower part of the table (see Fig. 160)

With *TRACE AVERAGE = ON*:, further statistical evaluations (RMS, AVG, Standard Deviation, Total Peak) for the previous sweeps are displayed in addition to the numeric results for the current sweep (see also Fig. 161).

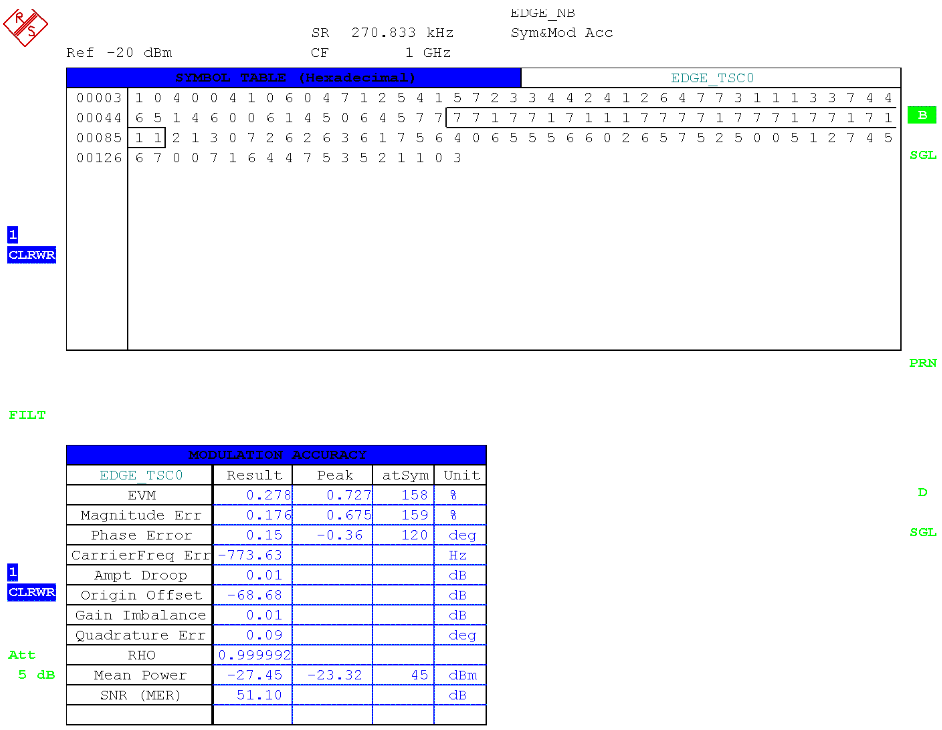


Fig. 160 Modulation Accuracy (single screen, Trace Average = off)

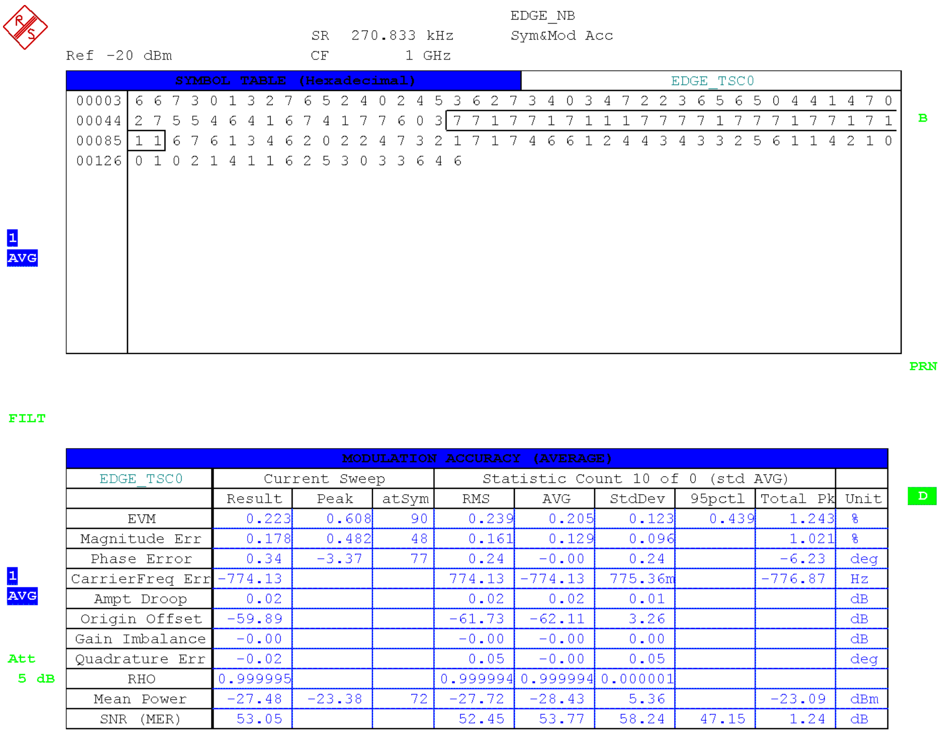


Fig. 161 Modulation Accuracy (single screen, Trace Average = on)

In the display mode **Split Screen**, either the information of the Modulation Accuracy representation or the table of decoded symbols is displayed.

Switching between these two display modes is done via hotkey A/B (upper half of split screen) or C/D (lower half of split screen).

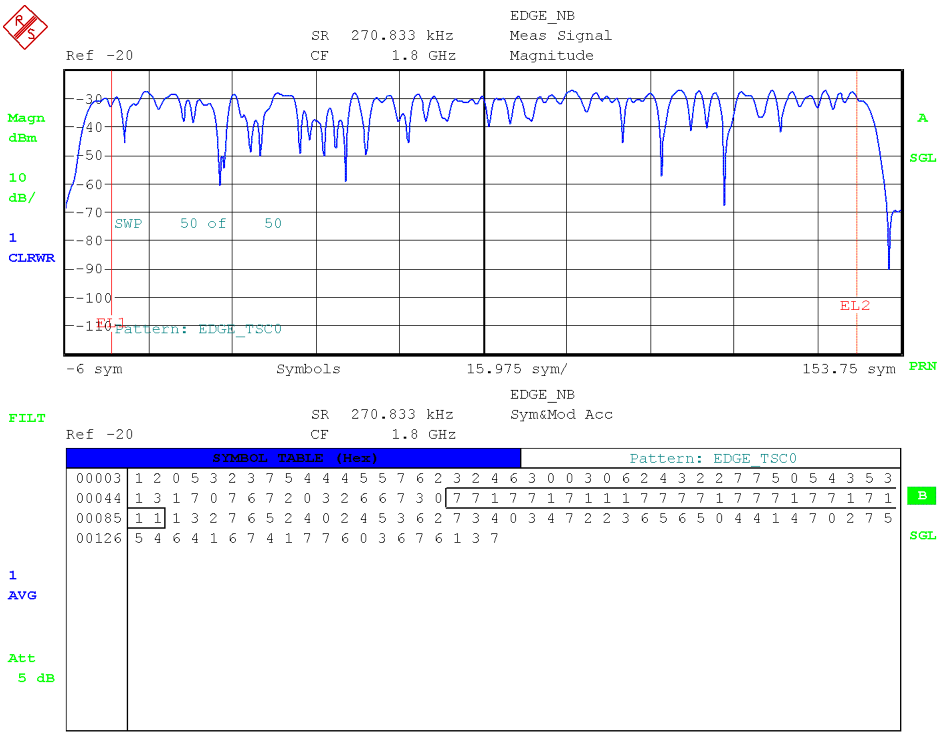


Fig. 162 Modulation Accuracy (split screen, Trace Average = on), indication of decoded symbols

```
Remote: CALC:FEED XTIM:DDEM:SYMB
        CALC:MARK:FUNC:DDEM:STAT:EVM? AVG
```

```
(general CALC:MARK:FUNC:DDEM:STAT:<result>? <type> )
```

RESULT LEN; NORMALIZE ON/OFF and POINTS/SYM

The function of these softkeys is identical with the softkey of the same name in section 5.7.

OFFSET EVM ON/OFF

The *OFFSET EVM ON/OFF* softkey influences the calculation of the error vector magnitude trace for Offset-QPSK only. It has no effect for all other modulations. It has no effect on results based on the MEAS or the REF signal.

At which samples will the difference between MEAS and REF signal be measured:

- *OFFSET EVM ON*: The error vector magnitude is calculated at the symbol instants of the I-part and the symbol instants of the Q-part of the Offset-QPSK signal. In other words: The half symbol duration delay of the Q-part is compensated. In firmware versions prior to the introduction of this softkey, this was method was always used for Offset-QPSK.
- *OFFSET EVM OFF:* The error vector magnitude is calculated at the symbol instants of the I-part and the corresponding sample of the Q-part of the signal. But the latter is not a symbol instant.

In other words: The Offset-QPSK signal is treated like a QPSK signal for the error vector magnitude calculation, the Q-delay is not compensated.

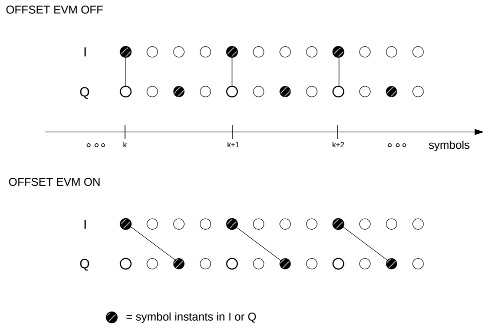


Fig. 163 Example how samples are selected depending on “OFFSET EVM ON/OFF” (shown for oversampling 4).

This softkey does not only influence the way how the difference between the MEAS and the REF signal is calculated (Numerator of the EVM formula). If the softkey “EVM CALC” is not set to “MAX SYMBOL”, but to “SIGNAL MEAN POWER”, the calculation of the normalization factor C (denominator of the EVM formula) is also switched to work in the same fashion. So the half symbol duration delay of the Q-part of the REF signal is either compensated or not.

This normalization factor C is not only used for EVM-based results, but also in the *SNR (MER)* calculation.

So in the case of Offset-QPSK this softkey “*OFFSET EVM ON/OFF*” has an effect on all these results:

- Error vector magnitude (EVM) trace
- All the numerical EVM results in the *Modulation Accuracy* table. Therefore the EVM in the table is either titled “*EVM offset*” or “*EVM no offset*”.
- The *SNR (MER)* in the *Modulation Accuracy* table, because of the changing normalization factor C.

The EVM result in the Modulation Accuracy table is lister as "EVM Offset" and "EVM No Offset" respectively.

Remote: `SENS:DDEM:ECAL:OFFS ON | OFF`

HIGHLIGHT

The *HIGHLIGHT* softkey highlights the symbol points in time using a square (see Fig. 182).

MAGER ABS

The *MAGER ABS* softkey (Magnitude Error Absolute On/Off) switches the calculation formula for Magnitude Error between:

ON Calculates the absolute value of the Magnitude Error.
Therefore the result is always positive.

OFF Calculates the Magnitude Error as a signed value.

This setting affects **only** the display of *Magnitude Error* as a function of time and the display of *Magnitude Error* in the modulation summary (see also section Glossary and Formulare).

ON is used as a default..

To get comparable results as for FSW-K70, *OFF* should be used. MAGER CALC has also to be set to SIGNAL MEAN POWER

`Remote: SENS:DDEM:MEAB ON | OFF`

MAGER CALC

The *MAGER CALC* softkey (Magnitude Error Calculation) switches the calculation formula for Magnitude Error between:

MAX *SYMBOL* Normalizes the magnitude error to the square root of the power of the symbol with the highest magnitude.

MEAN PWR Normalizes the magnitude error to the square root of the average signal power in the considered period of time.

This setting affect **only** the display of Magnitude Error as a function of time and the display of *RMS Magnitude Error* in the modulation summary (see also section Glossary and Formulare).

MAX SYMBOL is used as a defaultt.

`Remote: SENS:DDEM:MEC SYMB | SIGN`

To get comparable results as for FSW-K70, *OFF* should be used. MAGER CALC has also to be set to SIGNAL MEAN POWER

EVM CALC

The *EVM CALC* softkey switches the calculation formula for EVM between:

MAX SYM PWR Selects the traditional EVM formula and normalizes the difference between the MEAS and REF vectors to the square root of the power of the symbol with the highest magnitude.

MEAN PWR Normalizes the difference to the square root of the average signal power in the considered period of time. This method is used for the digital standard EDGE, for example.

These settings affect **only** the display of *EVM* as a function of time and the display of *RMS-EVM* in the modulation summary (see also section 10).

`Remote: SENS:DDEM:ECAL SYMB | SIGN`

REFDEVCOMP ON/OFF

The *REFDEVCOMP ON/OFF* softkey switches the method for calculating the frequency error for FSK modulation between the following:

ON	Scales the reference signal to the actual deviation of the measurement signal.
OFF	Uses the entered nominal deviation for the reference signal.

Remote: `CALC:FSK:DEV:COMP ON`

5.8.4 Selection of Displayed Measurement and Reference Signal - MEAS SIGNAL / REF SIGNAL Softkey

The softkeys *MEAS SIGNAL* and *REF SIGNAL* open further submenus for selecting the desired measurement result. The submenu is identical for both softkeys.

The following **quantities** can be displayed **as a function of time**:

MAGNITUDE	Magnitude of IQ data set
PHASE	Phase or argument of IQ data record
FREQUENCY	Frequency characteristic
REAL/IMAG	Inphase and quadrature component

Display in the IQ plane

IQ	IQ display

Display of derived quantities:

SPECTRUM	Spectral evaluations
SIGNAL STATISTIC	Statistical evaluations

The display modes:

FREQUENCY	Spectral evaluations
REAL/IMAG, EYE and *IQ*	Statistical evaluations

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FEED 'XTIM:DDEM:REF'
```

MAGNITUD
PHASE
FREQUENCY ABS /REL
REAL/IMAG
EYE I/Q
IQ VECT / CONST
SPECTRUM
SIGNAL STATISTIC

MAGNITUD

The *MAGNITUDE* softkey sets the result display to show the magnitude of the measurement or reference signal.

ABS The actual signal amplitude is displayed.

REL The signal amplitude is scaled to the ideal reference signal and is relative to the unit circle of the symbol mapping (see *IQ VECTOR* or *IQ CONSTELLATION* display).

$$MAG\_MEAS(n) = |MEAS(n)|;$$

or

$$MAG\_REF(n) = |REF(n)|$$

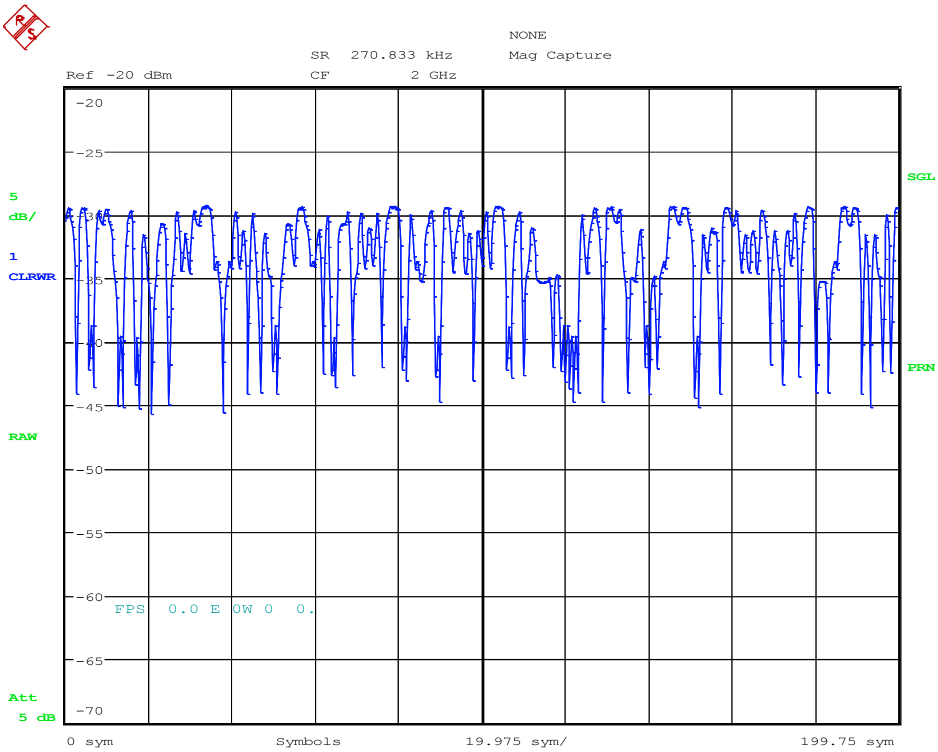


Fig. 164 Result display MAGNITUDE

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM MAGN
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
```

PHASE UNWRAP / WRAP

The *PHASE UNWRAP / WRAP* sets the result display to show the PHASE of the measurement or reference signal.

$$PHASE\_MEAS(n) = \angle MEAS(n);$$

or

$$PHASE\_REF(n) = \angle REF(n);$$

WRAP The display is limited to the value range of 2pi.

UNWRAP Also phase characteristics >2pi can be displayed.

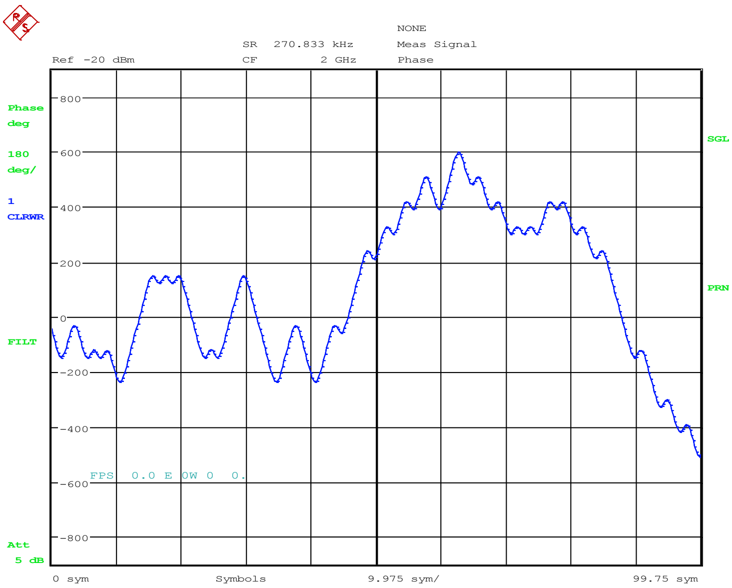


Fig. 165 Result display PHASE (UNWRAP)

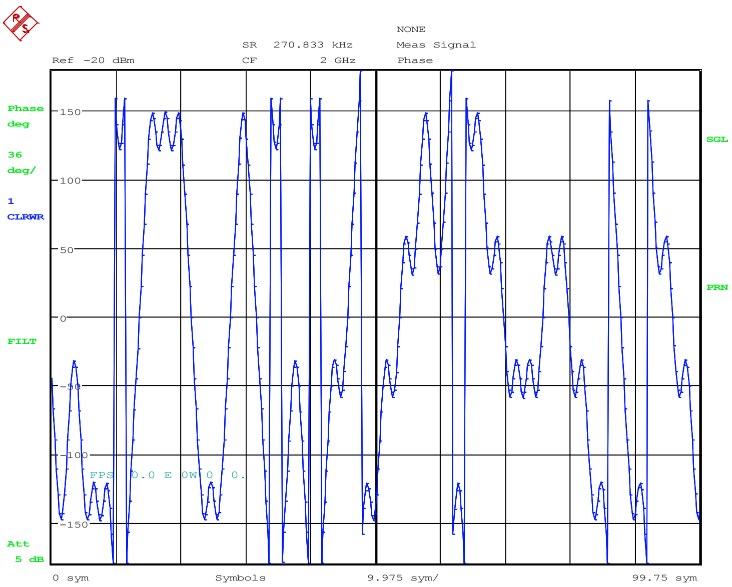


Fig. 166 Result display PHASE (WRAP)

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM PHAS | UPH
```

FREQUENCY ABS /REL

The *FREQUENCY ABS /REL* softkey sets the result display to show the current frequency of the measurement or reference signal.

The display of the current frequency is possible only for modulation modes FSK and MSK. It can either be normalized to the set reference deviation (*RELATIVE*) or performed with absolute axial scaling (*ABSOLUTE*).

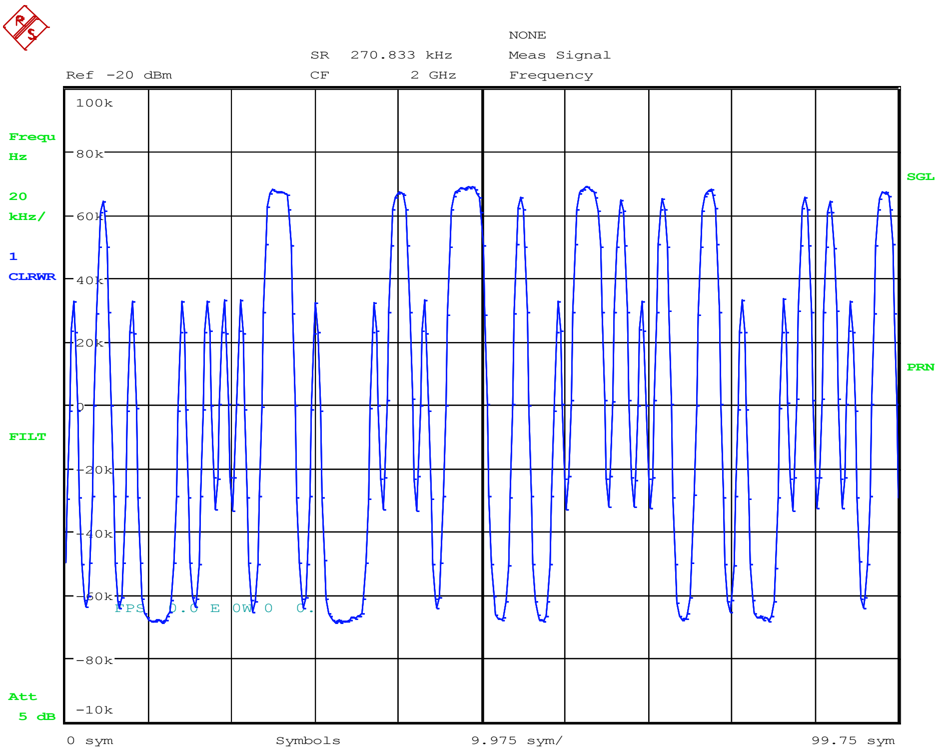


Fig. 167 Result display FREQUENCY (ABS)

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
```

REAL/IMAG

The *REAL/IMAG* softkey activates the representation of the 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.

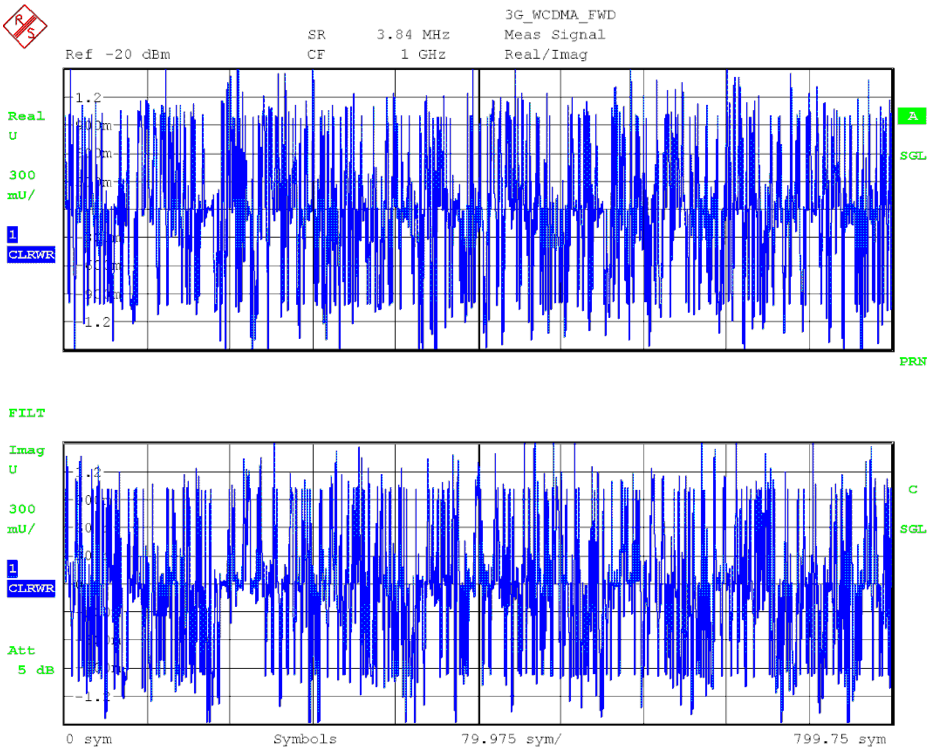


Fig. 168 Result display REAL/IMAG

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM RIM
```

EYE I/Q

The *EYE I/Q* softkey draws the eye pattern of the inphase (I) or quadrature channel (Q) as the result display. The x axis is given in the unit "Symbols". The value range of the x axis is from -1 to +1 symbols and CANNOT be set.

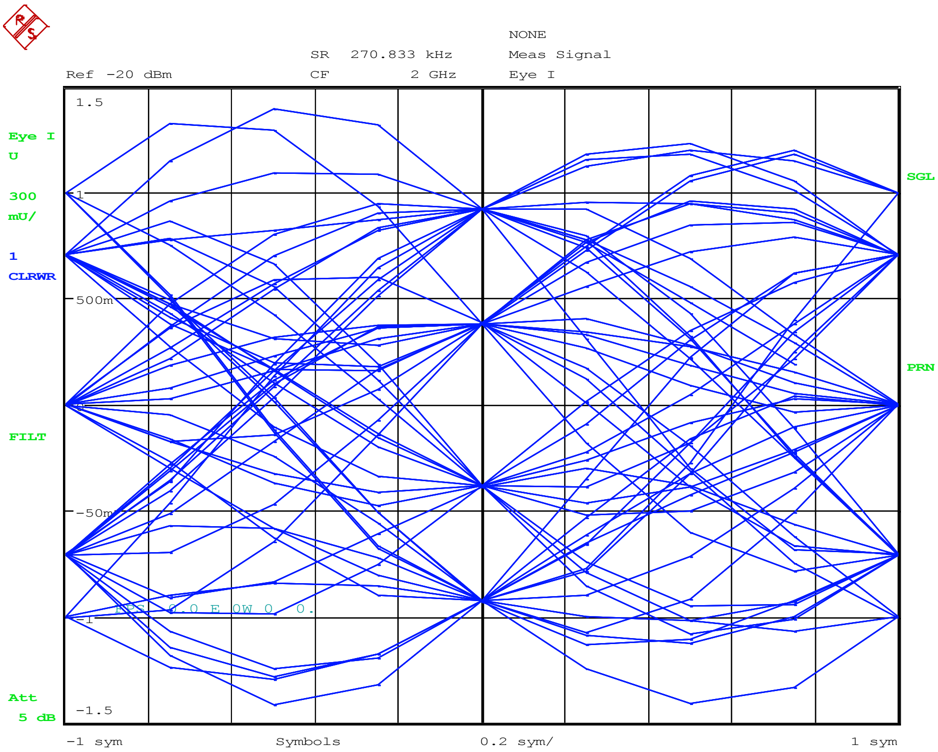


Fig. 169 Result display EYE

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM IEYE | QEYE
```

IQ VECT / CONST

The *IQ VECT / CONST* softkey draws the complex measurement or reference signal as an X/Y plot. It should be mentioned that the signals are filtered with the measurement filter, if it is switched on. Hence, a typical constellation can only be seen if the measurement filter removes the intersymbol interference (cf. Fig. 28 in chapter 3).

VECT (= vector diagram)	All available samples are drawn and connected.
CONST (=constellation diagram)	Only the symbol decision instants are drawn and not connected.

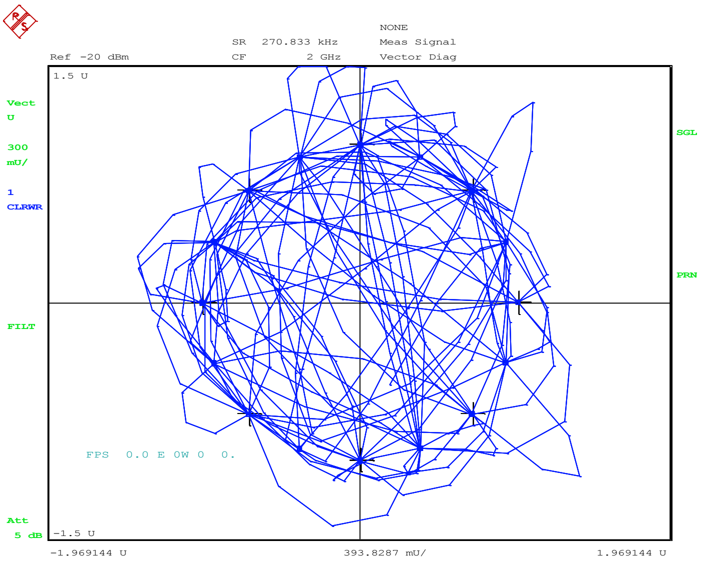


Fig. 170 Result display *IQ VECT*

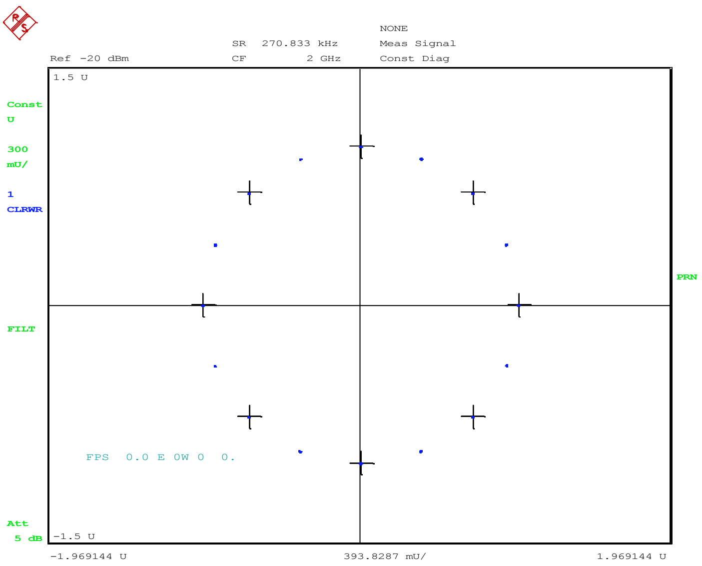


Fig. 171 Result display *IQ CONST*

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM COMP | CONS
```

SPECTRUM

The *SPECTRUM* softkey switches the set result display to a spectral evaluation of the result parameter.
Spectral evaluation is possible for the following result parameters:

- Magnitude
- Phase
- Frequency (only for MSK and FSK modulation modes)
- Real/Imag

The following diagrams provide examples of how the above parameters are displayed on screen. The y axis scaling including the unit (linear or logarithmic) is implemented by the y axis scaling of the corresponding measurement. The x axis scaling depends on the set symbol rate and the set *POINTS/SYMBOL*.
RANGE -> LIN/LOG switches the y axis scaling for the measurement display to logarithmic scaling:

- Spectrum → Magnitude
- Spectrum → Frequency (REL)
- Spectrum → Real/Imag

SPECTRUM and MAGNITUD

The *SPECTRUM / MAGNITUDE* softkey illustrates the spectral distribution of the *MAGNITUDE*.

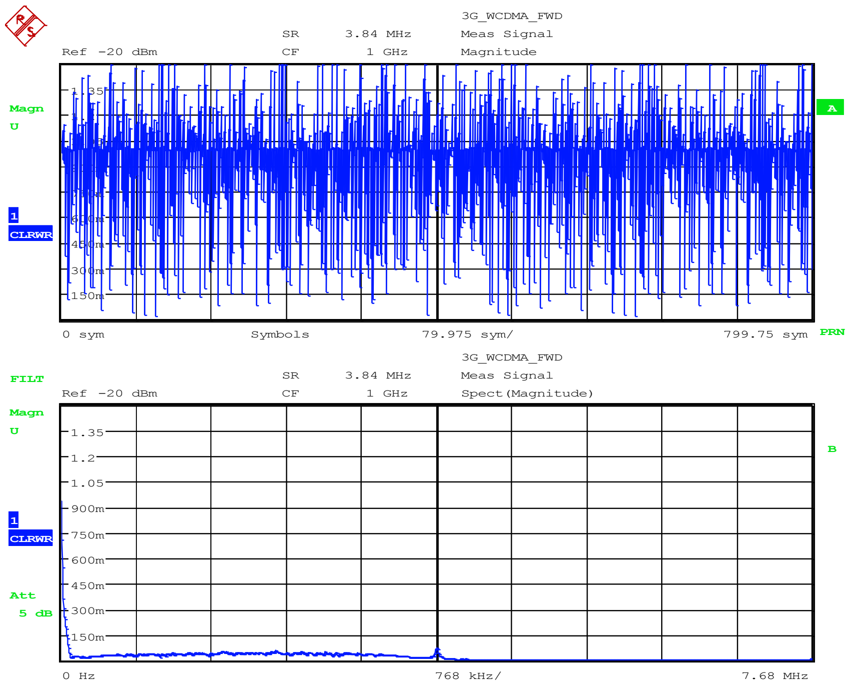


Fig. 172 Result display *SPECTRUM MAGNITUDE*

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM MAGN
        DISP:WIND:TRAC:Y:SCAL:MODE REL
        CALC:DDEM:SPEC:STAT ON
```

SPECTRUM and PHASE

The *SPECTRUM / PHASE* softkey illustrates the spectral distribution of the *PHASE*.

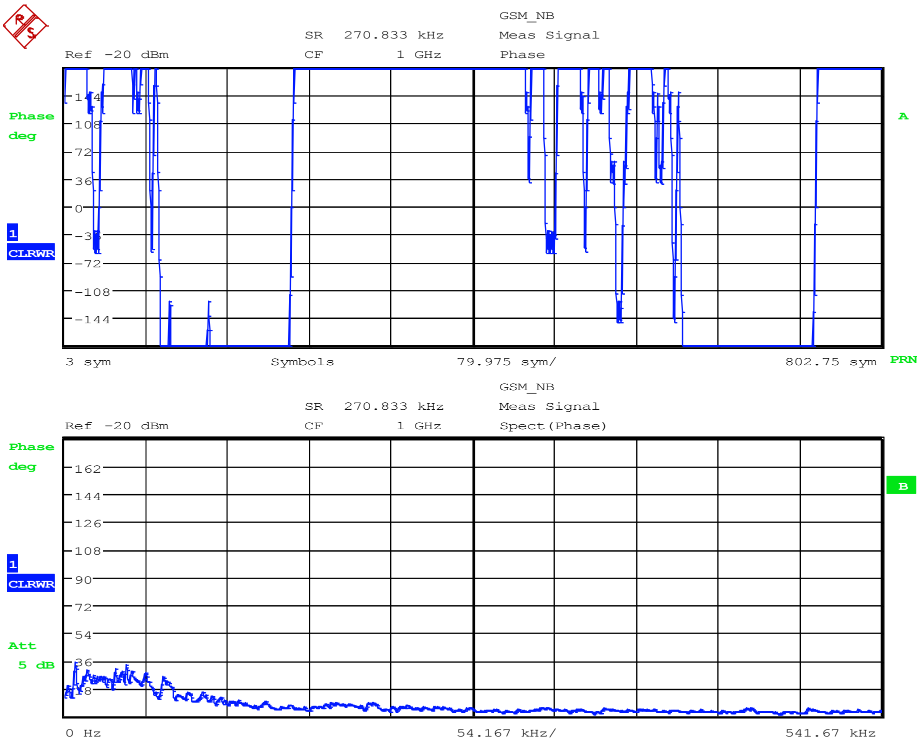


Fig. 173 Result display SPECTRUM PHASE

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM UPH
        CALC:DDEM:SPEC:STAT ON
```

SPECTRUM and FREQUENCY

The *SPECTRUM / FREQUENCY* softkey illustrates the spectral distribution of the *FREQUENCY* trace.

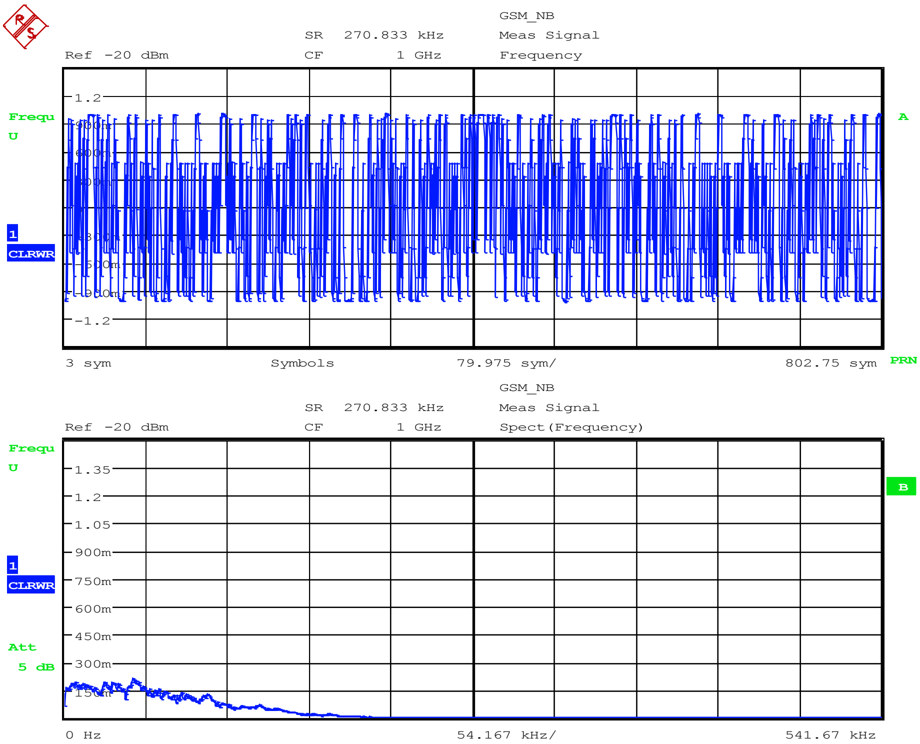


Fig. 174 **Result display *SIGNAL SPECTRUM FREQUENCY***

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS
        CALC:DDEM:SPEC:STAT ON
```

SPECTRUM and REAL/IMAG

The *SPECTRUM / REAL/IMAG* softkey illustrates the spectral distribution of the *REAL/IMAG* trace.

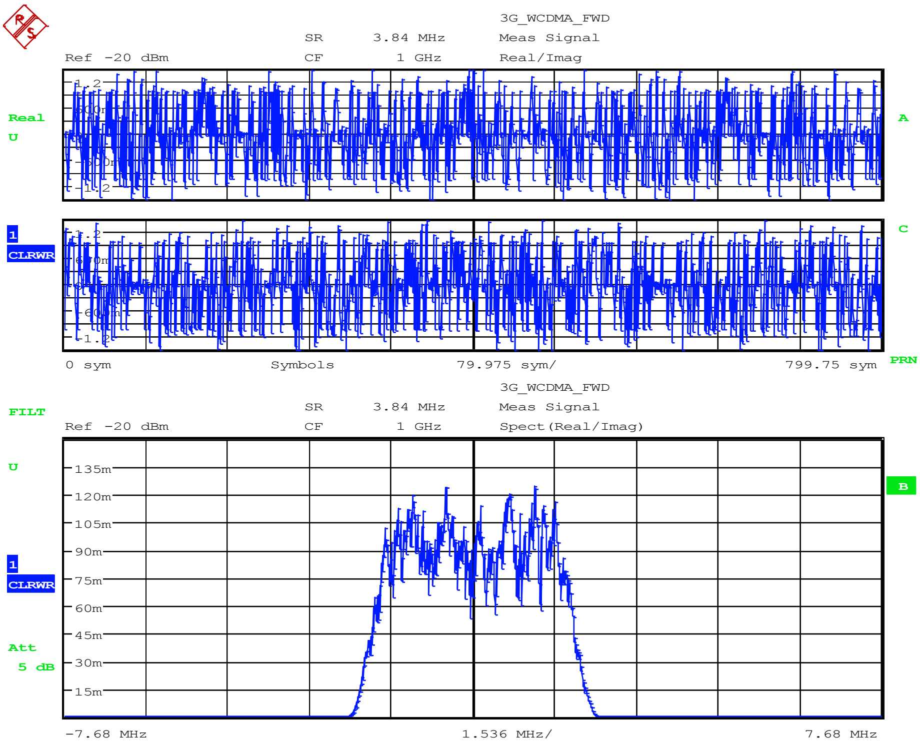


Fig. 175 Result display *REAL/IMAG (upper diagram)* Result display *SPECTRUM REAL/IMAG (lower diagram)*

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM RIM
        CALC:DDEM:SPEC:STAT ON
```

SIGNAL STATISTIC

The *SIGNAL STATISTIC* softkey switches the set result display to a statistical evaluation of the result parameter.

The display shows the frequency distribution (grouped in classes) of the measurement parameter as a bargraph. Classes outside the displayed range are assigned to the classes at the right or left margin of the representation.

Statistical evaluation is possible for the following result parameters:

- Magnitude
- Phase
- Frequency (only for MSK and FSK modulation modes)

The following diagrams provide examples of how the above parameters are displayed on screen. The x axis scaling including the unit (linear or logarithmic) is implemented by the y axis scaling of the corresponding measurement.

SIGNAL STATISTIC and MAGNITUDE

The *SIGNAL STATISTIC / MAGNITUDE* softkey illustrates the statistical distribution of the *MAGNITUDE*.

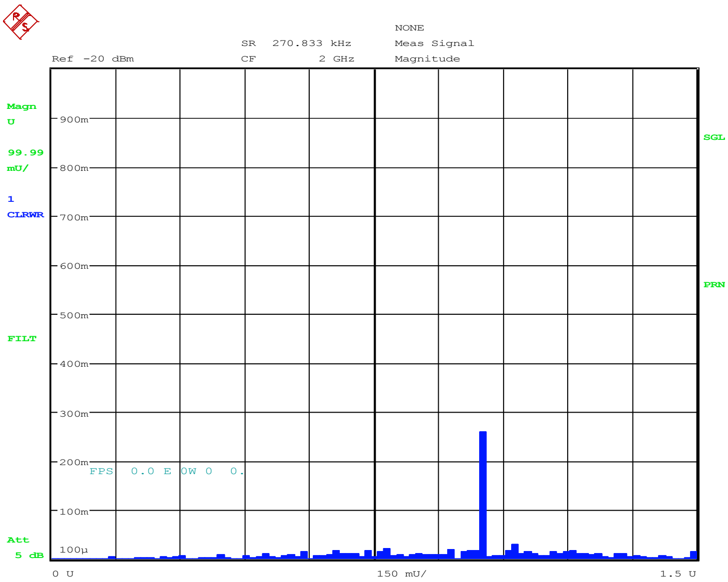


Fig. 176 Result display *SIGNAL STATISTIC MAGNITUDE*

The *RANGE -> Y_AXIS LIN / LOG* softkey is used to switch between linear and logarithmic scaling of the y axis. These setting options are possible for all statistical representations.

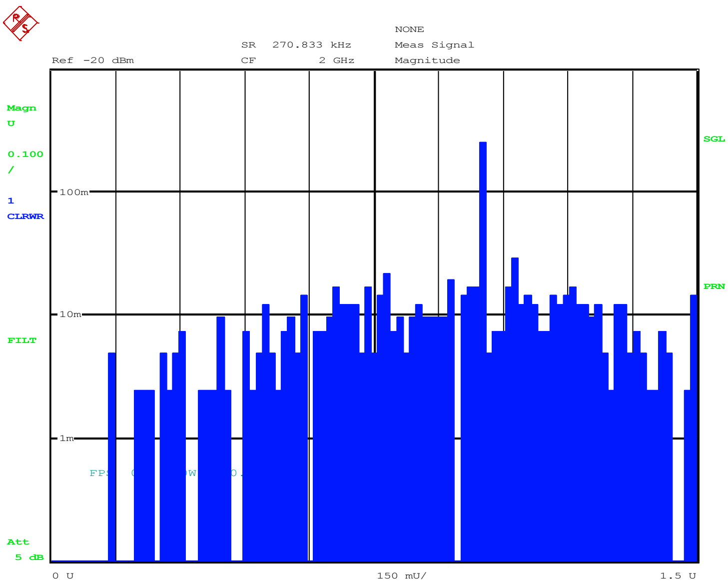


Fig. 177 Result display *SIGNAL STATISTIC MAGNITUDE* (log)

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM MAGN
        DISP:WIND:TRAC:Y:SCAL:MODE ABS
        CALC:STAT:CCDF:STAT ON
```

SIGNAL STATISTIC and PHASE

The *SIGNAL STATISTIC / PHASE* softkey illustrates the statistical distribution of the *PHASE*.

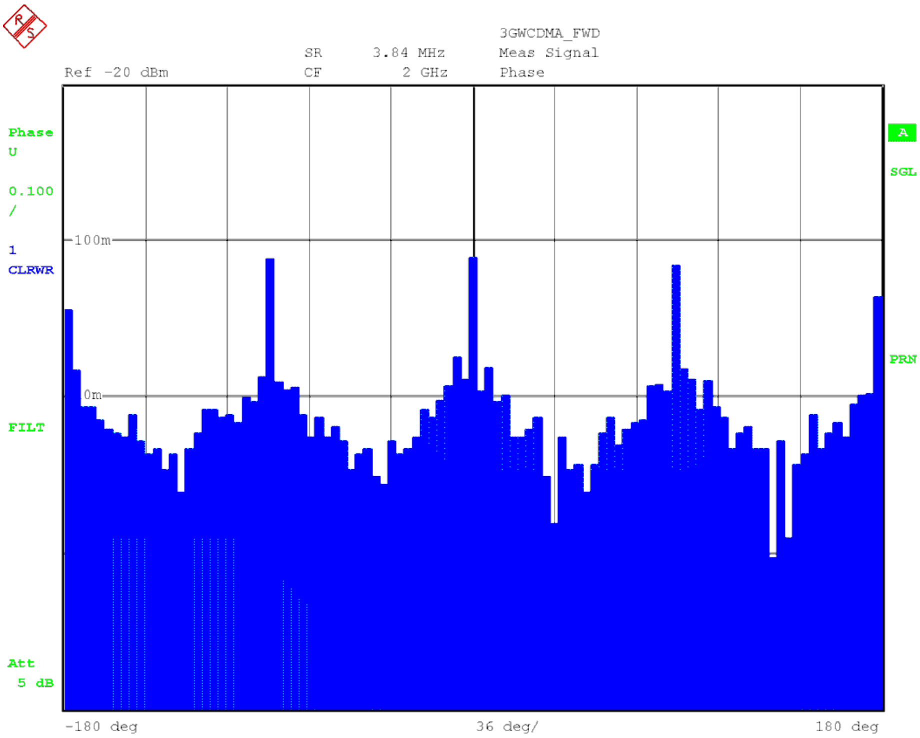


Fig. 178 Result display SIGNAL STATISTIC PHASE

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
        CALC:FORM PHAS
        CALC:STAT:CCDF:STAT ON
```

SIGNAL STATISTIC and FREQUENCY

The *SIGNAL STATISTIC / FREQUENCY* softkey illustrates the statistical distribution of the *FREQUENCY* trace.

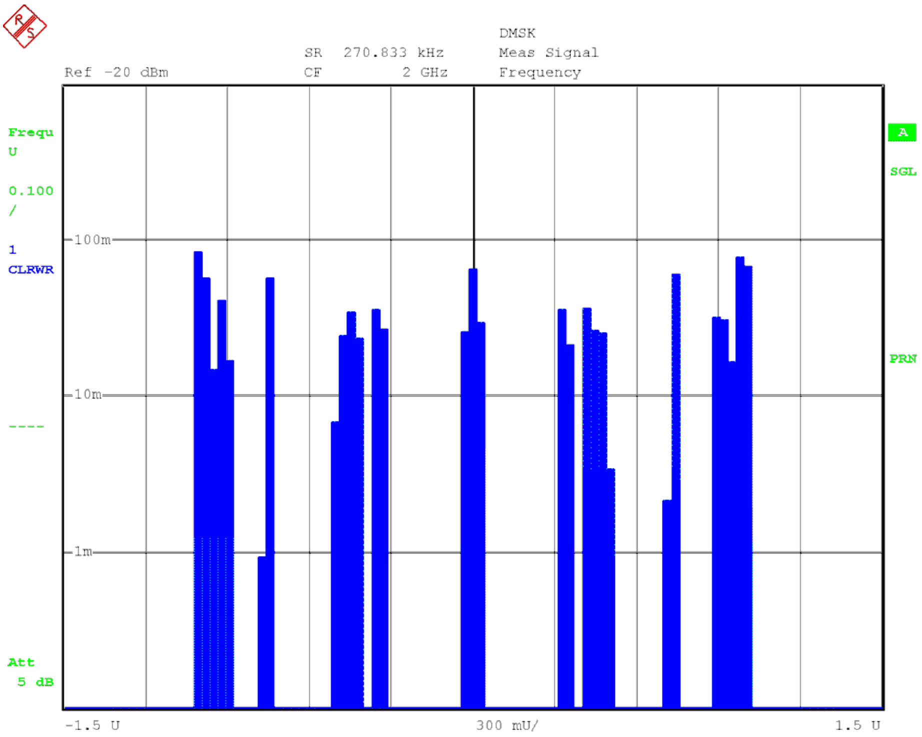


Fig. 179 Result display *SIGNAL STATISTIC FREQUENCY*

```
Remote: CALC:FEED 'XTIM:DDEM:MEAS'
         CALC:FORM FREQ
         DISP:WIND:TRAC:Y:SCAL:MODE ABS
         CALC:STAT:CCDF:STAT ON
```

5.8.5 Selection of Error Display - ERROR SIGNAL Softkey

MAGNITUDE ERROR
PHASE ERROR
FREQUENCY
REAL / IMAG
EVM
IQ ERROR (CONST/VECTOR)
ERROR SPECTRUM
ERROR STATISTIC

The *ERROR SIGNAL* softkey opens a submenu for setting the error display.

The following quantities can be displayed as a function of time:

MAGNITUDE ERROR	Error vector magnitude
PHASE ERROR	Phase error
FREQ ERROR	Frequency error (only MSK and FSK)

REAL/IMAG	Inphase and quadrature component

Display in the I/Q plane

IQ-ERROR	I/Q error display

Display of derived quantities:

AM&PM CONVERSION	Nonlinear distortion
ERROR SPECTRUM	Spectral evaluation
ERROR STATISTIC	Statistical evaluations

`Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'`

MAGNITUDE ERROR

The *MAGNITUDE ERROR* softkey activates the display of the magnitude difference between the *MEASUREMENT VECTOR* and the *REFERENCE VECTOR* as a function of time.

$$MAG\_ERR(t) = \left| \, |MEAS(t)| - |REF(t)| \, \right|;$$

The scaling of the measurement results is relative to the selected constellation diagram (unit circle).

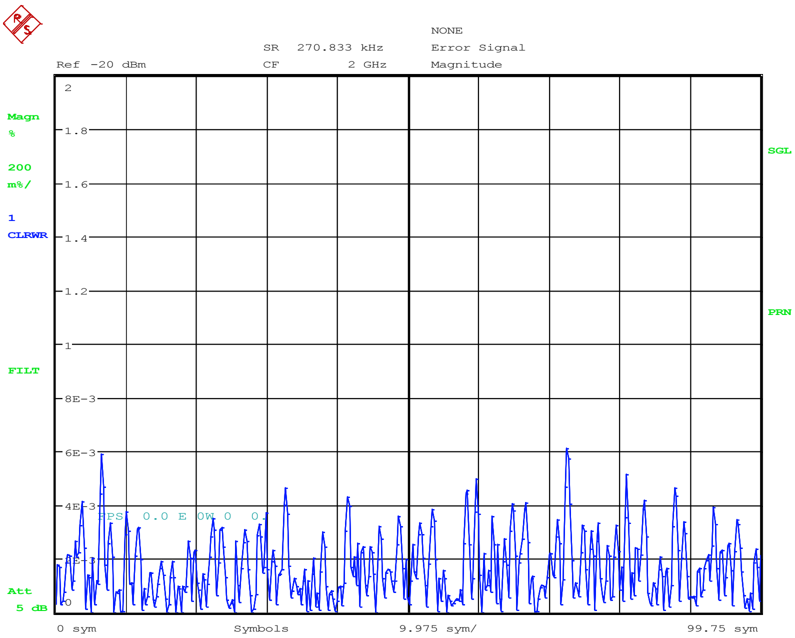


Fig. 180 MAGNITUDE ERROR result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM MAGN
```

PHASE ERROR

The *PHASE ERROR* softkey activates the display of the phase difference between the *MEASUREMENT VECTOR* and the *REFERENCE VECTOR* as a function of time.

$$PHASE\_ERR(t) = \arg\left(MEAS(t) \cdot REF^{*}(t)\right);$$

with MEAS the complex vector of the measurement signal,

and REF the complex vector of the reference signal.

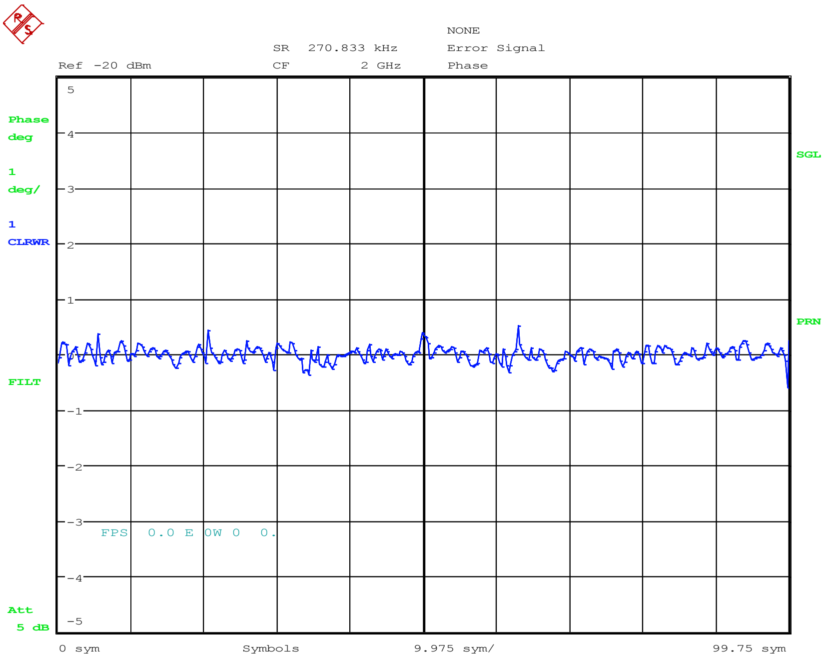


Fig. 181 *PHASE ERROR* result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM PHAS
```

FREQUENCY

The *FREQuency* softkey displays the current frequency error as a function of time for the sample points. The frequency error is calculated from the difference in current frequencies.

$$FREQ\_ERR(t) = FREQ(MEAS(t)) - FREQ(REF(t));$$

ABSOLUTE Absolute frequency scaling

RELATIVE Relative frequency scaling, i.e. referenced to the set reference deviation

This display is only available with MSK and FSK modulation methods.

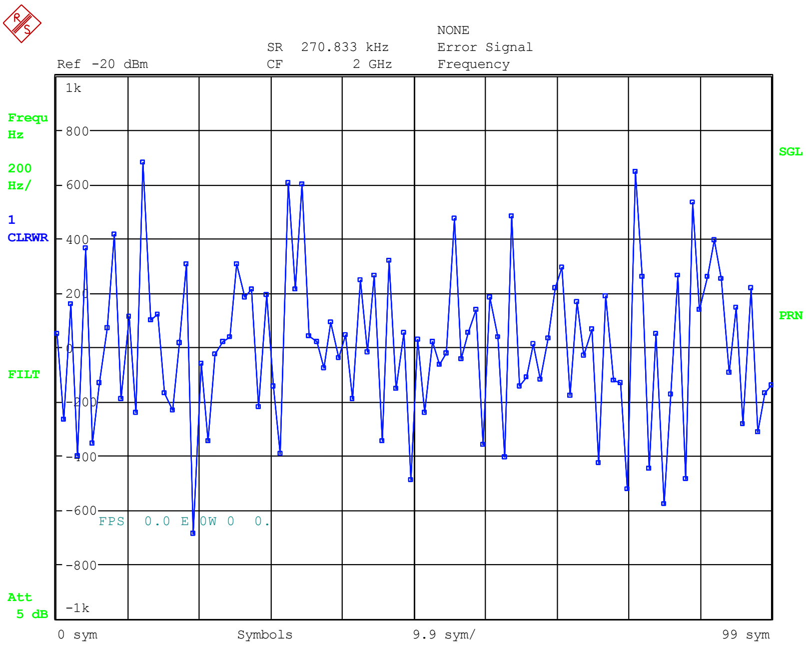


Fig. 182 FREQ ERROR result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
```

REAL / IMAG

The *REAL / IMAG* softkey uses a split screen to display the inphase and quadrature components of the error signal as a function of time.

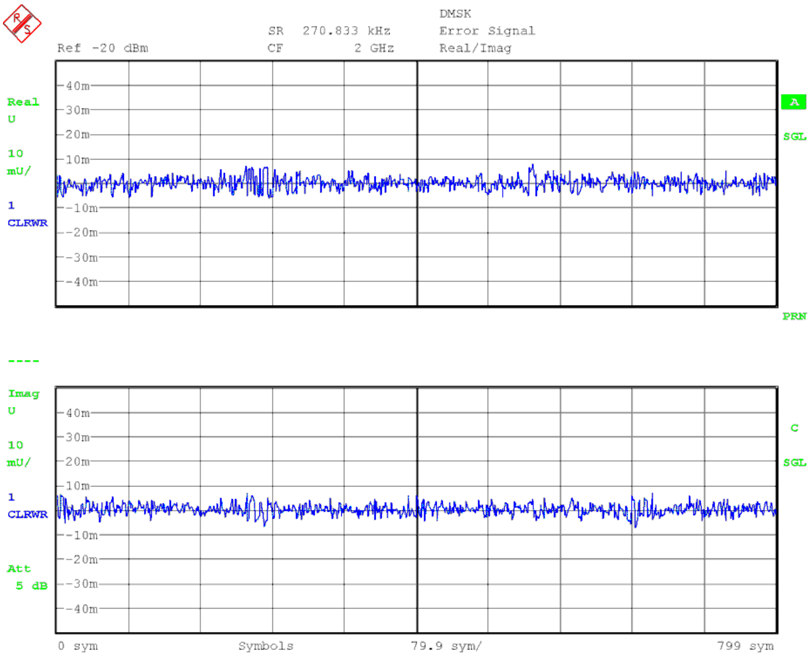


Fig. 183 REAL / IMAG result display

```
Remote:  CALC:FEED 'XTIM:DDEM:ERR:MPH'
         CALC:FORM RIM
```

AM & PM CONVERSION

The *AM & PM CONVERSION* softkey displays the amplitude or phase error of the measurement signal to the reference signal level (i.e. of an ideal, undistorted transmission signal). The test points are used to calculate the distortion characteristic, on which the markers move.

The result window is divided into two parts:

The *AM/AM* display shows the logarithm level of the reference signal horizontally, and the logarithm level of the measurement signal vertically. Nonlinear level distortion causes trace deviations from the 0 dB line.

The *AM/PM* display shows the logarithm level of the reference signal horizontally, and the linear phase error vertically. Phase distortion also causes trace deviations from the 0° line.

If a MEAS filter in the demodulation path has been switched on, the setting MEAS RESULT -> RESULT = RAW must be selected, otherwise the characteristic will be falsified by the MEAS filtering.

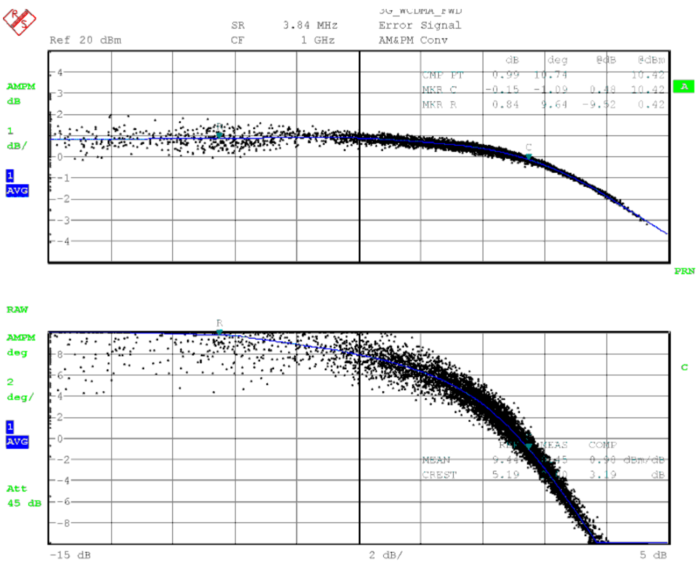


Fig. 184 *AM & PM CONVERSION* result display *(AM-AM upper diagram, AM-PM lower diagram)*

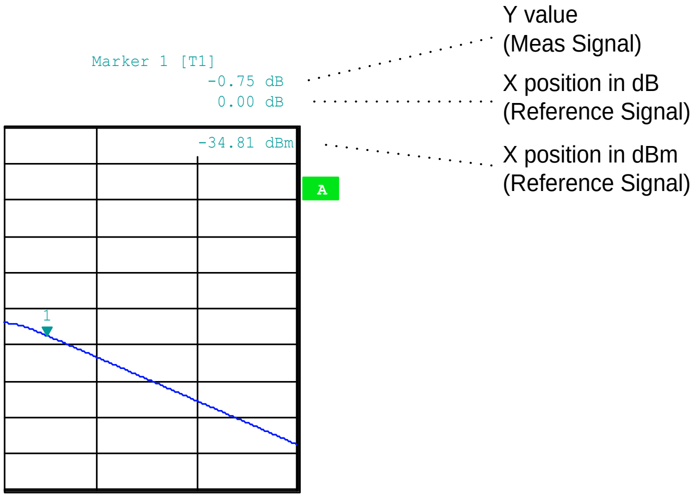


Fig. 185 *AM & PM CONVERSION* result display, marker field*)*

The MKR FCT -> COMP PT marker functions are used to calculate the compression point from the trace and the input power (Fig. 184, upper diagram). The difference between the mean powers or crest factors of the measurement and reference signals is used to calculate the results for the power compression at the current modulation of the DUT. The results (power compression and reduction of the crest factor) are shown in the lower diagram. These values are determined by using two markers which are automatically positioned on the interpolated distortion characteristic. If one of the two markers leaves the display area, these numeric values will not be displayed.

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM CONV
        CALC:MARK1:X:CONV:ABS?
```

EVM

The *EVM* (**e**rror **v**ector **m**agnitude) softkey displays the error vector magnitude as a function of time.

The calculation formula depends on the selected standard; the error vector magnitude typically refers to the unit circle.

The calculation formulae are explained in chapter 10

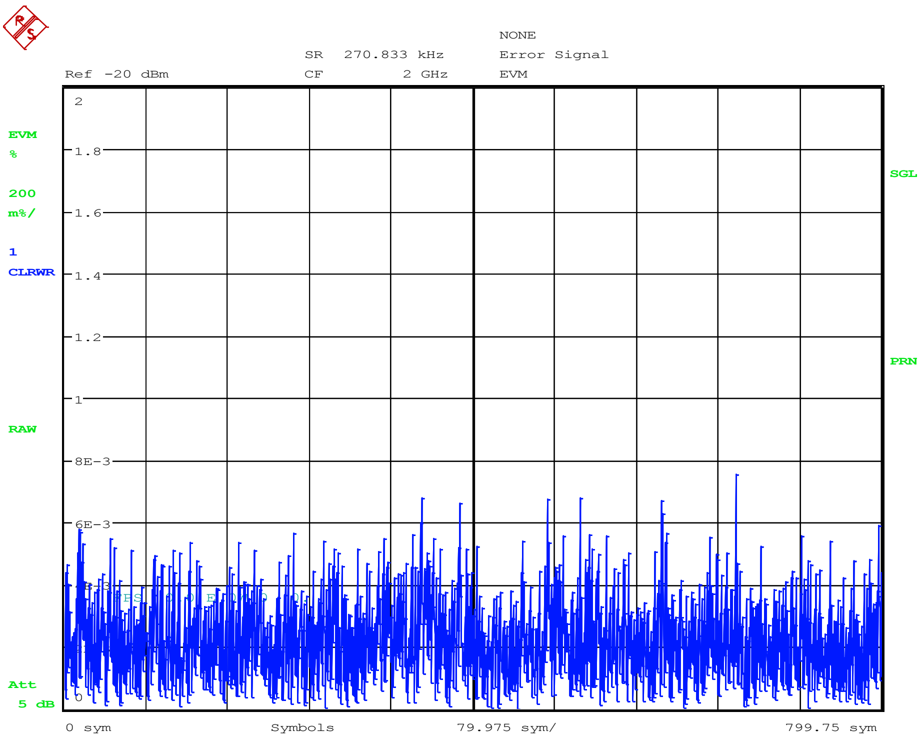


Fig. 186 EVM (error vector magnitude) result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:VECT'
        CALC:FORM MAGN
```

IQ ERROR (CONST/VECTOR)

The *IQ ERROR (CONST/VECTOR)* softkey displays the complex error vector in the I/Q plane. It opens a window for selecting the type of display.

VECTOR The trace is depicted with all available samples, and the samples are connected.

CONST Only the symbol decision points are depicted; they are not connected.

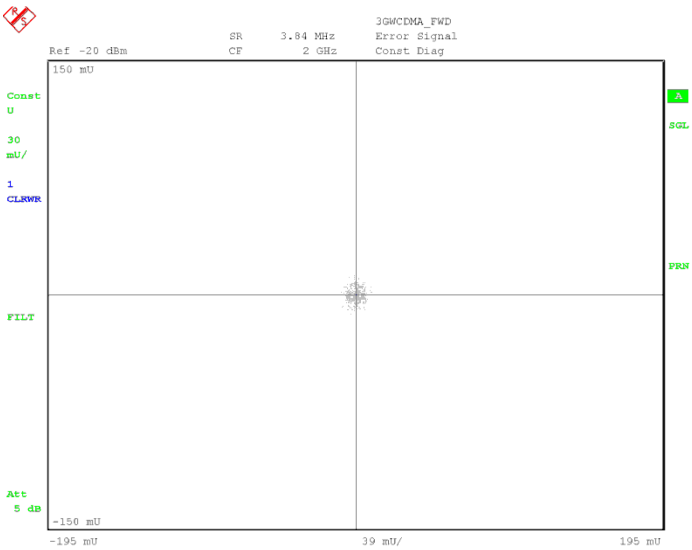


Fig. 187 IQ ERROR result display (constellation diagram)

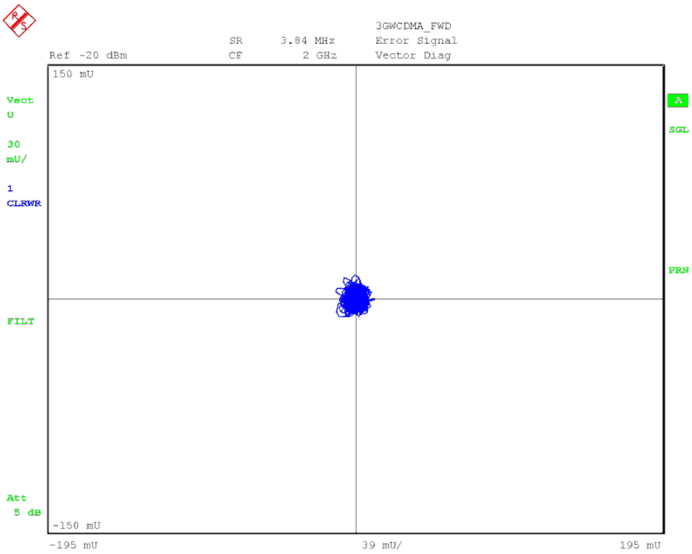


Fig. 188 IQ ERROR result display (vector display)

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:VECT'
        CALC:FORM COMP | CONS
```

ERROR SPECTRUM

The *ERROR SPECTRUM* softkey switches the previously set result display to a spectral evaluation of the result parameters.

Spectral evaluation is possible for the following result parameters:

- Magnitude Error
- Phase Error
- Frequency Error (only for MSK and FSK modulation modes)
- Error Vector Magnitude
- Real/Imag

The following diagrams provide display examples of how the above parameters are displayed. The y axis scaling, including the unit (linear or logarithmic), is implemented by the y axis scaling of the basic measurement. The x axis scaling depends on the set symbol rate and selected POINTS/SYMBOL.

RANGE -> LIN/LOG switches the y axis scaling for the measurement display to logarithmic scaling:

- Spectrum → Magnitude Error
- Spectrum → Frequency Error (REL)
- Spectrum → Error Real/Imag
- Spectrum → EVM

ERROR SPECTRUM and MAGNITUDE

The *ERROR SPECTRUM / MAGNITUDE ERROR* softkey illustrates the spectral distribution of the *MAGNITUDE ERROR* parameter.

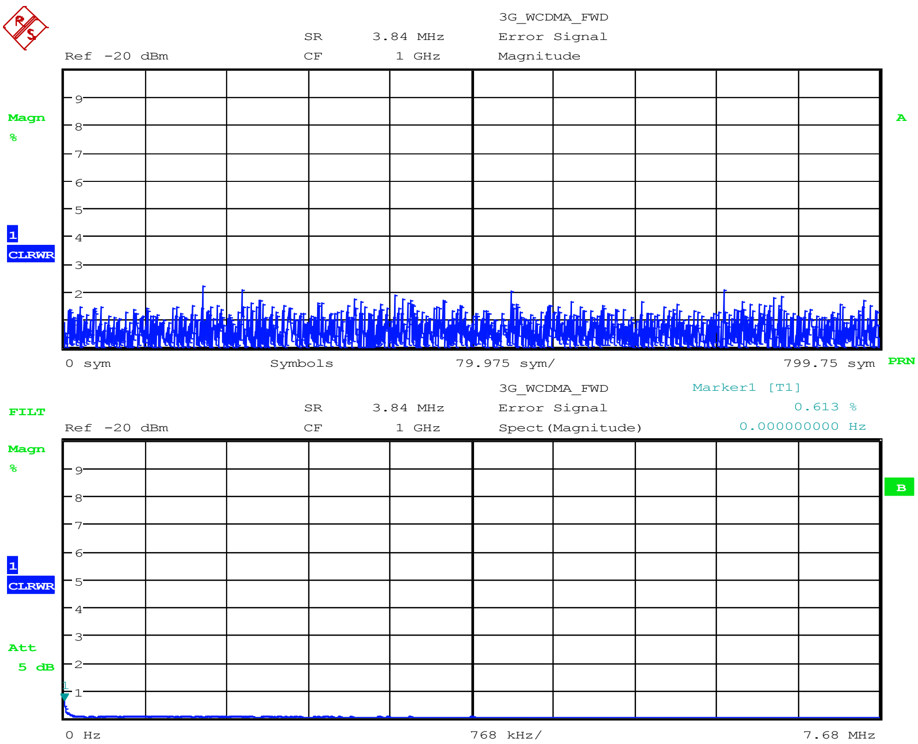


Fig. 189 Result display *MAGNITUDE ERROR (upper diagram)* Result display *ERROR SPECTRUM -> MAGNITUDE ERRORR (lower diagram)*

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM MAGN
        CALC:DDEM:SPEC:STAT  ON | OFF
```

ERROR SPECTRUM and PHASE ERROR

The *ERROR SPECTRUM / PHASE ERROR* softkey illustrates the spectral distribution of the *PHASE ERROR* parameter.

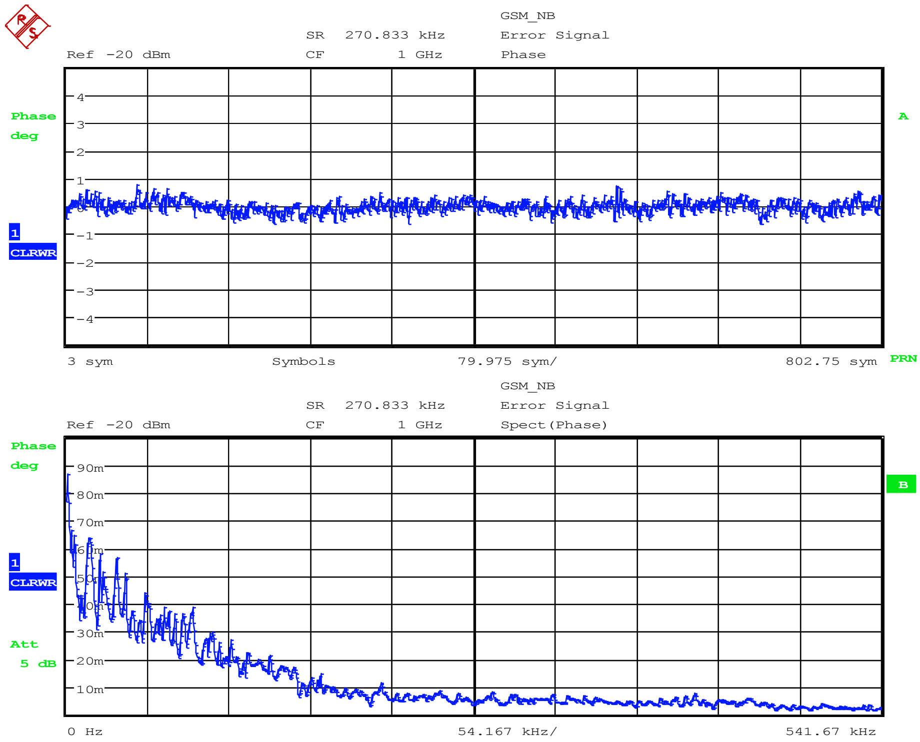


Fig. 190 Result display PHASE ERROR (upper diagram) Result display ERROR SPECTRUM -> PHASE ERRO (lower diagram)

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM PHAS
        CALC:DDEM:SPEC:STAT  ON | OFF
```

ERROR SPECTRUM and FREQ ERROR

The *ERROR SPECTRUM / FREQ ERRO*R softkey illustrates the spectral distribution of the *FREQUENCY ERROR* parameter.

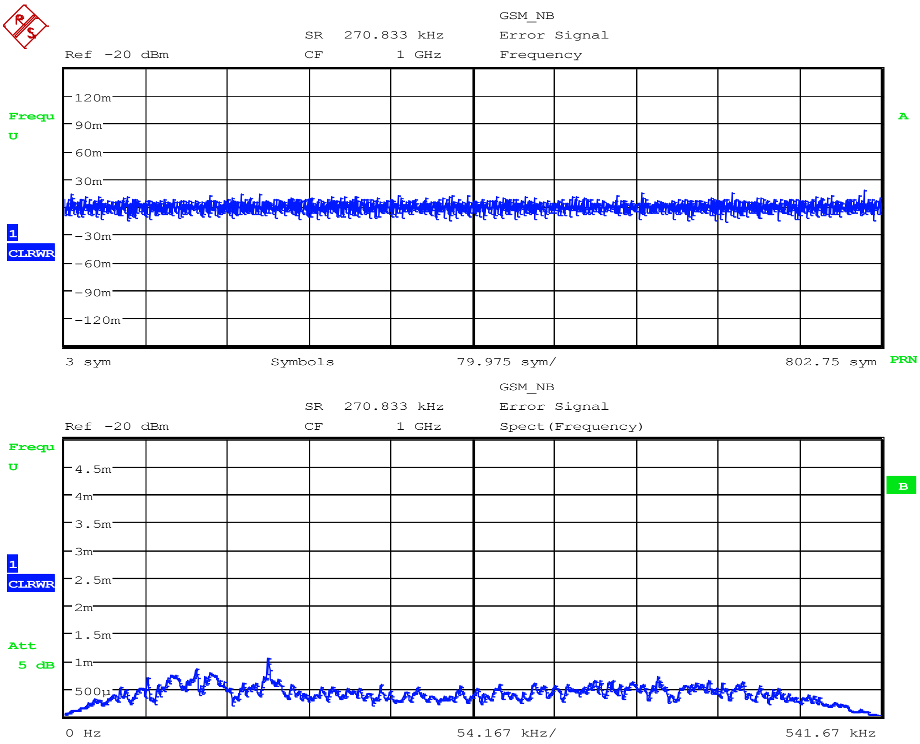


Fig. 191 Result display *FREQUENCY ERROR (upper diagram)*
Result display *ERROR SPECTRUM FREQUENCY ERROR (lower diagram)*

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM FREQ
        CALC:DDEM:SPEC:STAT ON | OFF
```

ERROR SPECTRUM and EVM

The *ERROR SPECTRUM / EVM* softkey illustrates the spectral distribution of the *EVM* parameter.

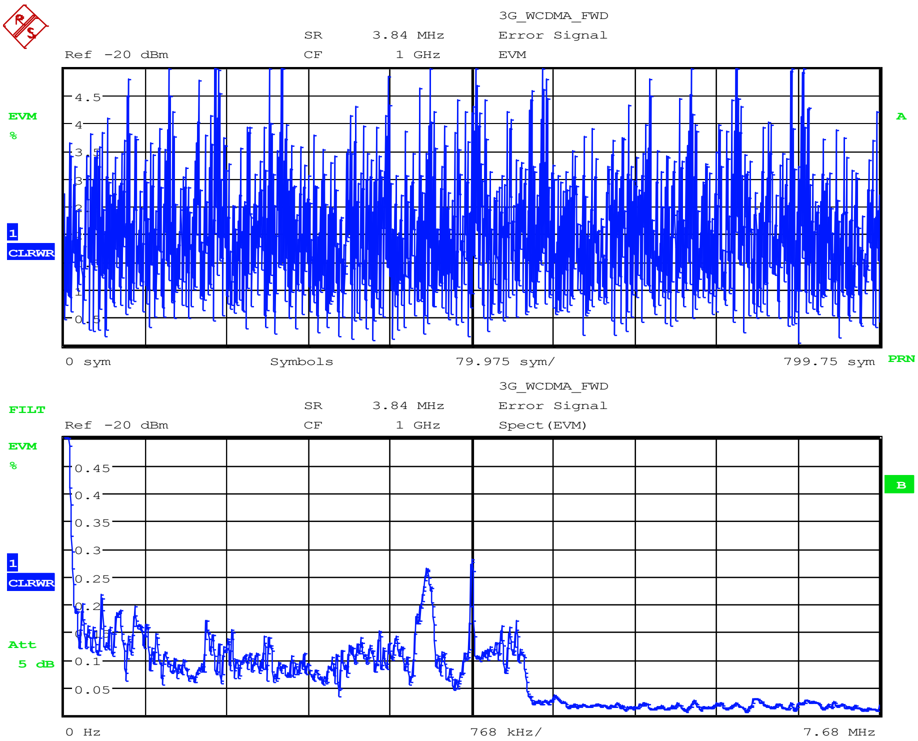


Fig. 192 Result display *EVM (upper diagram)* Result display *ERROR SPECTRUM -> EVM (lower diagram)*

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:VECT'
        CALC:FORM MAGN
        CALC:DDEM:SPEC:STAT  ON | OFF
```

ERROR SPECTRUM and REAL/IMAG

The *ERROR SPECTRUM / REAL/IMAG* softkey illustrates the spectral distribution of the complex error signal.

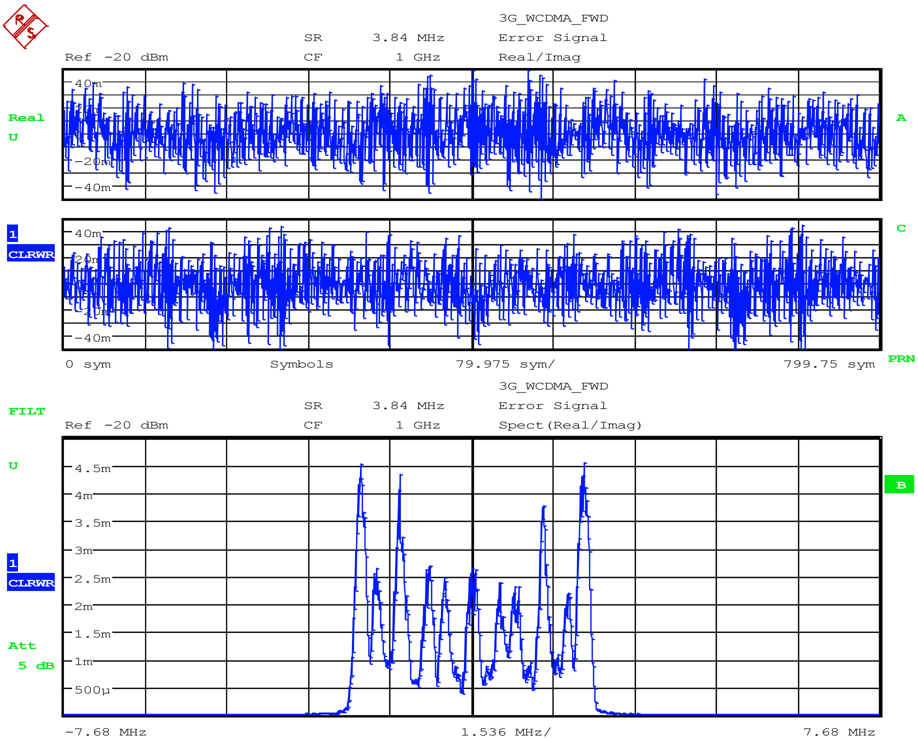


Fig. 193 Result display REAL/IMAG (upper diagram)
Result display ERROR SPECTRUM REAL/IMAG (lower diagram)

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:VECT'
        CALC:FORM MAGN
        CALC:DDEM:SPEC:STAT  ON | OFF
```

ERROR STATISTIC

The *ERROR STATISTIC* softkey switches the previously set result display to a statistical evaluation of the result parameters.

Statistical evaluation is possible for the following result parameters:

- Magnitude Error
- Phase Error
- Frequency Error (only for MSK and FSK modulation modes)
- Error Vector Magnitude

Statistical displays are particularly conclusive if nothing but the symbol decision instants are used (PTS / SYMB setting = 1).

The following diagrams provide display examples of how the above parameters are displayed. The x axis scaling, including the unit (linear or logarithmic), is implemented by the y axis scaling of the basic measurement.

ERROR STATISTIC and MAGNITUDE

The *ERROR STATISTIC / MAGNITUDE ERROR* softkey displays the statistical distribution of the *MAGNITUDE ERROR* parameter.

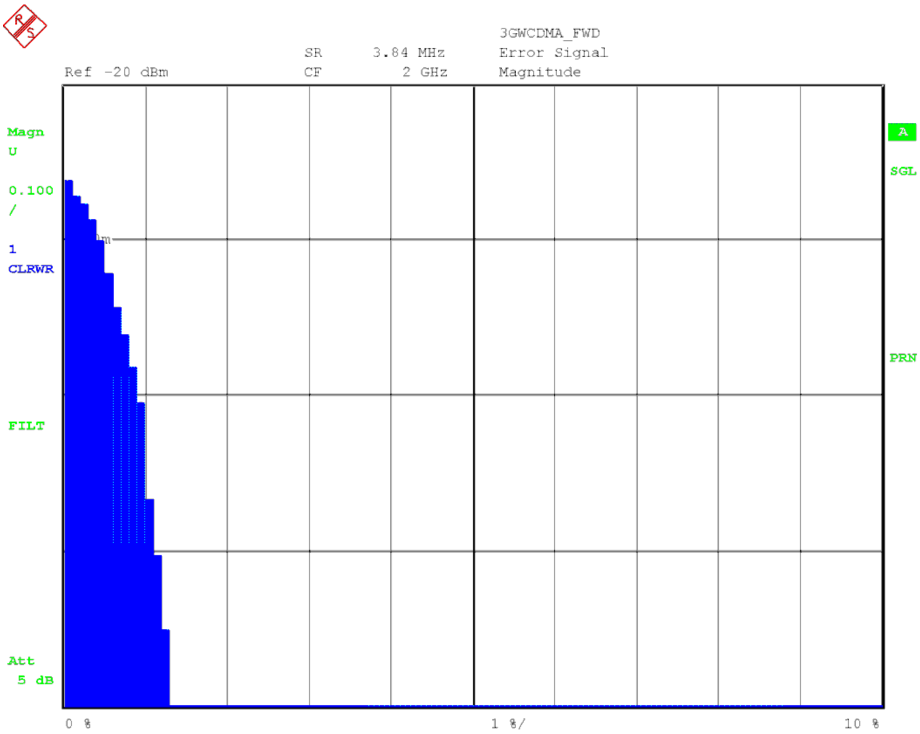


Fig. 194 ERROR STATISTIC MAGNITUDE result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM MAGN
        CALC:STAT:CCDF:STAT  ON | OFF
```

ERROR STATISTIC and PHASE ERROR

The *ERROR STATISTIC / PHASE ERROR* softkey displays the statistical distribution of the *PHASE ERROR* parameter.

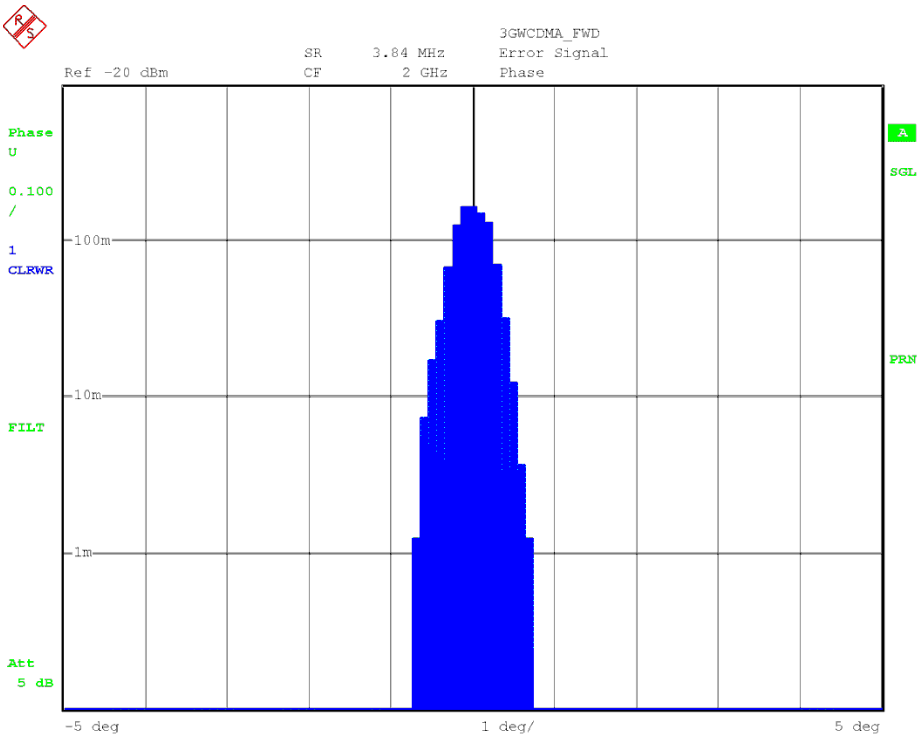


Fig. 195 ERROR STATISTIC PHASE result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM PHAS
        CALC:STAT:CCDF:STAT  ON | OFF
```

ERROR STATISTIC and FREQ ERROR

The *ERROR STATISTIC / FREQ ERROR* softkey displays the statistical distribution of the *FREQUENCY ERROR* parameter.

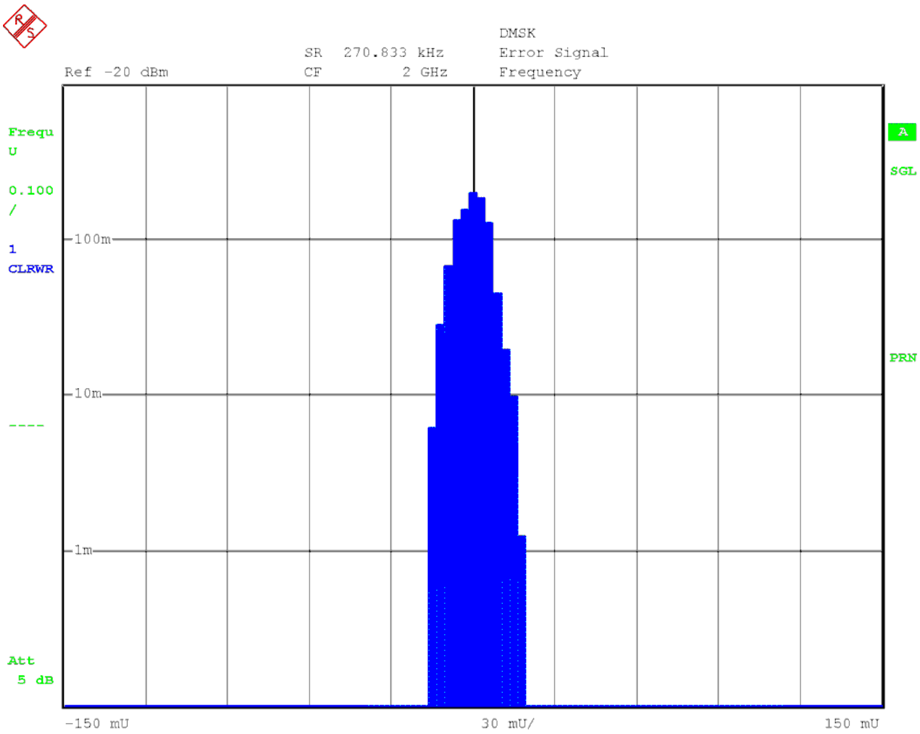


Fig. 196 ERROR STATISTIC FREQUENCY result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:MPH'
        CALC:FORM FREQ
        CALC:STAT:CCDF:STAT  ON | OFF
```

ERROR STATISTIC and EVM

The *ERROR STATISTIC / EVM* softkey displays the statistical distribution of the EVM parameter.

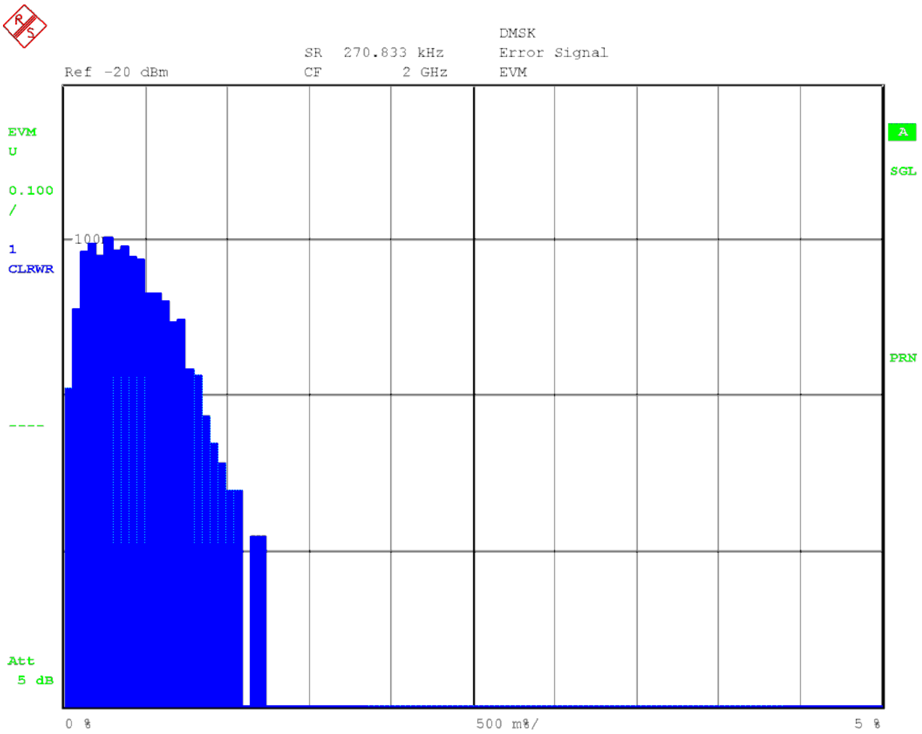


Fig. 197 ERROR STATISTIC EVM result display

```
Remote: CALC:FEED 'XTIM:DDEM:ERR:VECT'
        CALC:FORM MAGN
        CALC:STAT:CCDF:STAT  ON | OFF
```

5.8.6 Selection of the Raw Signal - CAPTURE BUFFER Softkey

MAG CAP BUFFER
FREQUENCY
REAL/IMAG
SPECTRUM
SIGNAL STATISTIC

The *CAPTURE BUFFER* softkey opens a submenu for setting the display of the raw signal of the record buffer.

The following quantities can be displayed as a function of time:

MAG CAP BUFFER Record buffer magnitude

FREQUENCY Frequency (only MSK and FSK)

REAL/IMAG Inphase and quadrature component

Display of derived quantities:

SPECTRUM	Spectral evaluation
SIGNAL STATISTIC	Statistical evaluations

The EVALUATION LINES for limiting the evaluation area do not have any relevance in the Capture Buffer evaluations.

ZOOM opens a submenu with for selecting the displayed section of the capture buffer and for controlling the demodulation.

Remote: CALC:FEED 'TCAP'

MAG CAP BUFFER

The *MAG CAP BUFFER* shows the magnitude of the unprocessed signal of the *RECORD BUFFER*.

The complete length of the *RECORD BUFFER* is shown, while all other display modes display only the *RESULT RANGE*. The displayed image is shown with absolute level scaling only.

This display mode is useful for doing the following:

- **Configuring a measurement**, especially trigger offset settings
- **Selecting** individual bursts

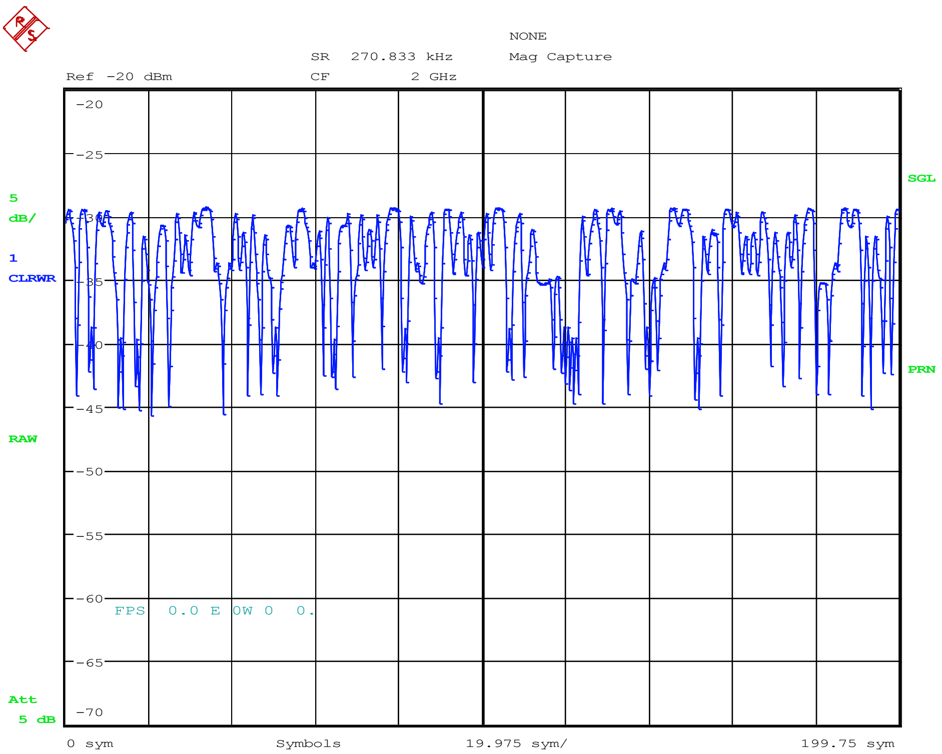


Fig. 198 Result display MAGNITUDE CAPTURE BUFFER

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM MAGN
```

FREQUENCY

The *FREQUENCY* softkey displays the frequency modulated signal of the unprocessed *RECORD BUFFERS*.

The complete length of the *RECORD BUFFER* is shown. The softkey is only available for modulation types MSK and FSK.

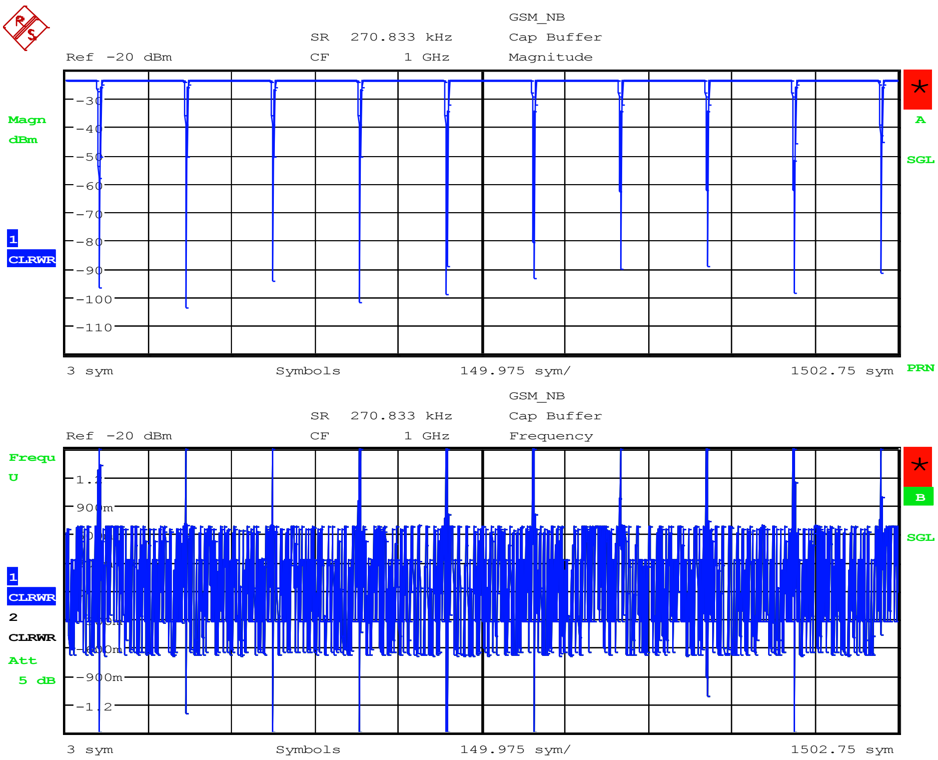


Fig. 199 Result display *MAGNITUDE CAPTURE BUFFER* (upper diagram)
Result display CAPTURE BUFFER -> FREQUENCY (lower diagram)

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
```

REAL/IMAG

The *REAL/IMAG* softkey displays the real and imaginary component of the unprocessed signal of the *RECORD BUFFER*.

The display is standardized to the REFERENCE LEVEL and covers the complete length of the *RECORD BUFFER.*

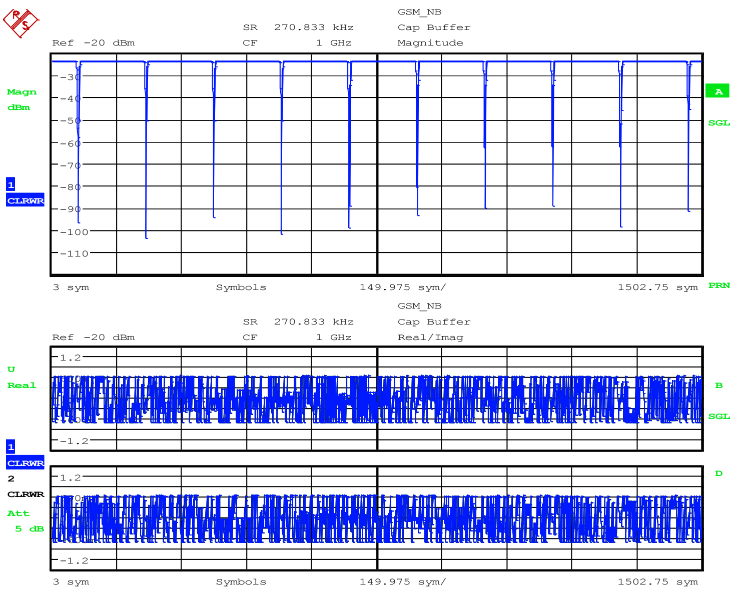


Fig. 200 Result display MAGNITUDE CAPTURE BUFFER (upper diagram)
Result display CAPTURE BUFFER -> REAL/IMAG (lower diagram)

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM RIM
```

SPECTRUM

The *SPECTRUM* softkey switches the set result display to a spectral evaluation (FFT) of the result parameter.

Spectral evaluation is possible for the following result parameters:

- *MAGNITUDE CAPTURE BUFFER*
- *FREQUENCY CAPTURE BUFFER* (only for MSK and FSK modulation modes)
- *REAL/IMAG CAPTUR BUFFER*

The following diagrams provide examples of how the above parameters are displayed on screen. The y axis scaling including the unit (linear or logarithmic) is implemented by the y axis scaling of the corresponding measurement. The x axis scaling depends on the set symbol rate and the set *POINTS/SYMBOL*.

RANGE -> LIN/LOG switches the y axis scaling for the measurement display to logarithmic scaling:

- Spectrum → Capture Buffer Frequency (REL)
- Spectrum → Capture Buffer Real/Imag

SPECTRUM and MAG CAP BUFFER

Simultaneously selecting the *SPECTRUM* and *MAG CAP BUFFER* softkeys shows the FFT magnitude versus the magnitude for the unprocessed signal in the *RECORD BUFFER*.

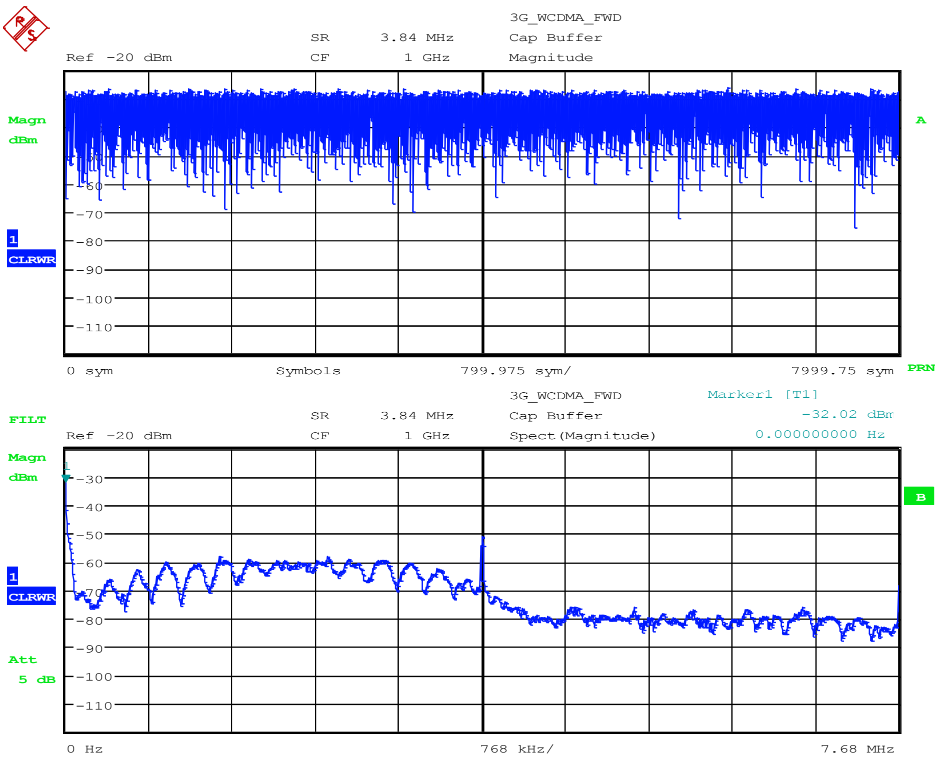


Fig. 201 Result display *CAPTURE BUFFER MAGNITUDE* (upper diagram)
Result display *SPECTRUM -> CAPTURE BUFFER MAGNITUDE* (lower diagram)

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM MAGN
        CALC:DDEM:SPEC:STAT ON
```

SPECTRUM and FREQUENCY

Simultaneously selecting the *SPECTRUM* and *FREQUENCY* softkeys shows the FFT magnitude versus the frequency modulated signal in the *RECORD BUFFER*.

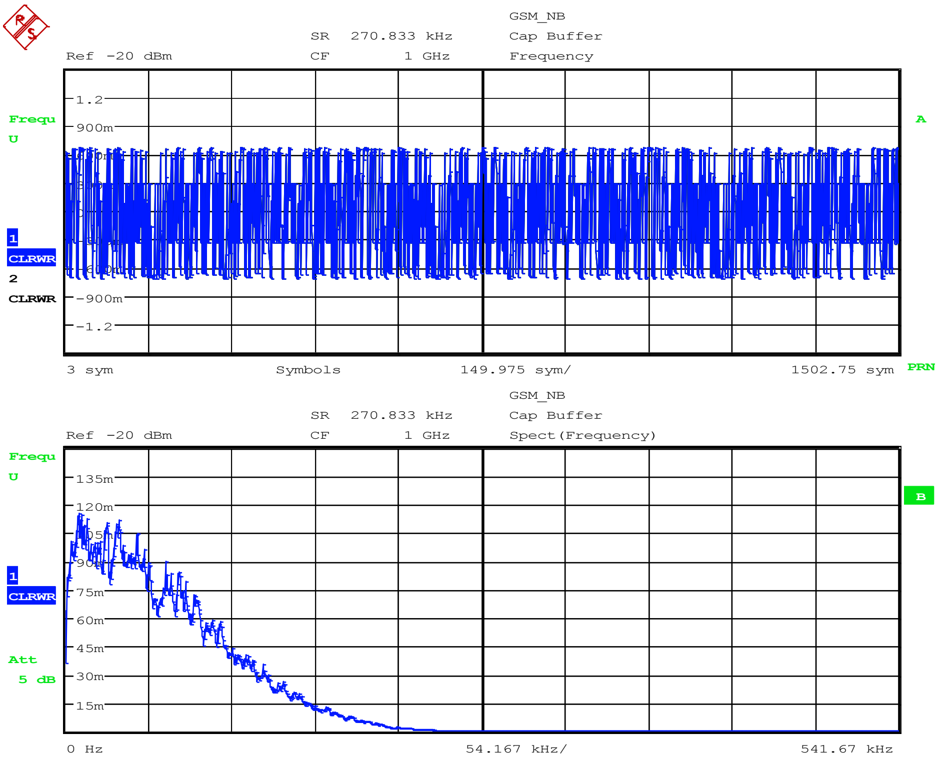


Fig. 202 Result display *CAPTURE BUFFER FREQUENCY* (upper diagram)
Result display *SPECTRUM -> CAPTURE BUFFER FREQUENCY* (lower diagram)

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
        CALC:DDEM:SPEC:STAT ON
```

SPECTRUM and REAL/IMAG

Simultaneously selecting the *SPECTRUM* and *REAL/IMAG* softkeys shows the FFT magnitude versus the real and imaginary component for the unprocessed signal in the *RECORD BUFFER*.

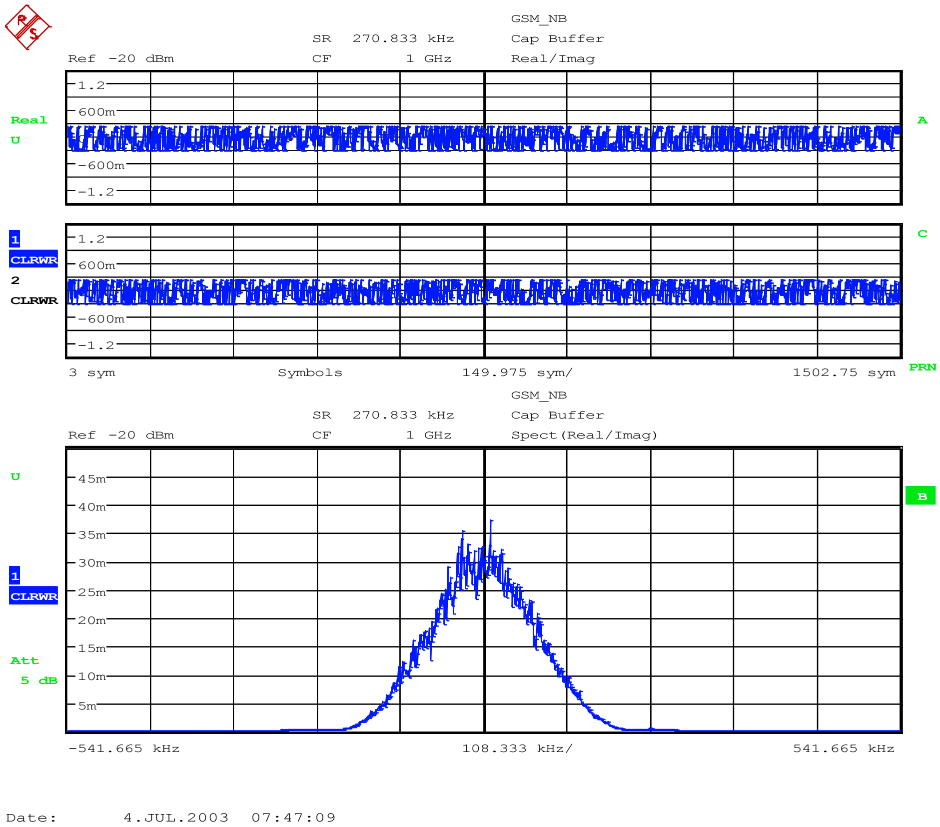


Fig. 203 Result display CAPTURE BUFFER REAL/IMAG (upper diagram)
Result display *SPECTRUM -> CAPTURE BUFFER REAL/IMAG* (lower diagram)

```
Remote: CALC:FEED 'TCAP'
        CALC:FORM RIM
        CALC:DDEM:SPEC:STAT ON
```

SIGNAL STATISTIC

The *SIGNAL STATISTIC* softkey switches the set result display to a statistical evaluation of the result parameter.

Statistical evaluation is possible for the following result parameters:

- MAGNITUDE CAPTURE BUFFER
- FREQUENCY CAPTURE BUFFER (only for MSK and FSK modulation modes)
- *REAL/IMAG CAPTURE BUFFER*

The following diagrams provide examples of how the above parameters are displayed on screen. The x axis scaling including the unit (linear or logarithmic) is implemented by the y axis scaling of the corresponding measurement.

SIGNAL STATISTIC and MAG CAP BUFFER

Simultaneously selecting the *STATISTIC* and *MAG CAP BUFFER* softkeys shows the frequency distribution of the amplitudes for the unprocessed signal in the *RECORD BUFFER*.

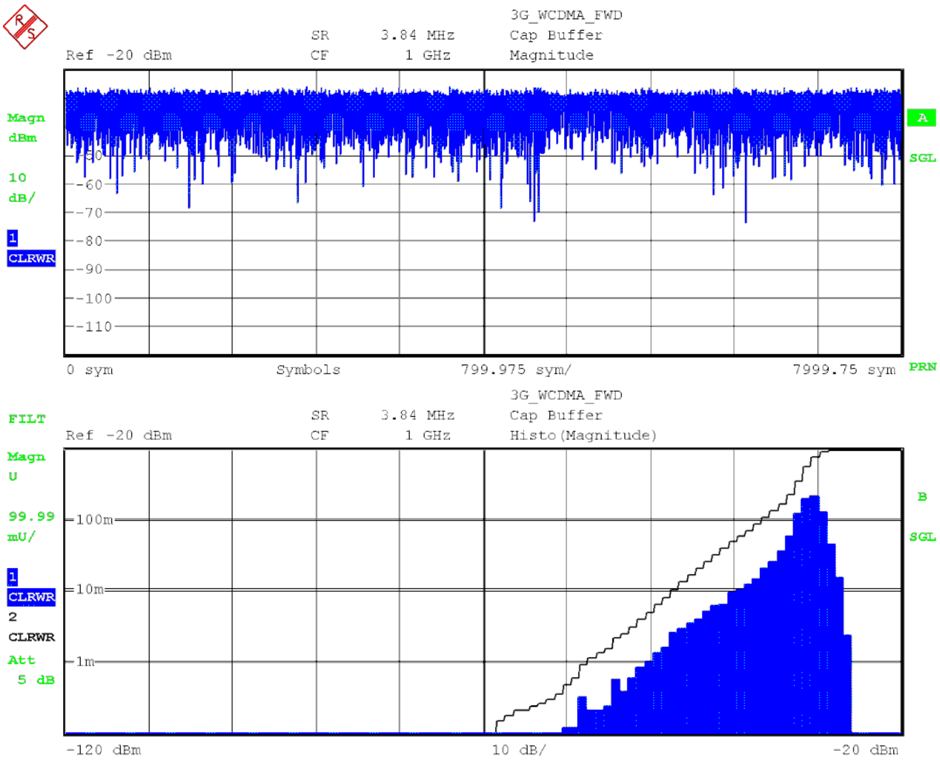


Fig. 204 Result display *MAGNITUDE CAPTURE BUFFER* (upper diagram)
Result display *STATISTIC -> MAGNITUDE CAPTURE BUFFER* (lower diagram)

```
Remote: CALC:FEED "TCAP"
        CALC:FORM MAGN
        CALC:STAT:CCDF:STAT ON
```

SIGNAL STATISTIC and FREQUENCY

Simultaneously selecting the *STATISTIC* and *FREQUENCY* softkeys shows the frequency distribution of the frequency for the frequency modulated signal in the *RECORD BUFFER*.

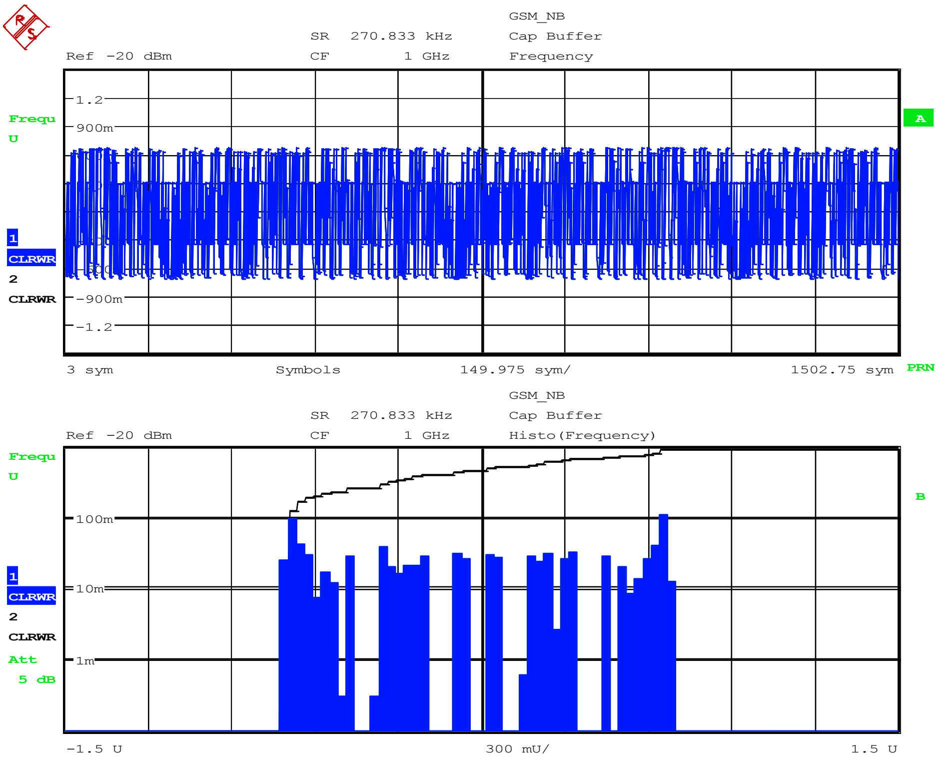


Fig. 205 Result display *FREQUENCY CAPTURE BUFFER* (upper diagram)
Result display *STATISTIC -> FREQUENCY CAPTURE BUFFER* (lower diagram)

```
Remote: CALC:FEED "TCAP"
        CALC:FORM FREQ
        DISP:WIND:TRAC:Y:SCAL:MODE ABS | REL
        CALC:STAT:CCDF:STAT ON
```

STATISTIC and REAL/IMAG

Simultaneously selecting the *STATISTIC* and REAL/IMAG softkeys shows the frequency distribution of real and imaginary component for the unprocessed signal in the *RECORD BUFFER*.

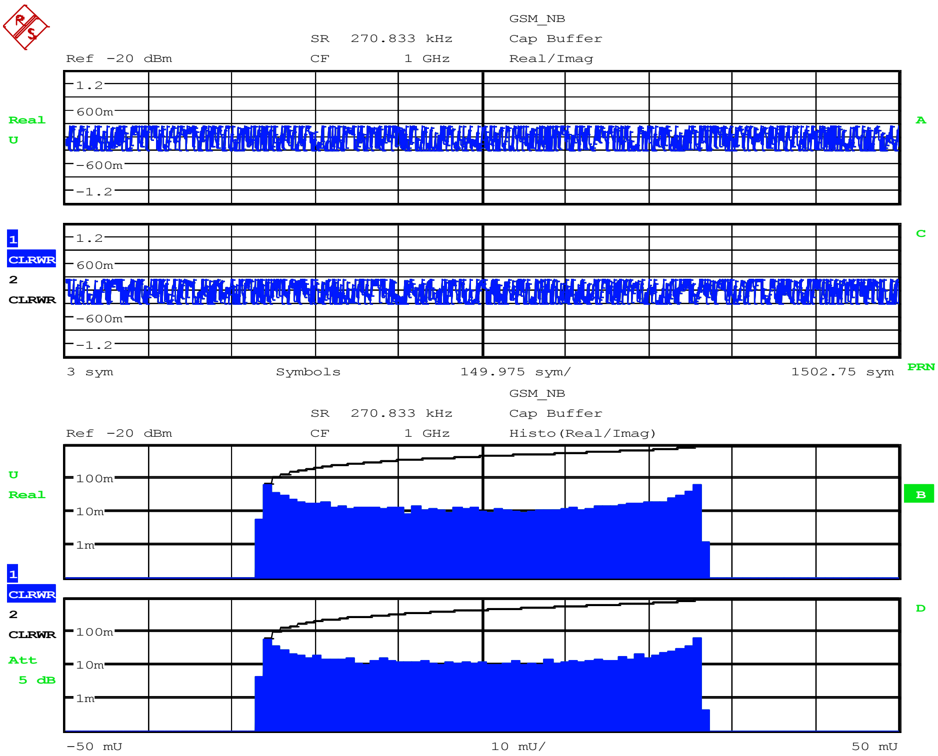


Fig. 206 Result display REAL/IMAG CAPTURE BUFFER (upper diagram)
Result display STATISTIC -> REAL/IMAG CAPTURE BUFFER (lower diagram)

```
Remote: CALC:FEED "TCAP"
        CALC:FORM RIM
        CALC:STAT:CCDF:STAT ON
```

5.8.7 Selection of Adaptive Equalizer Display - EQUALIZER Softkey

The adaptive equalizer generally has complex valued filter coefficients that can be displayed using the following modes:

Result calculation	**Display**	**Comments**
Impulse response (= filter coefficients)	Magnitude	Magnitude of the impulse response
	Real/Imag	Real- and imaginary part of the impulse response
	Phase	Angle of the impulse response
Frequency response (= FFT of filter coefficients)	Group Delay	Group Delay (of the transfer function)
	Phase Response	Angle of the transfer function
	Frequency Response	Magnitude of the transfer function
	Channel Response	Inverse Magnitude of the transfer function

Magnitude displays (magnitude, frequency response) can be scaled in linear or logarithmic y-axis. Phase displays (phase, phase response) are limited to the principal value range (wrap) or can be scaled to a freely adjustable range (unwrap).

The softkey *EQUALIZER* opens a submenu for analyzing the filter coefficients of the adaptive equalizer.

In an additional side-menu the equalizer control softkeys (EQUALIZER SETTINGS) are mirrored for convenience. (see softkey: Equalizer Settings / menu MODULATION SETTINGS)

A more detailed explanation of the equalizer’s functionality can be found in the section ‘Adaptive Equalizer Filter’.

MAGNITUDE
PHASE
REAL/IMAG
GROUP DELAY
PHASE RESPONSE
FREQ RESP
CHAN RESP

MAGNITUDE

The softkey *MAGNITUDE* sets the result display to show the magnitude of the equalizer’s impulse response (= magnitude of filter coefficients). If EQUALIZER = OFF is set, a neutral filter is displayed.

LIN linear scaling of the y-axis.

LOG logarithmic scaling of the y-axis (dB)

The x-axis is scaled in ‚symbols’in the range of:

$$\left[-\frac{Equalizer\_Length}{2} .... + \frac{Equalizer\_Length}{2}\right]$$

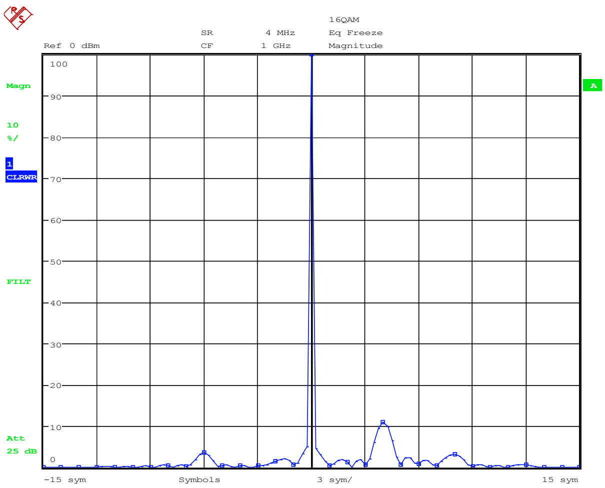


Fig. 207 Display of the filter coefficients *MAGNITUDE (LIN)*

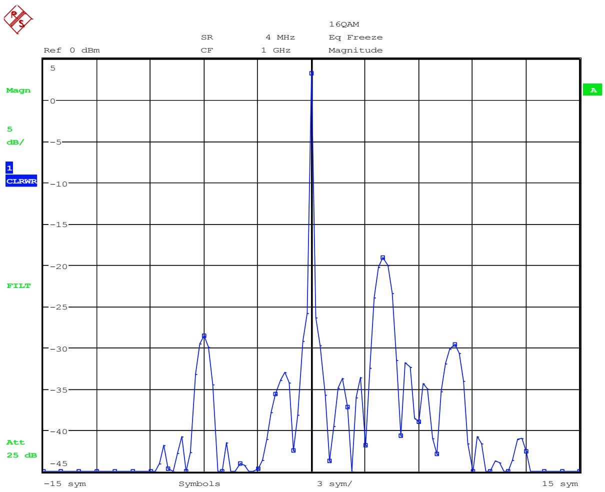


Fig. 208 Display of the filter coefficients *MAGNITUDE (LOG)*

Remote: LOG:

```
CALC:FEED 'XTIM:DDEM:IMP'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LOG
```

LIN:

```
CALC:FEED 'XTIM:DDEM:IMP'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LIN
```

PHASE

The softkey *PHASE* sets the result display to show the phase of the equalizer's impulse response (= phase of coefficients). If EQUALIZER = OFF is set, a neutral filter is displayed. (Phase = 0).

WRAP The display is limited to the value range of 2pi.

UNWRAP Also phase characteristics >2pi are displayed

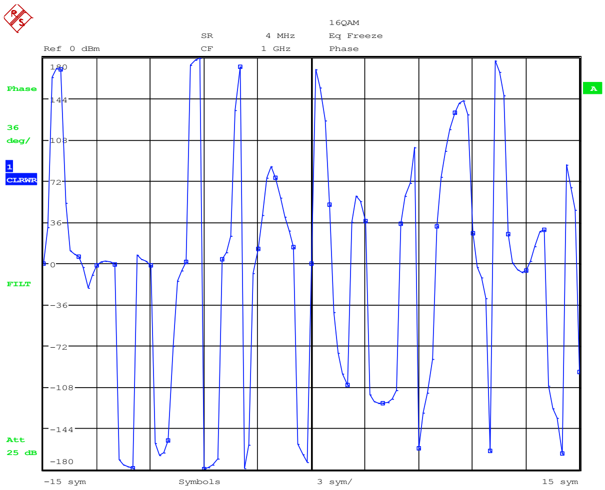


Fig. 209 Result display *PHASE(WRAP)*

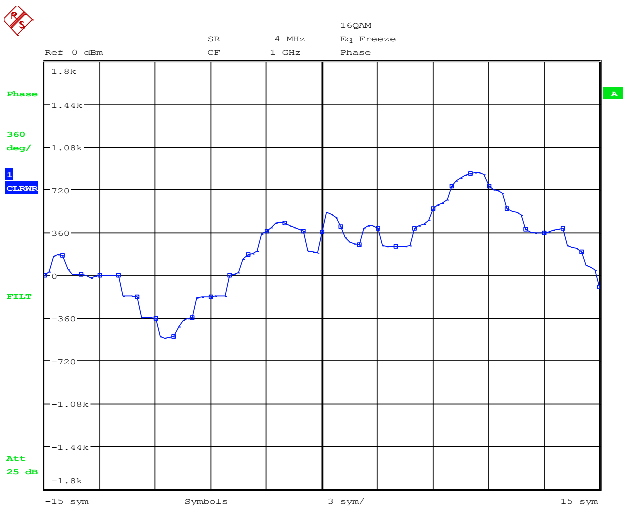


Fig. 210 Result display *PHASE(UNWRAP)*

`Remote:` WRAP

```
CALC:FEED 'XTIM:DDEM:IMP'
CALC:FORM PHAS
```

UNWRAP

```
CALC:FEED 'XTIM:DDEM:IMP'
CALC:FORM UPH
```

REAL/IMAG

The softkey *REAL/IMAG* sets the result display to show the complex impulse response. If EQUALIZER = OFF is set, a neutral filter is displayed.

The upper diagram draws the real part, the lower diagram the imaginary part of the complex valued impulse response.

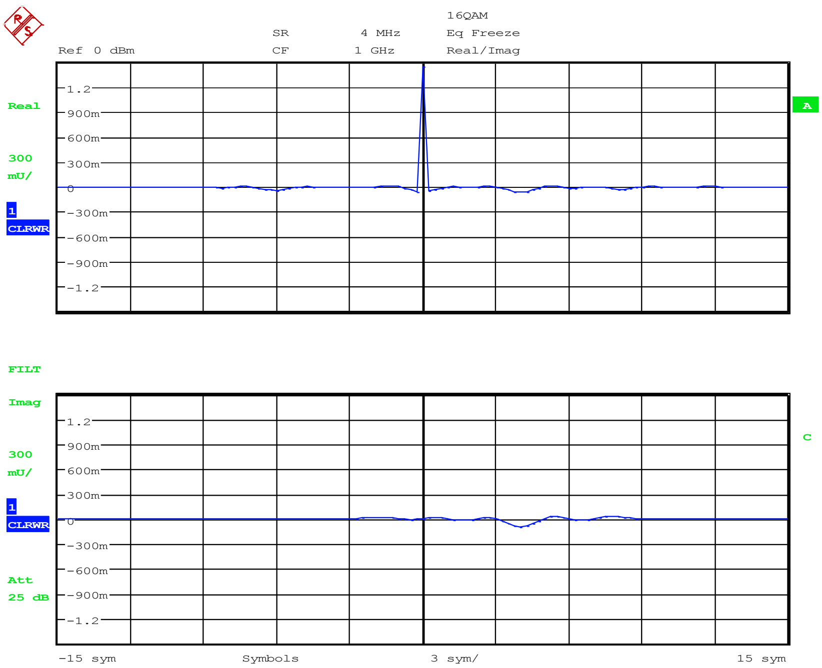


Fig. 211 Display result REAL/IMAG (impulse response = equalizer's filter coefficients)

```
Remote: CALC:FEED 'XTIM:DDEM:IMP'
        CALC:FORM RIM
```

GROUP DELAY

The softkey *GROUP DELAY* sets the result display to show the equalizer's group delay. If EQUALIZER = OFF is set, a neutral filter is displayed (group delay = 0).

The x-axis is scaled in Hz in the range of:

$$\left[-\frac{\text{points/symbol*symbolrate}}{2}....+\frac{\text{points/symbol*symbolrate}}{2}\right]$$

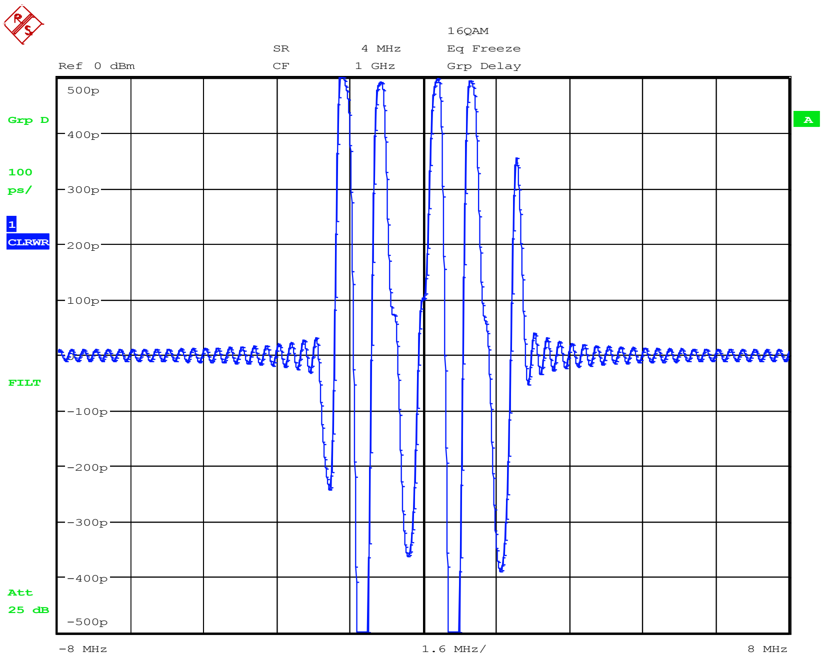


Fig. 212 Result display *GROUP DELAY*

```
Remote:  CALC:FEED 'XFR:DDEM:RAT'
         CALC:FORM GDEL
```

PHASE RESPONSE

The softkey *PHASE RESPONSE* sets the result display to show the phase of the equalizer's frequency response. If EQUALIZER = OFF is set, a neutral filter is displayed (phase = 0).

WRAP The display is limited to the value range of 2pi

UNWRAP *Also phase characteristics >2pi can be displayed*

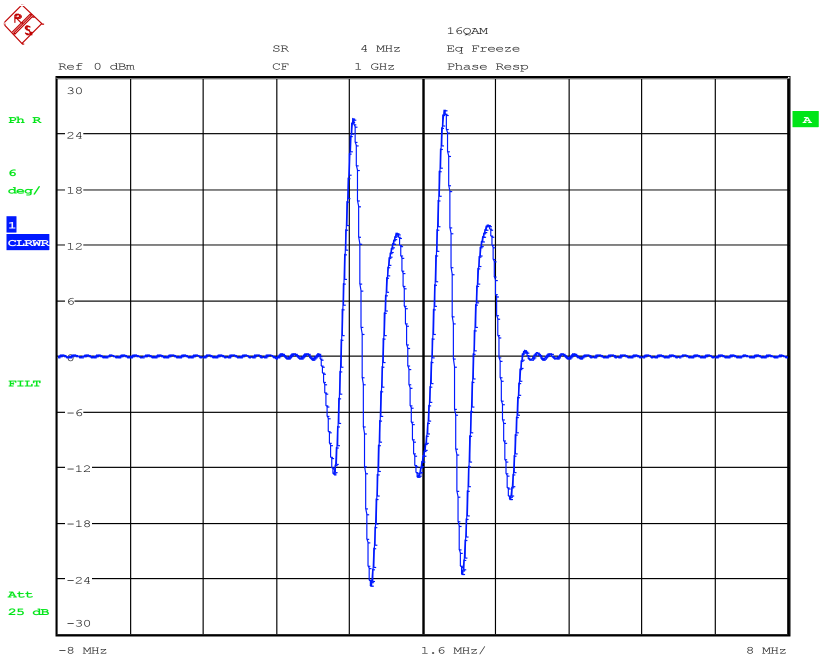


Fig. 213 Result display *PHASE RESPONSE*

Remote: WRAP:

```
CALC:FEED 'XFR:DDEM:RAT'
CALC:FORM PHAS
```

UNWRAP

```
CALC:FEED 'XFR:DDEM:RAT'
CALC:FORM UPH
```

FREQ RESP

The softkey *FREQ RESP* sets the result display to show the magnitude of the equalizer's frequency response. If EQUALIZER = OFF is set, a neutral filter is displayed (magnitude = 1 or 0 dB respectively).

LIN linear scaling of the y-axis.

LOG logarithmic scaling of the y-axis (dB).

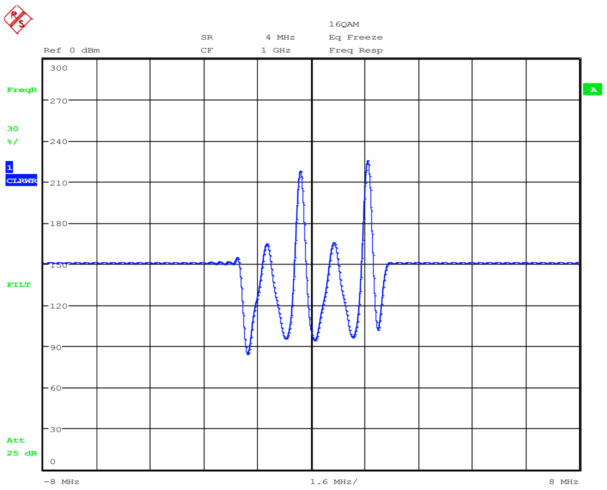


Fig. 214 Result display FREQ RESP (LIN)

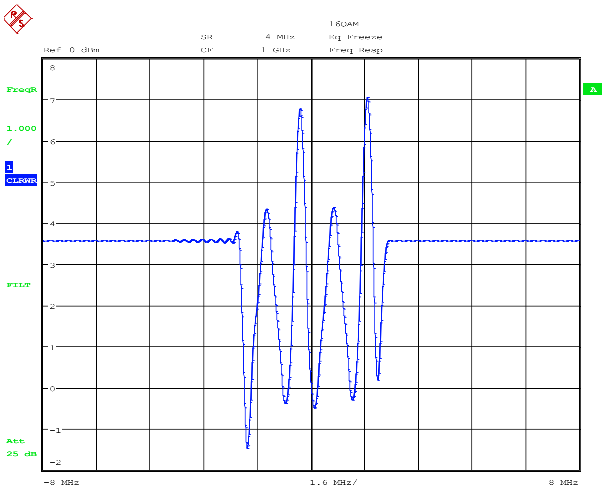


Fig. 215 Result display FREQ RESP (LOG)

`Remote:` LOG:

```
CALC:FEED 'XFR:DDEM:RAT'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LOG
```

LIN:

```
CALC:FEED 'XFR:DDEM:RAT'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LIN
```

CHAN RESP

The softkey *CHAN RESP* sets the result display to show frequency response of the DUT.

It is calculated from the inverse frequency response of the equalizer filter and is only valid within the bandwidth of the transmit and receive filter respectively.

If EQUALIZER = OFF is set, a neutral filter is displayed (magnitude = 1, respectively 0 dB).

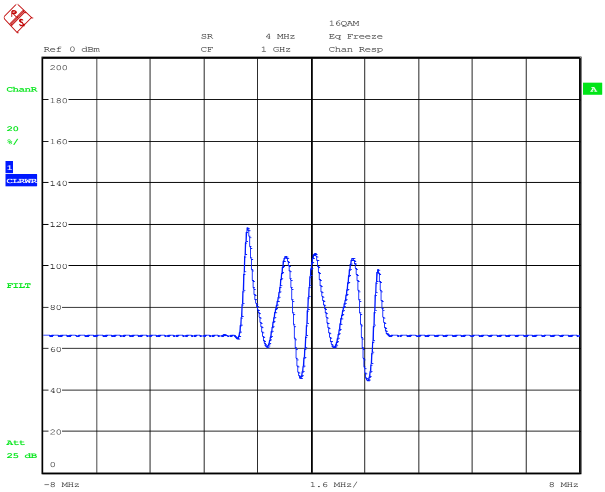


Fig. 216 Result display CHAN RESP (LIN)

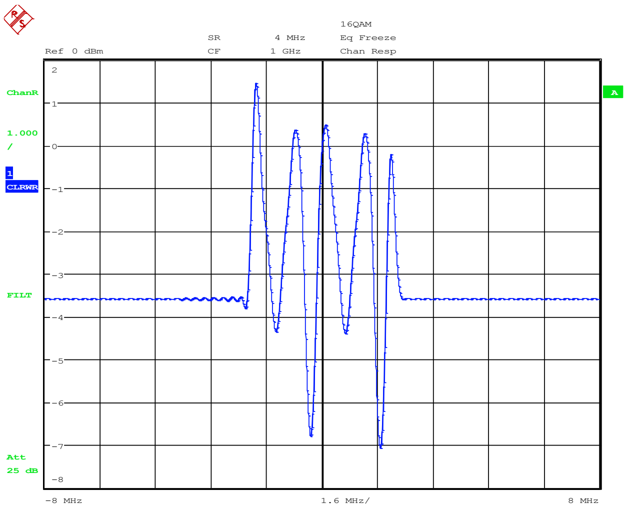


Fig. 217 Result display CHAN RESP (LOG)

`Remote:` LOG:

```
CALC:FEED 'XFR:DDEM:IRAT'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LOG
```

LIN:

```
CALC:FEED 'XFR:DDEM:IRAT'
CALC:FORM MAGN
DISP:TRAC:Y:SPAC LIN
```

5.9 Positioning of Display on Screen - FIT TRACE Softkey

This section describes the different spans if FIT settings are used.

The analyzer determines the demodulation range of signal processing (DSP_Demod_Range) after the instrument has been set. See chapter "*Record Buffer,"* for examples.

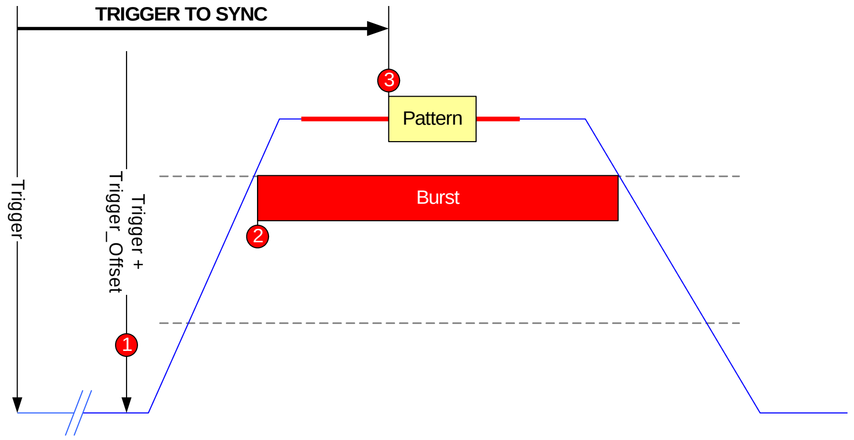


Fig. 218 Burst measurement by using an external trigger

Fig. 218 shows a burst measurement example when an external trigger is used.

Burst search is activated, and a synchronization pattern was found.

The *TRIGGER TO SYNC* result parameter is derived from the time difference between synchronization pattern and external trigger time.

Positioning of the screen display is possible via the marked reference points (see above):

- Trigger + Trigger_Offset
- Burst
- Pattern

Possible settings are:

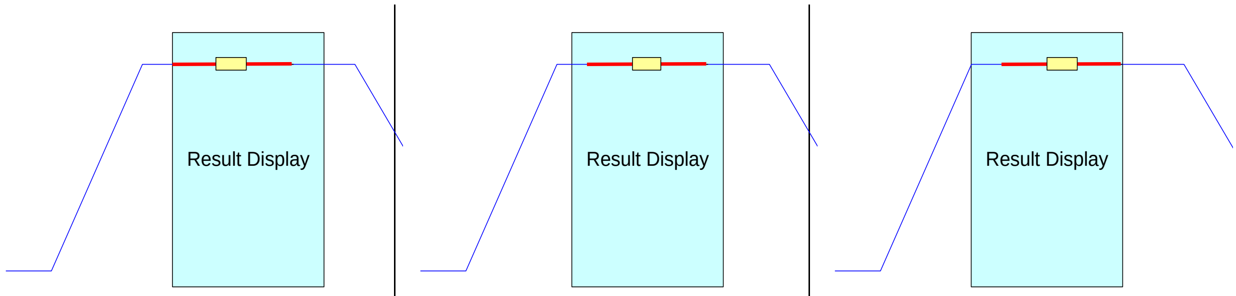
FIT TO LEFT: In this setting, the reference point (trigger, **start** of burst or **start** of pattern) is positioned to the left edge of the screen display.

FIT TO CENTER: The reference point (trigger, burst **center**, pattern **center**) is positioned to the **center** of the screen display.

FIT TO RIGHT: The reference point (trigger, **end** of burst, **end** of pattern) is positioned to the right edge of the screen display.

Examples are shown in the figures below.

Examples of FIT BURST, FIT PATTERN and FIT TRIGGER:



FIT BURST TO LEFT:

The beginning of the burst is positioned to the left screen edge.

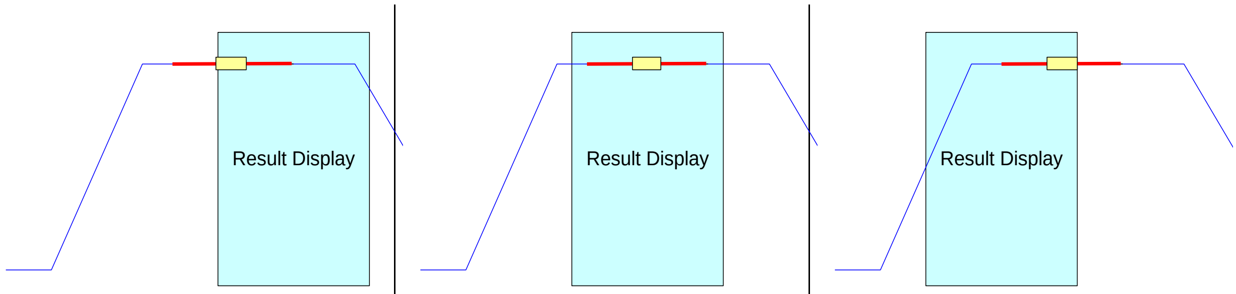
FIT BURST TO CENTER:

The center of the burst is positioned to the center of the screen.

FIT BURST TO RIGHT:

The end of the burst is positioned to the right screen edge.

Fig. 219 Examples of FIT: Fit Burst to Left / Center / Right



FIT PATTERN TO LEFT:

The **beginning** of the pattern is positioned to the **left** screen edge.

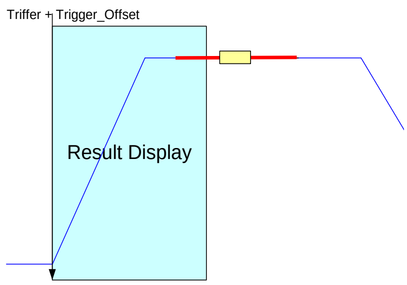
FIT PATTERN TO CENTER:

The **center** of the pattern is positioned to the **center** of the screen.

FIT PATTERN TO RIGHT:

The **end** of the pattern is positioned to the **right** screen edge.

Fig. 220 Examples of FIT: Fit Pattern to Left / Center / Right



FIT BURST TO TRIGGER:

The left screen edge is positioned to the TRIGGER+ TRIGGER_OFFSET

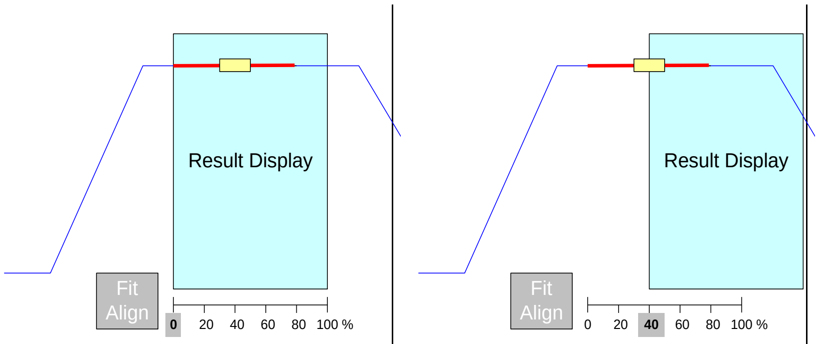
reference point.

Fig. 221 Examples of FIT: Fit Burst to Trigger

For FIT BURST TO TRIGGER only setting LEFT is available. Fine adjustment and manual shifting with FIT ALIGN or FIT OFFSET is not possible.

Fine adjustment using FIT ALIGN

FIT ALIGN allows manual shifting of the screen display (with reference to the selected reference point). Entry is in [%] of the screen width. A corresponding symbol setting can be set by means of the **FIT OFFSET** softkey.



FIT BURST TO LEFT.

The FIT ALIGN = 40% setting keeps the earlier reference point and shifts the **screen display** by 4/10 of RESULT LEN to the right.

Fig. 222 Examples of FIT: Fit Align

5.9.1 Scaling of Time Axis in Symbols

The zero point on the time or symbol axis can be matched within wide limits to the measurement requirements.

If a symbol cannot be numbered by means of the pattern search and standard definition, the following are assigned the symbol number "0" (depending on the selected reference point):

- beginning of a burst
- reference point trigger + trigger offset

This scale reference point is maintained even if the display is shifted.

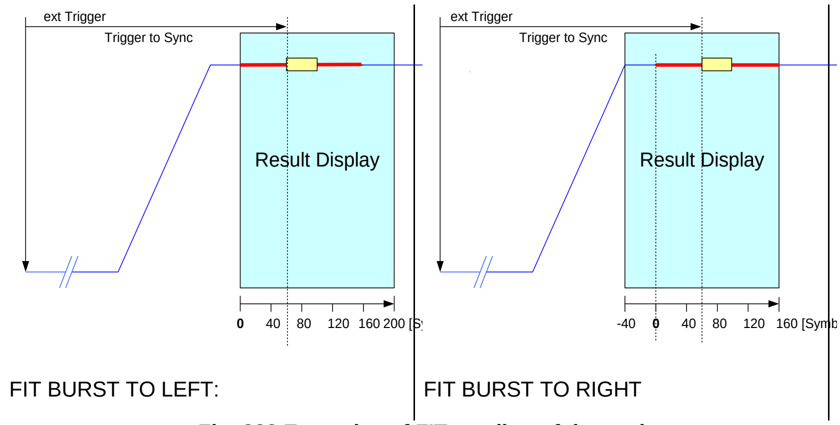


Fig. 223 Examples of FIT: scaling of time axis

A similar behaviour occurs with pattern-related measurements if the symbol number is specified by a digital standard definition.

Example: Because a standard was defined, the position number of the first pattern symbol is set to "53 (decimal)". This definition then applies to all positionings (left/center/right). The measured value for TRIGGER TO SYNC is obtained from the difference between external trigger time and beginning of pattern, independent of the positionings on the screen.

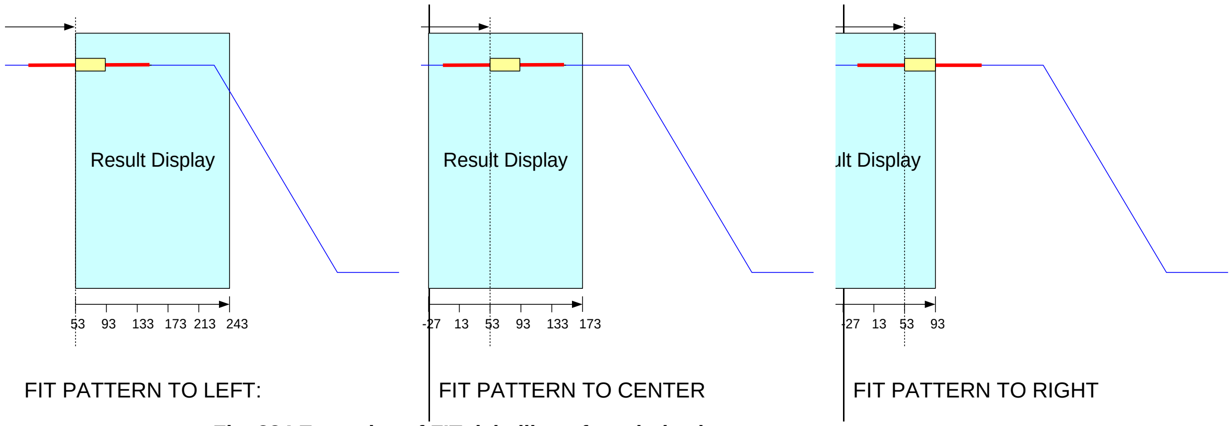


Fig. 224 Examples of FIT: labelling of symbol axis

5.9.2 FIT TRACE Menu

The FIT TRACE softkey opens the menu for positioning the measurements results on the display.

The reference point is selected by using the softkey group:

- FIT TRIGGER
- FIT BURST
- FIT PATTERN

The reference point is positioned on the display by using the key group:

- FIT ALIGN LEFT
- FIT ALIGN CENTER
- FIT ALIGN RIGHT

Positioning can be shifted by using the parameter

- *FIT ALIGN* (input in %) or
- *FIT OFFSET* (input in symbols)

Softkey SET SYMB # assigns a symbol number to the reference points

- start of USEFUL LENGTH
- trigger and trigger offset

In addition, the side menu allows *RECORD LEN* and *RESULT LEN* parameter settings.

PAT POS (pattern position) specifies the expected position of the start of the pattern relative to the start of the *USEFUL LENGTH*. The analyzer searches for the pattern in a range between

(pattern position) and

- (pattern position + pattern length)

with a tolerance of +/- 5 symbols.

For setting examples, see previous chapter.

```
Remote: CALC:TRAC:ADJ TRIG|BURS|PATT
        CALC:TRAC:ADJ:ALIG LEFT|CENT|RIGH
        CALC:TRAC:ADJ:ALIG:VAL <num_value>
        CALC:TRAC:ADJ:ALIG:OFF <num_value>
        DISP:WIND:TRACe:X:SCAL:VOFF <num>
        SENS:DDEM:STAN:SYNC:OFFS <num_val>
```

5.10 Multiple Evaluation and Section Displays - ZOOM Softkey

The *ZOOM* softkey opens the menu for setting the display area of the capture buffer and for controlling demodulation in multi-processing mode.

The following softkeys determine which area of the capture buffer to display:

- *ZOOM START*
- *ZOOM LENGTH*

```
Remote: SENS:DDEM:SEAR:MBUR:STAR 500SYM
        SENS:DDEM:SEAR:MBUR:LENG 1000SYM
```

The following softkeys control demodulation in multiple evaluation mode:

- *DEMOD NEXT RIGHT*
- *DEMOD RESTART*
- *DEMOD @ ZOOM START*

These softkeys are available only in MULTI mode in conjunction with SINGLE SWEEP. You can find a detailed description of this control (also for demodulation of burst signals) in the section "*Multiple Evaluation of a Captured Data Record (MULTI)*".

```
Remote: SENS:DDEM:SEAR:MBUR:FIND:NEXT
        SENS:DDEM:SEAR:MBUR:FIND:FIRS
        SENS:DDEM:SEAR:MBUR:FIND:STAR
```

The following softkey starts automatic data capture if the end of the record buffer has been reached:

- CAPTURE AUTO / OFF

If *CAPTURE OFF* is selected, data capture will not be started. When the end of the record buffer is reached, the message '**End of Buffer**'will be output. This softkey is available only in MULTI mode in conjunction with SINGLE SWEEP.

```
Remote: SENS:DDEM:SEAR:MBUR:CAP:AUTO OFF
```

The following softkey switches **multiple evaluation mode** on and off ("*Multiple Evaluation of a Captured Data Record (MULTI)*"):

MULTI ON/OFF

f MULTI ON is selected, a new capture is performed once the end of the record buffer has been reached. Otherwise, the message '**End of Buffer'**will be output.

```
Remote: SENS:DDEM:SEAR:MBUR ON
```

5.11 Setting of Span - RANGE Softkey

The *RANGE* softkey opens a menu for setting the display scaling and the span.

Scaling of the x axis for **I/Q and statistical displays** is controlled by the following softkeys:

- *X-AXIS /DIV*
- *X-AXIS REF VALUE*
- *X-AXIS REF POS*
- *X-AXIS LIN / LOG*

These softkeys are not available for time display since other operating parameters (RESULT LENGTH, FIT) determine the zero point and scaling.

The following softkeys control the zero point and scaling of the y axis for **I/Q, statistical and time displays:**

- Y-AXIS /DIV
- Y-AXIS REF VALUE
- Y-AXIS REF POS

The following softkey controls quantization of the x axis in **statistical displays:**

- *X-AXIS QUANTIZE*

The following sofkey restores the default setting of the current measurement window:

- DEFAULT SETTINGS

```
Remote:  CALC:STAT:SCAL:X:BCO <num_value>
         DISP:WIND:TRAC:X:SCAL:PDIV <num_value>
         DISP:WIND:TRAC:X:SCAL:RVAL <num_value>
         DISP:WIND:TRAC:X:SCAL:RPOS <num_value>
         DISP:WIND:TRAC:X:SPAC LIN | LOG
         DISP:WIND:TRAC:Y:SCAL:PDIV <num_value>
         DISP:WIND:TRAC:Y:SCAL:RVAL <num_value>
         DISP:WIND:TRAC:Y:SCAL:RPOS <num_value>
```

The *SYMBOLS & MOD ACC* display mode is used to switch the symbol value display in the *RANGE* submenu between:

- *Binary*
- Octal
- Decimal
- *Hexadecimal*

The selection of the display mode also affects the number of displayed symbols.

```
Remote: -
```

Examples:

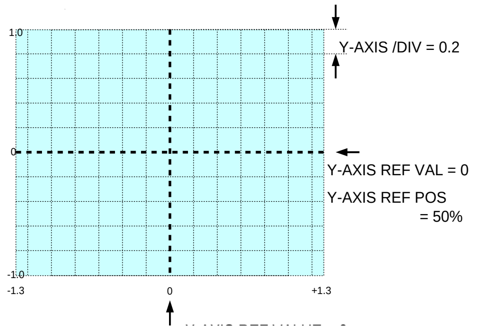


Fig. 225 Example of RANGE, I/Q display
X AXIS/DIV is used together with Y AXIS/DIV

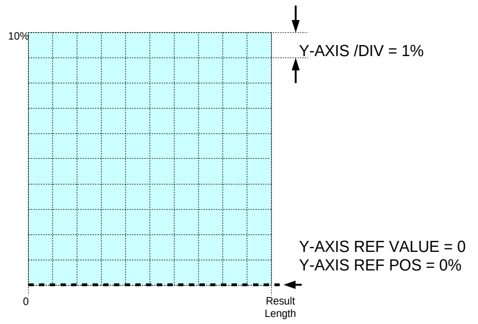


Fig. 226 Example of RANGE, time display (EVM lin)

Time displays and log scale (Mag Cap Buffer …)

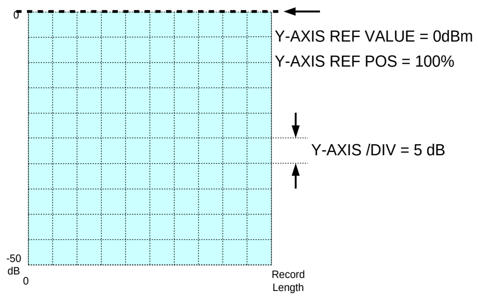


Fig. 227 Example of RANGE, time display, Mag Cap Buffer

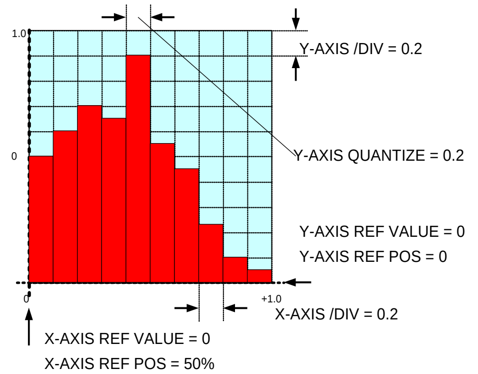


Fig. 228 Example of RANGE, statistical display Quantize

5.11.1 Automatic Setting of Reference Level - ADJUST LVL Softkey

The *ADJUST REF LVL* softkey sets the signal-adjusted reference level to the optimum setting value, taking into account an overload reserve.

A keystroke activates a setting that is performed once and does NOT provide continuous adjustment of the set level. After significant level changes of the applied input signal, or as a result of overload display, a reset is required to eliminate measurement errors due to insufficient dynamic range or overload.

In operating mode TRIGGER = FREE RUN the signal peak value within an observation period of 0.2 sec (or of the RECORD TIME if this time is longer) is determined, which in turn is required to determine the necessary instrument settings.

In a subsequent control measurement using adapted instrument settings, the values are checked and the instrument settings improved until the measured peak value is in a range between the set reference level and 5 dB below the reference level.

If an external trigger is active, the described sequence is invoked by triggered measurements with the set RECORD TIME.

If the slower periodicity signal varies, a manual reference level setting is recommended (see **Level Settings - Key AMPT -> REF LEVEL**).

To protect the instrument input against overload, the attenuator is limited to a minimum setting value of 10 dB when using the RF ATTEN AUTO setting.

When the attenuation is set manually using RF ATTEN MAN, the current attenuation setting is not undershot.

`Remote: SENS:DDEM:PRES:RLEV`

5.11.2 Restoring of Factory Settings - FACTORY DEFAULTS Softkey

The *FACTORY DEFAULTSS* softkey restores the factory settings of the following parameters for the R&S FSQ-K70/FSMR-B73/FSU-B73 option:

- GENERIC STANDARDS
- STANDARDS
- MAPPINGS
- PATTERN
- FILTER

ALL restores the factory settings of all of the above parameters.

All functions request a confirmation. If the answer is "yes", **parameters of the same name** (e.g. pattern) will be overwritten without any further individual queries.

`Remote: SENS:DDEM:FACT GST`

5.11.3 Importing Stand., Mappings, Pattern and Filter - IMPORT Softkey

STANDARD
MAPPINGS
FILTERS
EQUALIZERS
PATTERNS
PATH

The *IMPORT* softkey can be used to transfer the following from other R&S analyzers or from external programs (MAPWIZ, FILTWIZ) via file operations:

- STANDARDS
- MAPPINGS
- PATTERNS
- FILTERS
- EQUALIZER FILTER

PATH is used to set the path under which to search for external data. By default, this path points to the built-in disk drive.

All functions include a confirmation query. If a confirmation query is answered with "yes", **an existing file of the same name** will be overwritten (e.g. pattern file).

After the appropriate softkey is pressed, the path that is entered will be searched to find matching files of this type, and the files that are found will be displayed in a table. The cursor keys or rotary knob are used to make a selection. The file is copied to the instrument by confirming with the ENTER key. If no matching files are found in the path, a blank table will be displayed. It can be exited with ESC.

If standards are imported (*STANDARDS* softkey), the following items for each standard are also imported:

- Pattern
- Filter
- Mappings
- Equalizer Filter

If the confirmation query is answered with "yes" when standards are imported, all **existing files of the same name** will be overwritten without additional confirmation queries.

STANDARD

The STANDARDS softkey shows the table of digital standards available in the selected path.

Fig. 229 Selection list of digital standards EXPORT -> STANDARDS

Remote: `SENS:DDEM:IMP:STAN <name>,<path>`

MAPPINGS

The MAPPINGS softkey shows the table of mappings available in the selected path.

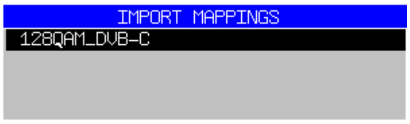


Fig. 230 Selection list of symbol mappings IMPORT -> MAPPINGS

`Remote: SENS:DDEM:IMP:MAPP <name>,<path>`

FILTERS

The FILTERS softkey shows the table of filters available in the selected path. No distinction is made between transmit, receive or measurement filters.

Fig. 231 Selection list of filters IMPORT -> FILTERS

`Remote: SENS:DDEM:IMP:FILT <name>,<path>`

EQUALIZERS

The EQUALIZERS softkey shows the table of equalizer filters available in the selected path. Only equalizer filters are listed, no transmit, receive or measurement filters.

Fig. 232 Selection list of filters IMPORT -> EQUALIZER

`Remote: SENS:DDEM:IMP:EQU 'name','path'`

PATTERNS

The PATTERNS softkey shows the table of patterns available in the selected path.

Fig. 233 Selection list of synchronization patterns IMPORT -> PATTERNS

`Remote: SENS:DDEM:IMP:PATT <name>,<path>`

PATH

The PATH softkey sets the path for the IMPORT function. The path is factory-set to the built-in disk drive. The setting also affects the EXPORT function.

Fig. 234 Selection of path IMPORT -> PATH

`Remote: -`
(the path is specified when the parameters are selected)

5.11.4 Export of Stand., Mappings, Pattern and Filter - EXPORT Softkey

The *EXPORT* softkey can be used to transfer the following from other R&S FSQ analyzers or from external programs (MAPWIZ, FILTWIZ) via file operations:

- STANDARDS
- MAPPINGS
- PATTERNS
- FILTERS
- EQUALIZER FILTER

PATH is used to set the path to which the internal files are to be copied. This path usually points to the built-in disk drive.

After the appropriate softkey is pressed, the existing internal files of the selected type are listed in a table. The cursor keys or rotary knob are used to make a selection. Pressing the ENTER key as confirmation copies the file to the diskette (or to another data medium that is connected). If no matching files are found in the instrument, a blank table will be displayed. It can be exited with ESC.

When standards are saved, also the following items associated with the standard are saved in compressed format:

- Pattern
- Filter
- Mappings
- Equalizer Filter

STANDARDS
MAPPINGS
FILTERS
EQUALIZERS
PATTERNS
PATH

STANDARDS

The STANDARDS softkey. shows the table of digital standards available in the instrument.

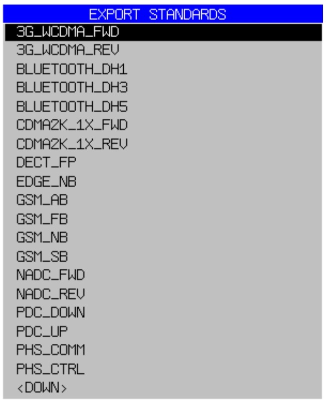


Fig. 235 Selection list of digital standards EXPORT -> STANDARDS

Remote: SENS:DDEM:EXP:GST <name>,<path>
SENS:DDEM:EXP:STAN <name>,<path

MAPPINGS

The MAPPINGS softkey shows the table of mappings available in the instrument.

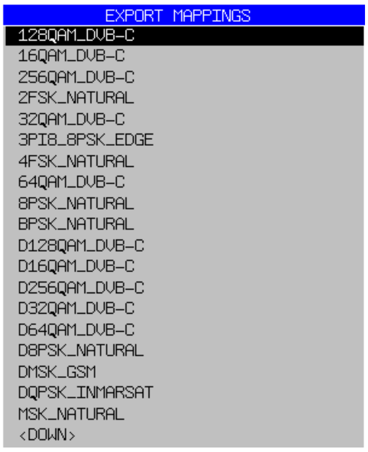


Fig. 236 Selection list of symbol mappings EXPORT -> MAPPINGS

Remote: SENS:DDEM:EXP:MAPP <name>,<path>

FILTERS

The FILTERS softkey shows the table of filters available as coefficients in the instrument. Analytic filters (root raised cosine, raised cosine, Gaussian) are calculated at runtime in the instrument and cannot be exported.

Fig. 237 Selection list of filters EXPORT -> FILTERS

Remote: SENS:DDEM:EXP:FILT <name>,<path>

EQUALIZERS

The *EQUALIZERS* softkey shows the table of equalizer filters available in the instrument. Only equalizer filters are listed, but no transmit, receive or measurement filters.

Fig. 238 Selection list of filters EXPORT -> EQUALIZER

Remote: SENS:DDEM:EXP:EQU 'name','path'

PATTERNS

The PATTERNS softkey shows the table of patterns available in the instrument.

Fig. 239 Selection list of synchronization patterns EXPORT -> PATTERNS

`Remote: SENS:DDEM:EXP:PATT <name>,<path>`

PATH

The PATH softkey sets the path for the EXPORT function. The path is factory-set to the built-in disk drive. The setting also affects the IMPORT function.

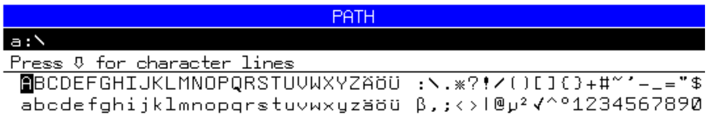


Fig. 240 Selection of the path EXPORT -> PATH

`Remote: -`

5.12 Overview of Other Menus

Operation of the other keys is very similar to that of the basic unit. Please note that some functions implemented in the basic unit are **not available** here. Such functions are only briefly mentioned in the following; for a detailed description refer to the manual of the basic unit.

The IEC/IEEE bus commands of the menus described below are found in the "Table of Softkeys Assigned to IEC/IEEE Bus Commands".

Any R&S FSQ-K70/FSMR-B73/FSU-B73-specific softkeys or menus **added** to extend the range of control functions are described in detail.

5.12.1 Default Settings - PRESET Key

The *PRESET* key resets the analyzer to the spectrum analyzer mode and activates the default settings of this mode.

The current settings of the VSA mode will be lost, too, because the R&S FSQ-K70/FSMR-B73/FSU-B73 option is also reset to a default status.

`Remote: *RST`

5.12.2 System Error Correction - CAL Key

The functions of the softkeys of the *CAL* menu are identical to those of the corresponding softkeys of the basic unit:

- *CAL TOTAL* Calculates the internal correction data of the instrument for system error correction.
- *CAL ABORT* Stops the collection of correction data.
- *CAL CORR ON /OFF* Switches on or off system error correction by means of the calculated data.
- *CAL RESULTS* Displays a table of calculated correction values.

5.12.3 General Instrument Settings - SETUP Key

The functions of the softkeys of the *SETUP* menu are identical to those of the corresponding softkeys of the basic unit. The option-specific softkeys are additionally available under *SIGNAL PATH* (see below).

- REFERENCE INT / EXT Switches between internal and external reference frequency.
- NOISE SRC ON/OFF Switches on or off the supply voltage for an external noise voltage source.
- SIGNAL SOURCE Selects the signal source for the Vector Signal Analyzer option (R&S FSQ-K70/FSMR-B73/FSU-B73).
- PREAMP Switches on or off the preamplifier.
- GENERAL SETUP Opens a submenu where the instrument interfaces and the time of day can be configured and software options activated.

- SYSTEM INFO — Opens a submenu for the display of module data and system messages.
- SERVICE — Opens a submenu with functions for maintenance and troubleshooting.

The SIGNAL SOURCE softkey opens a submenu for selecting the input signal source for the R&S FSQ-K70 option:

- *YIG FILTER ON / OFF* — Connects a broadband YIG filter for image-frequency rejection into the signal path. The default setting for the R&S FSQ-K70 option is OFF. Frequency response and phase response of this filter are not corrected by instrument calibration. The softkey is only available on instrument models R&S FSQ8 and R&S FSQ26.

The following softkeys are available only if the R&S FSQ-B71 option (baseband input) is installed (see manual of option for detailled description):

- *RFPATH* — Selects the RF input socket as a signal input.
- *BASEBAND ANALOG* — Selects the analog IQ baseband inputs as a signal source.
- *IQ INPUT 50Ω/1kΩ* — Switches the input impedance of the analog IQ inputs between 50 Ω and 1 kΩ.
- *BALANCED ON / OFF* — Switches the analog baseband inputs between BALANCED and UNBALANCED mode.
- *LOWPASS 36 MHz* — Connects an analog lowpass filter with 36 MHz cutoff frequency (for image-frequency rejection) into the signal paths of the baseband inputs.
- *DITHER ON / OFF* — Controls a dither generator for the reduction of mixture products on the A/D converter characteristic.

5.12.4 Documentation of Results - HCOPY Key

The functions of the softkeys of the *HCOPY* menu are identical to those of the corresponding softkeys of the basic unit.

PRINT SCREEN	Starts the printing of results (all diagrams, traces, markers, marker lists, etc displayed on the screen).
PRINT TRACE	Starts the printing of all traces displayed on the screen WITHOUT including any further information.
PRINT TABLE	Starts the printing of configuration tables and display lists WITHOUT including the underlying result diagrams and labelling.
HARDCOPY ABORT	Stops the current printing job.
DEVICE1 / DEVICE2	Selects one of two possible printers and opens a configuration table for the selected printer.
COLORS	Opens a submenu for colour settings.
COMMENT SCREEN A / B	Enables the input of a comment for screen A or screen B. Comments will not be displayed but appear only on the hardcopy.
INSTALL PRINTER	Opens a dialog window for installation of a printer (side menu).

In the case of averaged IQ displays such as IQ Constellation and EYE, the trace last measured is output in the hard copy function.

5.12.5 Frequency Settings - FREQ Key

The functions of the softkeys of the *FREQUENCY* menu are identical to those of the corresponding softkeys of the basic unit.

- *CENTER* — Enables the center frequency of the analyzer to be set.
- *CF STEP* — Selects automatic (CF STEP = AUTO) or manual (CF STEP = MAN) step size selection.
  In the automatic mode, the step size is varied by 1/1000 of the selected center frequency. In the manual mode, the step size is varied via the CF STEP SIZE setting parameter.
- *CF STEP SIZE* — Enables selection of the step size for center frequency setting in the manual mode by means of the rotary knob or the navigation keys.
- *FREQUENCY OFFSET* — Adds a numerical offset to the values plotted along the frequency axis without changing the currently selected center frequency. Frequency offsets between -100 GHz and +100 GHz can be added; the default setting is 0 Hz.

5.12.6 Span

The SPAN key has no function with respect to the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

5.12.7 Level Settings - AMPT Key

The *AMP*T key opens a menu for making the settings for the reference level, for control of the RF attenuation at the instrument input, and for selecting the level display unit.

• *REF LEVEL*	Enables input of the reference level. If the reference level is entered manually, care should be taken to avoid analyzer overdrive during IQ data input.
• *REF LEVEL UNIT*	Selects the unit for the reference level.
• *RANGE*	Opens another menu for setting the display scaling. A softkey of identical name and function is also included in the *OPTIONS* menu of the R&S FSQ-K70/FSMR-B73/FSU-B73 option; see section "*Setting of Span - RANGE Softkey*".
• *DISPLAY UNIT*	Opens a submenu for selecting the unit for the displayed trace (dBm, %, rad, deg)
• *RF INPUT AC / DC*	Selects AC or DC coupling for the RF input.
• *RF ATTEN MANUAL*	Enables manual setting of RF attenuation independently of the reference level.
• *RF ATTEN AUTO*	Activates automatic setting of the RF attenuation to an optimal value as a function of the selected reference level.
• *ADJUST REF LVL*	Determines the applied signal level by means of a pre-measurement and sets the reference level of the instrument to an optimal value. A softkey of identical name and function is also included in the *OPTIONS* menu of the R&S FSQ-K70/FSMR-B73/FSU-B73 option.
• *REF LEVEL OFFSET*	Enables the input of a numerical level offset for the displayed trace.
• *MIXER*	Opens a submenu for setting the mixer level.

5.12.8 Selection of Units for Display - DISPLAY UNIT Key

The *DISPLAY UNIT* softkey opens a menu for selecting the units for the values displayed as well as linear or logarithmic display of results.

• *Y UNIT LOG DB*	Selects logarithmic scaling for the display of results and the Y axis.
• *Y UNIT LIN*	Selects linear scaling for the display of results and the Y axis.
• *Y UNIT RAD*	Selects radians (RAD) for the display of the phase or phase error of the measured signal.
• *Y UNIT DEG*	Selects angular degrees (DEG) for the display of the phase or phase error of the measured signal.
• *X UNIT TIME*	Selects seconds (SEC) for the display of time.
• *X UNIT SYMBOL*	Selects symbols (SYM) for the display of time.

5.12.9 Setting of Bandwidth for Analog IF Filter - BW Key

The *BW* key opens a submenu for setting the bandwidth of the analog IF filters.

RES BW MANUAL

Enables manual selection of the filters with nominal bandwidths of 300 kHz, 500 kHz, 1/3/5/10/20/50 MHz (RBW 20 and 50 MHz for R&S FSMR and R&S FSQ only).
For bandwidths ≥ 3 MHz, the amplitude and phase response are corrected up to typically 2/3 of the nominal frequency; within this bandwidth, filter effects on demodulation results can be ignored.
The maximum achievable corrected bandwidth is
for R&S FSQ/FSMR 28 MHz (50 MHz RBW filter),
for R&S FSU 7 MHz (10 MHz RBW filter).
For more information and details regarding the role these filters play in vector signal analysis, refer to chapter "Getting Started/Analog RBW Prefilters" of this manual.
For bandwidths < 3 MHz, amplitude and phase response correction is not performed.
Only max. 10 % of the nominal bandwidth of the filters should be used to avoid the risk of increased measurement errors.
Manual filter selection is recommended if difficult reception conditions prevail, e.g.:
strong signals on adjacent channels,
interference through mixture products and other signals.

RES BW AUTO

Activates the automatic selection of a resolution bandwidth that matches the current instrument settings. Amplitude and phase response are corrected in this case.

5.12.10 Sweep Settings - Sweep Key

Sweep Settings - Sweep Key

- CONTINUOUS SWEEP
- SINGLE SWEEP
- SWEEP COUNT

CONTINUOUS SWEEP

Consecutive test cycles are performed with the current instrument settings. During each cycle, data collection, signal demodulation, and the display of results take place anew.

SINGLE SWEEP

A complete test cycle is performed.
To start a new cycle, the softkey has to be actuated again.
If a parameter is changed after a test cycle, no new data will be collected, but the **old RECORD BUFFER data** will be re-demodulated **with the modified parameterization** and the result re-displayed.

If a parameter change **directly affects data collection** such that no meaningful result will be displayed, a warning message is output; possible parameter changes include:

- Ext. Trigger
- Symbol Rate
- Points / Symbol
- Record Buffer
- Digital Standard

The changed parameter is not taken into account until the next test cycle (next single sweep).

MULTI ON/OFF switches **multiple evaluation mode** on and off. If MULTI ON is selected, a new capture is performed once the end of the record buffer has been reached. Otherwise, the message '**End of Buffer'** will be output.

CAPTURE AUTO / OFF starts automatic data capture if the end of the record buffer has been reached. If *CAPTURE OFF* is selected, data capture will not be started. When the end of the record buffer is reached, the message '**End of Buffer**'will be output. This softkey is available only in MULTI mode in conjunction with SINGLE SWEEP.

DEMOD NEXT RIGHT
DEMOD RESTART
DEMOD @ ZOOM START control demodulation in multiple evaluation mode. These softkeys are available only in MULTI mode in conjunction with SINGLE SWEEP. You can find a detailed description of this control (also for demodulation of burst signals) in the section "*Multiple Evaluation of a Captured Data Record (MULTI)*".

SWEEP COUNT Enables input of the number of sweeps the analyzer will perform after the start of SINGLE SWEEP. If Trace Average, Min or Max Hold is active, this input at the same time defines the number of averages to be taken (see description of *TRACE* menu).

5.12.11 MEAS Key

The *TRIGGER* key opens a menu for selecting a trigger source for the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

5.12.12 Trigger Settings - TRIGGER Key

The *TRIGGER* key opens a menu for selecting a trigger source for the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

FREE RUN Activates a free-running test sequence, i.e. measurements are not started by a trigger, but a measurement is immediately started after the previous one has been completed. *FREE RUN* is the default setting of the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

EXTERN Activates an external TTL trigger signal, which is applied to the EXT TRIGGER /GATE input on the rear of the instrument. The external trigger level can be adjusted in the range from 0.5V to 3.5V. The polarity of the trigger signal can be selected with *POLARITY*.

`Remote: TRIG:LEV 2.1`

IF POWER Activates triggering of the measurement by means of signals located outside the measurement channel. The softkey will be available only if the R&S FSQ-B71 baseband input option is not enabled.

I/Q LEVEL Activates triggering of the measurement by the baseband signal. The trigger threshold can be defined in an input window (in dBm). The softkey will be available only if the R&S FSQ-B73 baseband input option is enabled. (*SETUP-SIGNAL SOURCE - BASEBAND ANALOG*).

TRIGGER OFFSET Used to set a time interval between the trigger event and the start of data collection:

If a **positive trigger offset** is entered, the start of data collection will be delayed relative to the trigger signal.

If a **negative trigger offset** is entered, the start of data collection will be advanced relative to the trigger signal.

POLARITY Selects the polarity of the trigger edge; i.e. data will be collected on the positive (= POS) or the negative (= NEG) edge of the trigger signal.

MEAS ONLY ON BURST
MEAS ONLY ON PATT

Data collection and demodulation are performed in either case, whereas results are displayed only if the demodulated signal contains either a synchronization pattern or constitutes a burst signal. A softkey of identical name and function is included in the *BURST & PATTERN* menu (*BURST & PATTERN* softkey) of the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

5.12.13 Trace Functions - TRACE Key

The *TRACE* key opens a menu for setting the trace functions.

SELECT TRACE selects the trace of the active measurement screen.

The trace **display mode** can be selected as follows:

CLEAR WRITE Overwrite mode; the old trace is deleted after each measurement and overwritten by the new trace.

VIEW The current trace is frozen.

BLANK	The selected trace is blanked.

Weighting of the complete trace is selected as follows:

AVERAGE	The average value is determined.
MAX HOLD	The maximum value is determined.
MIN HOLD	The minimum value is determined.
RMS	The calculation of the RMS value is determined

Export of all active traces is selected as follows:

FILE EXPORT	All active traces are stored
DATA TRACE	Defines the TRACE data type
DATA RAW	The data type RAW DATA is selected. The formats ASCII and WAVEFORM are supported. ***Note:*** *Files saved with format WAVEFORM are loadable by R&S SMU signal generator.*
HEADER	A file header is created or not
DECIM SEP	The decimal separator is selected.
FILE IMPORT	Imports the I/Q RAW data previously stored with FILE EXPORT (DATA RAW, format binary).

Trace averaging

Sweep count setting	**Prior to reaching selected sweep count (n < N)**	**After reaching selected sweep count (n>= N)**
SWEEP COUNT = 0	-	$TRACE_n = \frac{9}{10} * TRACE_{n-1} + \frac{1}{10} * Messkurve_n$
SWEEP COUNT = 1	-	$TRACE_n = Messkurve_n$
SWEEP COUNT > 1	$TRACE_n = \frac{1}{n}\left[\sum_{i=1}^{n-1}(TRACE_i) + Messkurve_n\right]$	$TRACE_n = \frac{N-1}{N} * TRACE_{n-1} + \frac{1}{N} * Messkurve_n$

Invoking the AVERAGE function with IQ displays (e.g. IQ Constellation, EYE) does not result in the averaging of traces but rather displays the current measurement without deleting the displayed measurements (overwrite mode). This setting can be used to check the dispersion of points in the constellation diagram over many sweeps. The hard copy function prints only the last sweep.

5.12.13.1 Trace Export

The file consists of the containing important scaling parameters and a data section containing the trace data. The data of the file header consist of three columns, each separated by a semicolon:

parameter name; numeric value; basic unit.

The data section starts with the keyword " Trace <n> " (<n> = number of stored trace), followed by the measured data in one or several columns (depending on measurement) which are also separated by a semicolon.

The number of measurement values and therefore the size of the output file is determined:

- by parameters RESULT LENGTH, POINT/SYMBOL for trace data
- by parameter RECORD LENGTH for raw data

In particular, storing the I/Q raw data with up to 16 millions samples can take several minutes.

When CAPTURE BUFFER is displayed, the results displayed in the zoom window will be exported.

The format of the stored data can be read in from spreadsheet calculation programs, eg MS-Excel. It is necessary to define ';'as a separator.

The *FILE EXPORT* softkey stores all active traces in a file with ASCII format.

```
Remote: FORM ASC
        MMEM:STOR:TRAC ......
```

The *DATA RAW/* softkey selects the output of the measured raw I/Q data or the trace data.

```
Remote: FORM:DEXP:MODE RAW:FORM ASC | BIN | WAV
```

The *HEADER ON/OFF* softkey defines whether important instrument settings should be stored at the beginning of the file. The instrument model, the version and the date are always transferred.

```
Remote: FORM:DEXP:HEAD OFF
```

The *DECIM SEP* softkey softkey selects the decimal separator for the ASCII file. The choice is '.'(decimal point) or ','(comma). The decimal separator used in various language versions of evaluation programs (e.g. MS-Excel) can be selected so that the packages are supported.

```
Remote: FORM:DEXP:DSEP POIN
```

Since version 4.50 the additional lines "Preamplifier" and "Transducer" are added to the export file.

Since version 4.72 the additional lines "Error Calculation" and " Error Absolute" are added to the export file for Magnitude Error and/or EVM traces.

Example:

	Content of file	Description
File header	`Type;FSQ;`	Instrument model
	`Version;4.55;`	Firmware version
	`Date;08.Jun 2009;`	Date record storage date
	`Mode;VSA;DB1.50`	Instrument operating mode
	`Digital Standard;GSM_NB;`	Digital standard
	`Demodulator;DMSK;`	Demodulation
	`Center Freq;100000000;Hz`	Center frequency
	`Freq Offset;0;Hz`	Frequency offset
	`Ref. Level;-20;dBm`	Reference level
	`Level Offset;0;dB`	Level offset
	`RF Att;5;dB`	Input attenuation
	`El Att;0;dB`	Input attenuation (with option FSU-B25 only)
	`Symbol Rate;270833;Hz`	Symbol rate
	`Transmit Filter;GAUSS;`	Filter settings
	`Receive Filter;NONE;`	
	`Measurement Filter;NONE;`	
	`Raw Data Filter;ON;`	
	`Alpha BT;0.300000;`	
	`Signal;RF Input;`	Signal source
	`Result Length;160;`	Result length
	`Record Length;1500;`	Record buffer length
	`Points per symbol;4;`	Points per symbol
	`x Axis Start;-9.000000;symbols`	Scaling of x-axis
	`x Axis Stop;150.750000;symbols`	
	`y per div;1.000000;deg`	Scaling of y-axis
	`Ref Value y-Axis;0.000000;deg`	
	`Ref Value Position;50.000000;%`	
	`Sweep Count;0;`	Number of sweeps set
	`Preamplifier;OFF;`	Preamplfier state (OFF, if no preamplifier is available)
	`Transducer;OFF;`	Tranducer state (always OFF)
Data part of the file	`Trace;1;`	Trace
	`Screen;A;`	Screen A
Trace 1 / Screen A	`Meas Result;Error;`	Measurement:
	`Meas Signal;Phase;`	Error Signal, Phase Error
	`Demodulator;DMSK;`	
	`ResultMode;Trace;`	Trace mode
	`x Unit;symbols;`	Unit of x and y values
	`y Unit;deg;`	
	`Trace Mode;CLR/WRITE;`	Display mode of trace: CLR/WRITE, AVERAGE, MAXHOLD, MINHOLD
	`Values;640;`	Number of measurement points
	`1.834240`	Measured values::
	`1.662848`	<real>, <imag>
	`.......`	<imag> being available only with Real/Imag, Polar- and Constellation diagrams.
	`-0.127578`	
	`-0.889226`	

Data part of the file Trace 1 / Screen B		
	Trace;1; Screen;B; Meas Result;Meas; Meas Signal;Magnitude; Demodulator;DMSK;	Trace Screen B Measurement: Meas Signal, Magnitude
	ResultMode;Trace; x Unit;symbols; y Unit;deg; Trace Mode;CLR/WRITE; Values;640;	
	0.681856 0.680534 .... 0.682217	

5.12.13.2 Trace Import

Softkey *FILE IMPORT* imports I/Q RAW data previously stored with FILE EXPORT (DATA RAW, format binary).

This softkey is only available, if DATA RAW is selected with format BINARY.

The import of the I/Q RAW data requires the MULTI mode to be active. This mode is automatically switched on with start of the load process. For more details refer to HOME VSA → MEAS RESULT → CAPTURE BUFFER → ZOOM → MULTI.

The VSA base settings (<file_name>.VAV) are loaded first. The I/Q RAW data <file_name>.BIN are loaded in a second step.

Remote: `MMEM:LOAD:TRAC 1,'D:\rawdat'`

5.12.14 Limit Lines Settings - LINES Key

The LINES key has no function with respect to the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

Limit lines are used on the display to mark level characteristics or spectral distributions whose upper and lower limits must not be exceeded. For example, upper and lower limit lines can be set for the tolerance range of a GSM burst, and these limit lines are automatically checked to determine if they have been exceeded.

LINES are not available for the following result and error displays:

- Modulation errors / symbols
- IQ displays (vector and constellation diagram)
- Real/Imag
- Statistic

Softkey operation is identical to the limit lines of the spectrum analyzer.

5.12.15 Screen Configuration - DISP Key

The *DISPLAY* key opens a menu for screen configuration. The functions of the softkeys of the *DISPLAY* menu are largely identical to those of the corresponding softkeys of the basic unit.

FULL SCREEN Selects full-screen display of results, i.e. in a single diagram.
SPLIT SCREEN Selects split-screen display of results, i.e. in two diagrams.

```
Remote: DISP:FORM SING
        DISP:WIND<1|2>:SEL
```

Unlike the spectrum mode of the basic unit, the two screens are **NOT decoupled** from each other in the split screen mode. The traces shown in the two measurement screens are coupled to common IQ data across the *RESULT LENGTH* (width of display), and *FIT TRACE* (positioning of events on the display) likewise acts on both windows.

Exceptions to this rule are the *MAGNITUDE CAPTURE BUFFER* setting and the *MODULATION ERROR* measurement.

MAG CAP BUFFER automatically adapts the width of the active screen to match the complete *RECORD BUFFER*.

Numerical evaluations of the *MODULATION ERROR* screen are specific to the useful part of a burst or to the *EVAL LINES*.

CONFIG DISPLAY Opens a submenu for setting the colours, the brightness and the colour saturation of the display. For detailed information refer to the manual of the basic unit.

5.12.16 File Management - FILE Key

The *FILE* key opens a menu for saving and restoring complete instrument settings plus, for the R&S FSQ-K70/FSMR-B73/FSU-B73 option, standard definitions, user filters and synchronization patterns.

SAVE Saves the current instrument settings.
RECALL Restores the selected instrument setting.

NOTICE

The RECALL function should be used with great care as far as the R&S FSQ-K70/FSMR-B73/FSU-B73 settings are concerned:
Currently selected **standard definitions, user filters and synchronization patterns** will be **overwritten** if a saved version is recalled.
Any current **modifications** made will be lost when the saved version is restored with RECALL.

EDIT COMMENT Opens an input window for adding a comment to the data set to be saved.
ITEMS TO SAVE/RCL Selects the settings to be saved.

DATA SET LIST	Opens a management table for the saved data sets.
STARTUP RECALL	Defines the data set to be automatically loaded on startup of the instrument.
FILE MANAGER	Opens a submenu for storage media and file management.

A detailed description of the above softkeys can be found in the manual of the basic unit.

5.12.17 Marker Settings - MARKER Key

The *MARKER* key opens a menu for marker settings.

Markers are used for marking points of interest on a trace and for defined reading of a trace.

In contrast to the basic unit, the R&S FSQ-K70/FSMR-B73/FSU-B73 option does not allow screen sections to be defined by means of markers.

The measurement screen is in this case exclusively defined by the *RESULT LENGTH* and *FIT TRACE* settings.

The values measured for the active marker are output in the marker field in the upper right screen area.

MARKER 1...4	Selects the active marker.
MARKER NORM/ DELTA	Switches between marker function and delta marker function.
ALL MARKER OFF	Switches off all markers on the screen.
MKR -> TRACE	Sets the active marker to a new trace. The new trace must be visible on the active screen.

5.12.18 Marker Settings (Marker to) - MKR -> Key

The *MKR ->* key opens a menu for finding the maximum and minimum values on a trace.

In the case of the R&S FSQ-K70/FSMR-B73/FSU-B73 option, the active marker does NOT cause a change of the instrument setting.

SELECT MARKER	Selects a desired marker; if that marker was switched off, it will be switched on by this function.
MAX PEAK	Places the marker on the maximum value.
MIN PEAK	Places the marker on the minimum value.
MAX |PEAK|	Places the marker on the maximum absolute value.
MKR -> TRACE	Places the active marker on a selectable active trace.

5.12.19 Marker Functions - MKR FCTN Key

The *MKR FCT* softkey opens a menu with special markers and calculation functions.

The *COMP PT* softkey opens a menu for entering the compression factor needed and displays it within the measurement window.

The default setting is 1 dB.

The compression point of the DUT is determined using two markers in the AM/AM diagram. The markers are horizontally spaced at 10 dB, and both markers are moved along the trace until the vertical spacing is 1 dB. The position of marker {C} indicates the compression point of the DUT.

The compression point and other parameters are displayed in the AM/PM measurement diagram. Scaling of the AM/PM diagram is relative to the unit circle of the constellation diagram. The power of the marker is recalculated to the input power and displayed in dBm.

In addition, the mean power and the crest factor of the reference and measurement signals as well as the difference between the results are calculated and displayed in the lower diagram (see figure).

These values indicate the compression of the mean power or the reduction of the crest factor for the current modulation of the DUT.

If either of the two compression markers exceeds the borders of the diagram, a compression point will not be calculated and output.

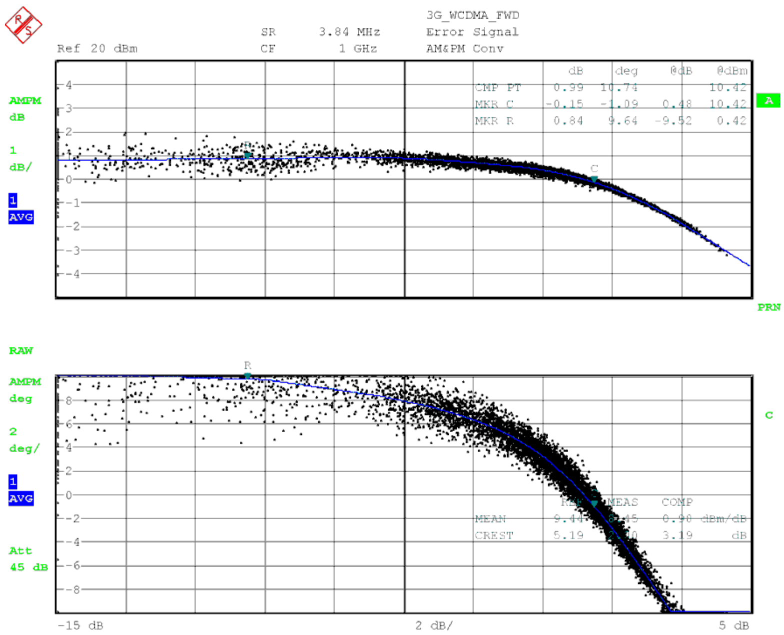


Fig. 241 AM/AM and AM/PM diagram with calculation of the compression point

```
Remote: CALC:MARK:FUN:CPO:STAT ON|OFF
        CALC:MARK:FUN:CPO:VAL <num_val>
        CALC:MARK:FUN:CPO:PHD?
        CALC:MARK:FUN:CPO:POW?
```

5.12.19.1 Menu MKR FCTN - SUMMARY MARKER

The summary marker functions allows several evaluations of a complete trace data set. These evaluation functions can be activated in parallel. The result is displayed in the marker info field.

The measured values are updated after each sweep or averaged over a user-defined number of sweeps (*AVERAGE ON/OFF* and *NUMBER OF SWEEPS*) in order to determine e.g. the mean power over several bursts. For determination of the peak value (*MAX HOLD ON*) the maximum value from several sweeps is displayed.

Example:

Marker info field for: *MEAN* selected, *AVERAGE ON* and *MAX HOLD ON.*

MEAN HOLD	12.03 deg
MEAN AV	11.75 deg

SUM MKR ON/OFF
MAX |PEAK|
+ PEAK
PEAK
+/-PEAK
RMS
MEAN
STANDARD DEVIATION
LIMIT ON/OFF
START LIMIT
STOP LIMIT
MAX HOLD ON/OFF
AVERAGE ON/OFF
NUMBER OF SWEEPS

SUM MKR ON/OFF

The *SUM MKR ON/OFF* softkey switches summary marker on and off. When entering the submenu it is *ON* since the summary marker measurement is already switched on with the SUMMARY MARKER softkey in the main menu.

The measurement is performed on the trace on which marker 1 is placed. To evaluate another trace, marker 1 should be set on another trace using the SELECT TRACE softkey in menu MKR.

```
Remote: CALC:MARK:FUNC:SUMM:MAX ON
        CALC:MARK:FUNC:SUMM:MAX:RES?
        CALC:MARK:FUNC:SUMM:PPE ON
        CALC:MARK:FUNC:SUMM:PPE:RES?
        CALC:MARK:FUNC:SUMM:NPE ON
        CALC:MARK:FUNC:SUMM:NPE:RES?
        CALC:MARK:FUNC:SUMM:MIDD ON
        CALC:MARK:FUNC:SUMM:MIDD:RES?
        CALC:MARK:FUNC:SUMM:RMS ON
        CALC:MARK:FUNC:SUMM:RMS:RES?
        CALC:MARK:FUNC:SUMM:MEAN ON
        CALC:MARK:FUNC:SUMM:MEAN:RES?
        CALC:MARK:FUNC:SUMM:SDEV ON
        CALC:MARK:FUNC:SUMM:SDEV:RES?
```

MAX |PEAK|

The *MAX |PEAK|* softkey switches on the calculation of the absolute peak value from the points of the displayed trace or a segment thereof.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:MAX ON
        CALC:MARK:FUNC:SUMM:MAX:RES?
```

+ PEAK

The *PEAK* softkey switches on the calculation of the positive peak value from the points of the displayed trace or a segment thereof.

For the positive peak, the largest positive peak value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the peak values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:PPE ON
        CALC:MARK:FUNC:SUMM:PPE:RES?
```

PEAK

The *PEAK* softkey switches on the calculation of the negative peak value from the points of the displayed trace or a segment thereof.
For the negative peak, the largest negative peak value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the peak values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:NPE ON
        CALC:MARK:FUNC:SUMM:NPE:RES?
```

+/-PEAK

The *PEAK* softkey switches on the calculation of the mean peak value from the points of the displayed trace or a segment thereof.

For the maximum mean peak, the largest mean peak value obtained since the activation of *MAX HOLD ON* is displayed. For the maximum mean peak, the largest mean peak value obtained since the activation of *MAX HOLD ON* is displayed. With *AVERAGE ON*, the peak values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:MIDD ON
        CALC:MARK:FUNC:SUMM:MIDD:RES?
```

RMS

The *RMS* softkey switches on the calculation of the rms value from the points of the displayed trace or a segment of it.

For the maximum peak, the largest rms value obtained since the activation of *MAX HOLD ON* is displayed. With *AVERAGE ON*, the rms values of a trace are averaged over several sweeps and displayed.
The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:RMS ON
        CALC:MARK:FUNC:SUMM:RMS:RES?
```

MEAN

The *MEAN* softkey switches on the calculation of the mean value from the points of the displayed trace or a segment of it. The linear mean value of the equivalent voltages is calculated.

For the maximum peak, the largest mean value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the mean values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:MEAN ON
        CALC:MARK:FUNC:SUMM:MEAN:RES?
```

STANDARD DEVIATION

The *STANDARD DEVIATION* softkey switches on the calculation of the standard deviation of trace points from the mean value and outputs them as measured value. The measurement of the mean power is automatically switched on at the same time.

For the maximum peak, the largest standard deviation obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the standard deviations of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

```
Remote: CALC:MARK:FUNC:SUMM:SDEV ON
        CALC:MARK:FUNC:SUMM:SDEV:RES?
```

LIMIT ON/OFF

The *LIMIT ON/OFF* softkey selects the limited (*ON*) or non-limited (*OFF*) evaluation range.

The evaluation range is defined by the *START LIMIT* and *STOP LIMIT* softkeys. If *LIMIT = ON*, signals are only searched between the two lines.

If only one limit line is switched on, time line 1 is the lower limit and the upper limit corresponds to the end of grid. If time line 2 is also switched on, it defines the upper limit.

In addition, the default position is limited to the eval range, defined by the position of the eval lines 1 and 2. This is usefull for bursted signals, where the usefull part of the burst is defined by the eval line position.

If no limit line is switched on, the evaluation range is not limited.

The default setting is *LIMIT = OFF*.

`Remote: CALC:MARK:X:SLIM OFF`

START LIMIT

The *START LIMIT* softkey activates the entry of the lower limit of the evaluation range.

`Remote: CALC:MARK:X:SLIM:LEFT <value>`

STOP LIMIT

The *STOP LIMIT* softkey activates the entry of the upper limit of the evaluation range.

`Remote: CALC:MARK:X:SLIM:RIGH <value>`

MAX HOLD ON/OFF

The *MAX HOLD ON/OFF* softkey switches the display of the maximum peak obtained from measurements at successive sweeps on and off.

The displayed maximum peak is only updated at the end of a sweep if a higher value has occurred.

The maximum value can be reset by switching the *MAX HOLD ON / OFF* softkey off and on again.

```
Remote: CALC:MARK:FUNC:SUMM:PHOL ON
        CALC:MARK:FUNC:SUMM:MAX:PHOL:RES?
        CALC:MARK:FUNC:SUMM:PPE:PHOL:RES?
        CALC:MARK:FUNC:SUMM:NPE:PHOL:RES?
        CALC:MARK:FUNC:SUMM:MIDD:PHOL:RES?
        CALC:MARK:FUNC:SUMM:RMS:PHOL:RES?
        CALC:MARK:FUNC:SUMM:MEAN:PHOL:RES?
        CALC:MARK:FUNC:SUMM:SDEV:PHOL:RES?
```

AVERAGE ON/OFF

The *AVERAGE ON/OFF* softkey switches averaging over successive sweep measurements on and off.

The measured values can be reset by switching the *AVERAGE ON / OFF* softkey off and on again.

```
Remote: CALC:MARK:FUNC:SUMM:AVER ON
        CALC:MARK:FUNC:SUMM:MAX:AVER:RES?
        CALC:MARK:FUNC:SUMM:PPE:AVER:RES?
        CALC:MARK:FUNC:SUMM:NPE:AVER:RES?
        CALC:MARK:FUNC:SUMM:RMS:AVER:RES?
        CALC:MARK:FUNC:SUMM:MIDD:AVER:RES?
        CALC:MARK:FUNC:SUMM:MEAN:AVER:RES?
        CALC:MARK:FUNC:SUMM:SDEV:AVER:RES?
```

NUMBER OF SWEEPS

The *NUMBER OF SWEEPS* softkey activates the entry of the number of sweeps for maximum or average value calculation.

SINGLE SWEEP mode	The R&S FSQ/FSMR/FSU performs measurements until the selected number of sweeps is reached and stops then.
CONTINUOUS SWEEP mode	Averaging is carried out until the selected number of sweeps is reached. After that, averaging is performed in continuous mode. and is then continued as running averaging. Calculation of the maximum peak (*MAX HOLD*) is performed continuously irrespective of the selected number of sweeps.

The valid range values is 0 to 32767.
Depending on the specified number of sweeps, averaging is carried out according to the following rules:

- *NUMBER OF SWEEPS* = 0 — Continuous averaging is carried out over 10 measured values.
- *NUMBER OF SWEEPS* = 1 — No averaging is carried out.
- *NUMBER OF SWEEPS* > 1 — Averaging is carried out over the set number of measured values.

This setting is equivalent to the setting of the sweep count in the TRACE menu

```
Remote: SWE:COUN <value>
```

5.13 Troubleshooting

Based on measurement examples, this chapter provides information on how to identify possible sources of error or incorrect instrument settings in the event that measurement results appear unlikely.

5.13.1 Different Symbol Rate Setting in Transmitter and Analyzer

Even very slight discrepancies between the transmitter and the receiver symbol rate will produce an increase of the displayed EVM. This manifests itself by a V-shaped characteristic of the EVM as a function of time. The following two diagrams show the EVM when the symbol rate setting is identical (Fig. 242) and with a deviation of only 0.005% of the symbol rate (Fig. 243). The effect is explained by the decision points of the measurement signal "drifting away" over the demodulation range: optimum matching in the displayed measurement is achieved only at the center of the demodulation range.

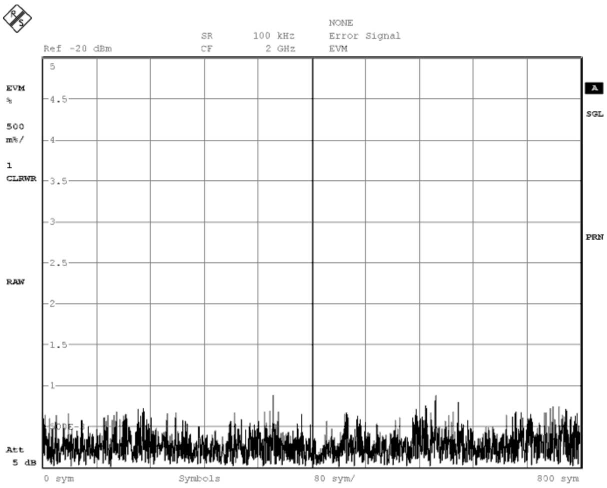


Fig. 242 Displayed EVM with correct setting of the symbol rate

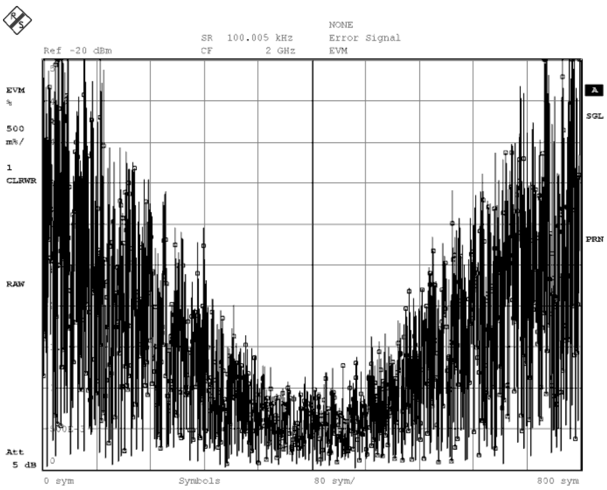


Fig. 243 Displayed EVM with incorrect setting of the symbol rate

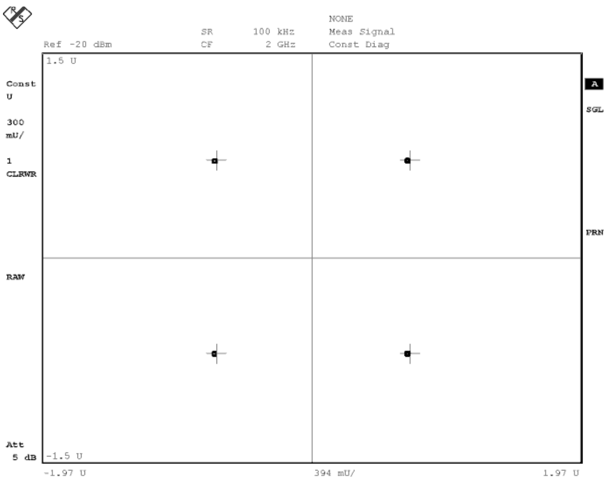


Fig. 244 Constellation diagram with correct setting of the symbol rate

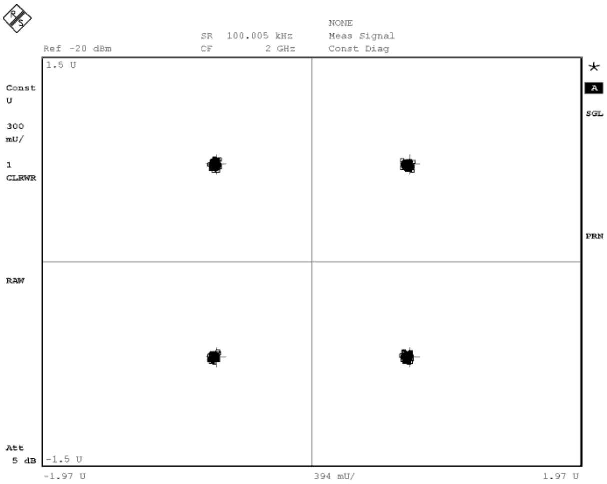


Fig. 245 Constellation diagram with incorrect setting of the symbol rate

5.13.2 Different Filter Settings in Transmitter and Analyzer

The type of receive filter (e.g. raised cosine) and the ALFA/BT bandwidth parameter settings in the analyzer must exactly agree with the settings in the transmitter. In this case, too, even very slight discrepancies have a strong impact on the displayed errors.

In the following example, a root raised cosine was used as the transmit and receive filter, the bandwidth factor ALFA/BT = 0.22 was set in the transmitter, and ALFA/BT = 0.25 was set in the analyzer. Although the illustrated effect causes only a slight increase in the EVM at the decision points (Fig. 246 and Fig. 247 bottom), the spectral analysis of the error signal already shows a noticeable increase at the edge of the spectrum, while the spectrum is nearly flat at the correct filter setting (Fig. 248 and Fig. 249).

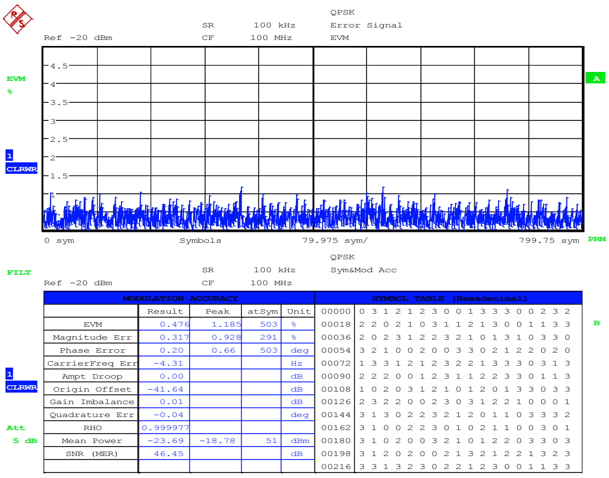


Fig. 246 Displayed EVM with correct filter settings (decision points only)

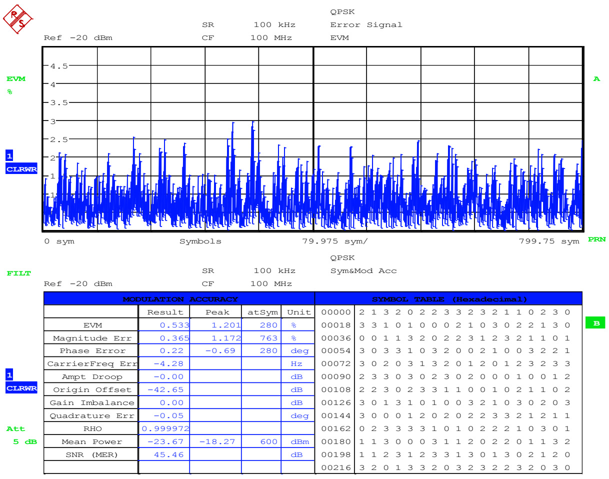


Fig. 247 Displayed EVM with different filter settings (decision points only)

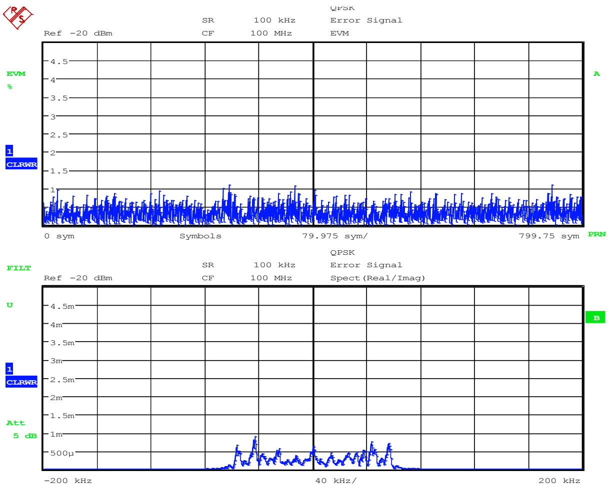


Fig. 248 Displayed error spectrum with correct filter settings

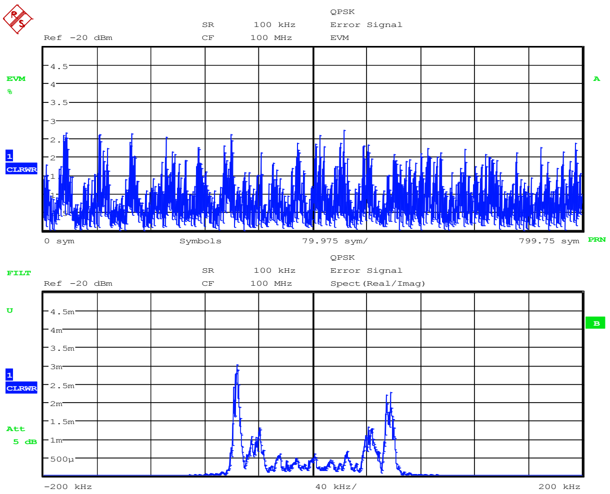


Fig. 249 Displayed error spectrum with different filter settings

5.13.3 Incorrect Modulation of Analyzer

In the event of a poor signal-to-noise ratio, for example in the presence of a weak input signal, the measured modulation error will considerably increase. The diagrams below are an example of this, showing the measured error for a strongly reduced input signal level (approx. 60 dB below reference signal level). The statistical distribution of the Magnitude Error at the decision points provides information on the noise structure of the interfering signal.

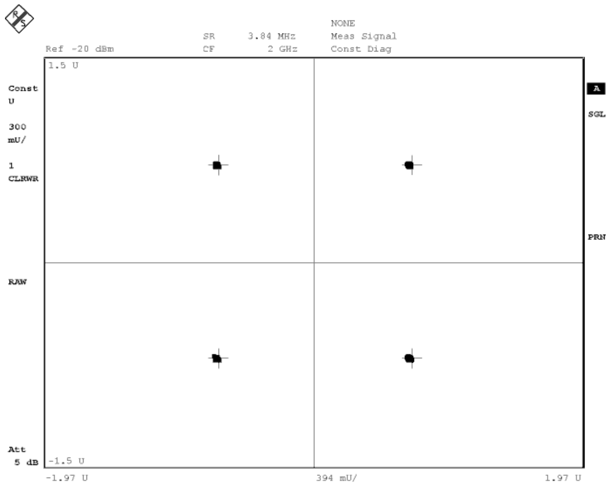


Fig. 250 Constellation diagram with correct modulation

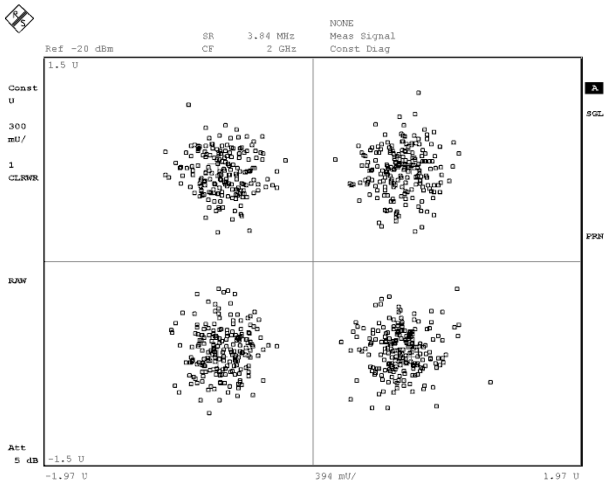


Fig. 251 Constellation diagram with superimposed noise in the event of underdrive

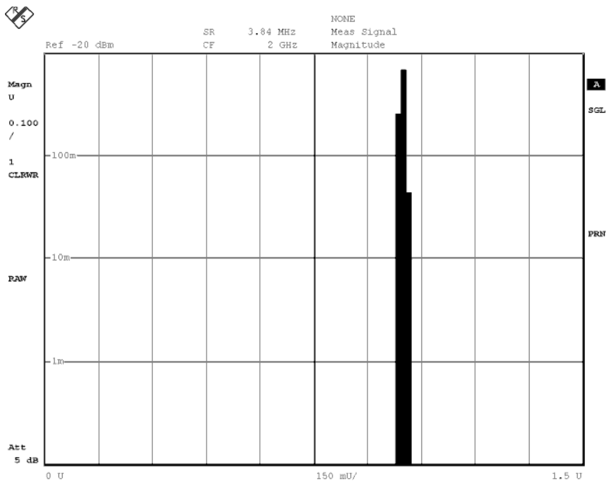


Fig. 252 Statistical distribution of magnitude error with correct modulation

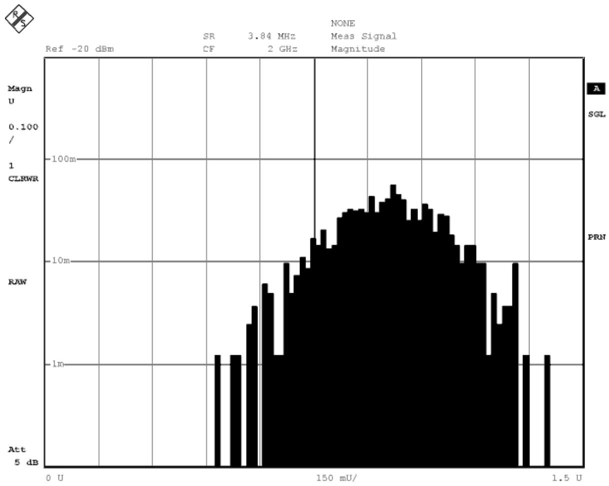


Fig. 253 Statistical distribution of magnitude error in the event of underdrive

5.13.4 Overdrive Condition of the Analyzer

Overdrive of the instrument is signalled by a message on the display and must in any case be avoided. When the unit is driven with input signals approx. 2 dB to 3 dB above the set reference level, clipping will start in the A/D converter in the analyzer measurement path.

Clipping is typically indicated by short-term sharp increases of the displayed EVM and by instability of the phase error in the AM/PM conversion diagram in the upper level range (reference level > 0 dB). Examples of this are shown in the figures below. The actual trace in the AM/PM conversion diagram fluctuates between the two extreme conditions shown below.

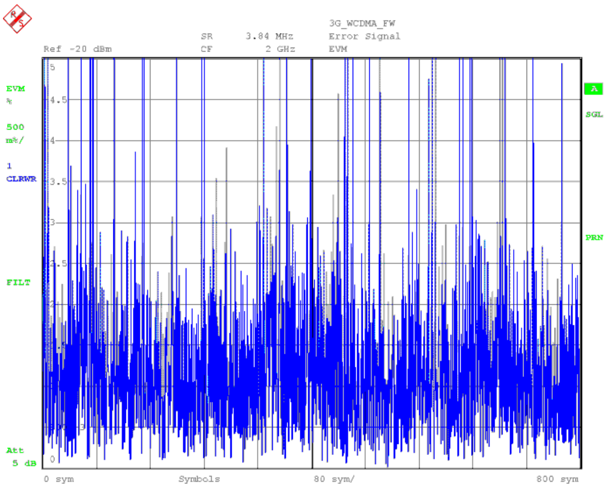


Fig. 254 Displayed EVM with overdrive condition

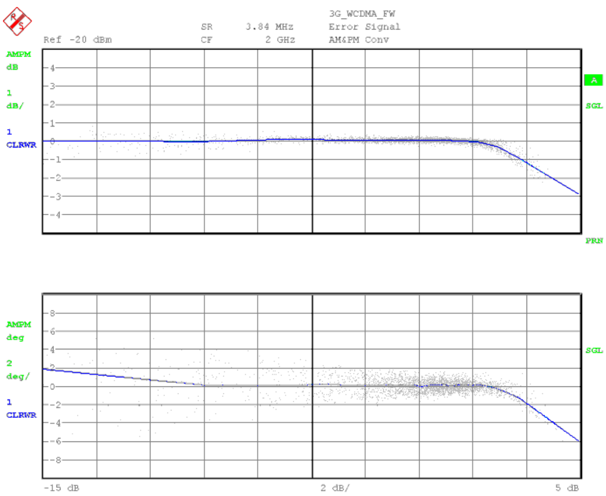


Fig. 255 Possible AM/PM conversion diagram with overdrive condition

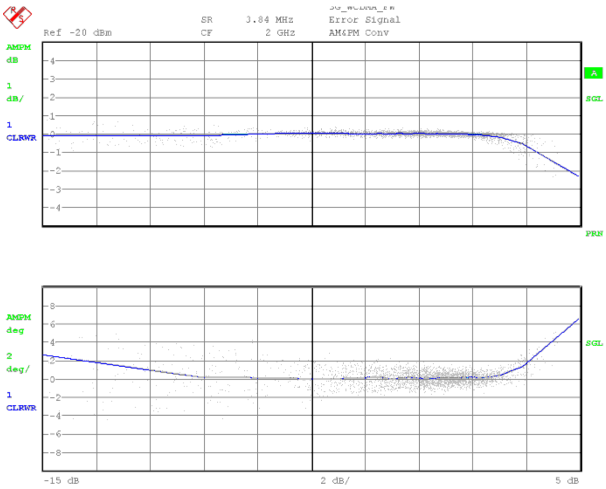


Fig. 256 Possible AM/PM conversion diagram with overdrive condition

6 Remote: Control Commands

In the following sections, the commands for the operating mode Vector Signal Analysis (VSA), Option R&S FSQ-K70/FSMR-B73/FSU-B73, are first listed in a table according to the command subsystem and then described in detail. For the most part, the notation used complies with SCPI specifications. The SCPI conformance information is part of the command description.

The commands for the Analyzer R&S FSQ/FSU/FSUP/FSG or Measuring Receiver R&S FSMR are provided in the manual for the basic unit. The table in which the softkey is assigned to the IEC/IEEE bus command lists all commands that are required to execute this function. The table also includes the commands that are valid in the basic unit for other operating modes.

CALCulate - Subsystem
DISPlay - Subsystem
FORMat -Subsystem
INSTrument - Subsystem
MMEMory - Subsystem
SENSe - Subsystem
TRACe – Subsystem
TRIGger - Subsystem

6.1 CALCulate - Subsystem

CALCulate:DDEM - Subsystem
CALCulate:FEED - Subsystem
CALCulate:FORMat - Subsystem
CALCulate:ELIN - Subsystem
CALCulate:MARKer:FUNCtion Subsystem
CALCulate:STATistics - Subsystem
CALCulate:TRACe - Subsystem
CALCulate:UNIT - Subsystem

The CALCulate subsystem contains commands for converting instrument data, transforming and carrying out corrections. These functions are carried out subsequent to data acquistion, i.e. following the SENSe subsystem.

he numeric suffix is used in CALCulate to make the distinction between the two measurement windows SCREEN A and SCREEN B:

- CALCulate1 = Screen A
- CALCulate2 = Screen B.

The vector signal analysis mode additionally includes the suffixes 3 and 4 in the case of CALCulate. Thus, a distinction is made between SCREEN C and SCREEN D:

- CALCulate3 = Screen C
- CALCulate4 = Screen D.

For commands without suffix, screen A is selected automatically.

- Full Screen — The settings are valid for the measurement window selected with the numeric suffix. They become effective as soon as the corresponding measurement window has been selected as active measurement window using the command `DISPlay[:WINDow<1|2>]:SELect`. Triggering measurements and querying measured values is possible only in the active measurement window.
- Split Screen — The settings are valid for the measurement window selected by means of the numeric suffix and become effective immediately.

6.1.1 CALCulate:DDEM - Subsystem

CALCulate<1|2>:DDEM:SPECtrum[:STATe]

This command switches the set result display to a spectral evaluation of the result parameter. Spectral evaluation is possible for the following result parameters:

Magnitude (`:CALCulate<1|2>:FORMat MAGNitude`)

Phase (`:CALCulate<1|2>:FORMat PHASe | UPHase`)

Frequency (`:CALCulate<1|2>:FORMat FREQuency`,
MSK and FSK modulation only)

Real/Imag (`:CALCulate<1|2>:FORMat RIMag`)

Parameter

ON | OFF

Example

```
CALC:FEED 'XTIM:DDEM:MEAS'
'Selects the display of the  measurement signal
CALC:FORM PHAS
'Selects the display of the phase
CALC:DDEM:SPEC:STAT ON
'Selects the display of the spectral distribution of the
'phase
```

Characteristics

*RST value: OFF
SCPI: device-specific

6.1.2 CALCulate:FEED - Subsystem

The CALCulate:FEED subsystem selects the type of evaluation for the measured data. This corresponds to the selection of the result display in manual operation.

CALCulate<1|2>:FEED <string>

This command selects the measured data to be displayed.

Parameters for Option R&S FSQ-K70/FSMR-B73/FSU-B73:

‘XTIM:DDEM:MEAS’	Result display of measurement signal (synchronized to symbol clock)
‘XTIM:DDEM:REF’	Result display of reference signal (internally generated from demodulated measurement signal)
‘XTIM:DDEM:ERR:MPH’	Result display of error signal (magnitude and phase error)
‘XTIM:DDEM:ERR:VECT’	Result display of vector error signal
‘XTIM:DDEMod:IMP‘	Result display of equalizer for magnitude, phase and real/imag
‘XFR:DDEMod:RAT‘	Result display of equalizer for phase and frequency response
‘XFR:DDEMod:IRAT‘	Result display of equalizer for channel response
‘XTIM:DDEM:SYMB’	Symbol table (demodulated bits and table with modulation errors)
‘TCAP’	Result display of measurement signal in capture buffer

Example

```
CALC:FEED ‘XTIM:DDEM:ERR:VECT’
'Selects the display of the vector error signal.
```

Characteristics

*RST value: ‘XTIM:DDEM:MEAS’

SCPI: conforming

6.1.3 CALCulate:FORMat - Subsystem

The CALCulate:FORMat subsystem determines the postprocessing and conversion of measured data. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

The subsystem is available only in the operating mode Vector Signal Analysis with Option FSQ-K70.

CALCulate<1|2>:FORMat
CALCulate<1|2>:FSK:DEViation:REFerence
CALCulate<1|2>:FSK:DEViation:COMPensation

CALCulate<1|2>:FORMat

This command defines the display of traces.

Parameter

The availability of the parameters depends on the setting under CALCulate:FEED:

MAGNitude	Display of magnitude over time.
PHASe | UPHase	Display of phase over time with or without ("unwrapped"). Limitation to ±180°
RIMag	Display of inphase or quadrature component over time.
FREQuency	Display of frequency over time.
COMP	Display of polar vector diagram (complex).
CONS	Display of polar vector diagram (constellation)
GEDelay	Display of equalizer data as group delay

Can be set if the measurement signal (MEAS SIGNAL) and the reference signal is displayed (REFERENCE SIGNAL).

IEYE | QEYE	Eye diagram of inphase and quadrature component.

Can be set if the modulation error (ERROR SIGNAL) is displayed.

CONVersion	Display of AM & PM conversion

Example

```
CALC:FORM CONS
```

Characteristics:

*RST value: MAGNitude

SCPI: conforming

CALCulate<1|2>:FSK:DEViation:COMPensation

This command selects the method for calculating the frequency error for FSK modulation.

Parameter:

ON Scales the reference signal to the actual deviation of the measurement signal.

OFF Uses the entered nominal deviation for the reference signal

Example

```
CALC:FSK:DEV:COMP ON
```

Characteristics:

*RST value: OFF

SCPI: device-specific

This command is only available for FSK modulation.

CALCulate<1|2>:FSK:DEViation:REFerence

This command defines the reference value of the frequency deviation for FSK modulation.

Parameter

<numeric_value>

Example

```
CALC:FSK:DEV:REF 20kHz
```

Characteristics:

*RST value: -

SCPI: device-specific

6.1.4 CALCulate:ELIN - Subsystem

The CALCulate:ELIN subsystem determines the evaluation range. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

CALCulate<1|2>:ELIN<1|2>

This command defines the position of the evaluation line in the diagram. The evaluation line limits the evaluation range for numeric parameters.

Parameter

<numeric_value>

Example

`CALC:ELIN 5SYM`

Characteristics

*RST value: - (STATe auf OFF)

SCPI: device-specific

CALCulate<1|2>:ELIN<1|2>:STATe

The command switches both evaluation lines on or off. The suffix under ELIN is irrelevant.

Parameter

ON | OFF

Example

`CALC:ELIN:STAT OFF'Switches the evaluation line off.`

Characteristics

*RST value: OFF

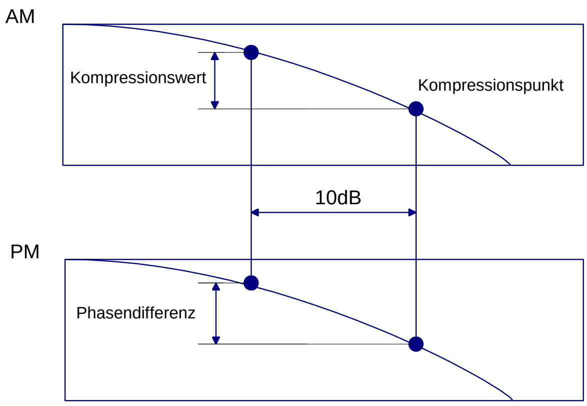
SCPI: device-specific

6.1.5 CALCulate:MARKer:FUNCtion Subsystem

The CALCulate:MARKer:FUNCtion subsystem includes the marker functions for Option R&S FSQ-K70/FSMR-B73/FSU-B73.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint[:STATe]

This command activates compression point measurement. Compression points can be measured only in the AM/PM diagram.



The compression value is set with `CALC:MARK:FUNC:CPO:VAL`.
The compression point is queried with `CALC:MARK:FUNC:CPO:POW?`.
The phase difference is queried with `CALC:MARK:FUNC:CPO:PHD?`.

Parameter

ON | OFF

Example

```
CALC:MARK:FUNC:CPO ON
'activates compression point measurement
```

Characteristics:

*RST value: OFF

SCPI: device-specific

The numeric suffix for MARKer has no meaning with this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:VALue

This command defines the compression value of the compression point measurement.

Example

```
CALC:MARK:FUNC:CPO:VAL 3
'sets the compression value to 3 dB
```

Characteristics:

*RST value: 1dB

SCPI: device-specific

The numeric suffix for MARKer has no meaning with this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:PHDiff?

This command queries the phase shift in the compression point measurement.

Example

```
INIT:CONT OFF              'switches to Single Sweep mode
CALC:MARK:FUNC:CPO:VAL 3   'sets the compression point to 3 dB
CALC:MARK:FUNC:CPO ON      'activates compression point
                           'measurement
INIT;*WAI                  'starts a sweep and waits for the
                           'end
CALC:MARK:FUNC:CPO:PHD?    'outputs the result for phase
                           'difference
```

Characteristics:

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value. The numeric suffix for MARKer has no meaning with this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:POWer?

This command queries the phase shift in the compression point measurement.

Example

```
INIT:CONT OFF
'switches to Single Sweep mode
CALC:MARK:FUNC:CPO:VAL 3
'sets the compression point to 3 dB
CALC:MARK:FUNC:CPO ON
'activates compression point measurement
INIT;*WAI
'starts a sweep and waits for the end
CALC:MARK:FUNC:CPO:POW?
'starts a sweep and waits for the end
```

Characteristics:

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value. The numeric suffix for MARKer has no meaning with this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:DATA?

This command queries the other results in the compression point measurement. Six results are returned for this command.

<Ref Mean Pwr>, <Meas Mean Pwr>, <Cmp Mean Pwr>, <Ref Crest>, <Meas Crest>, <Cmp Crest>, <reserviert1>, <reserviert2>

Parameter

Ref Mean Pwr:	Theoretical power of the ref signal + additional gain from AM/PM diagr.
Meas Mean Pwr:	Measured mean power
Cmp Mean Pwr:	Power loss at current modulation
Ref Crest:	Crest factor of the ideal signal
Meas Crest:	Crest factor of the measured signal at current modulation
Cmp Crest:	Difference of the crest factors
<reserved1|2>	reserved for expansion

Example

```
"INIT:CONT OFF"           'switches to Single Sweep mode
"CALC:MARK:FUNC:CPO:VAL 3"   'sets compression value to 3 dB
"CALC:MARK:FUNC:CPO ON"   'activates compression point
                          'measurement
"INIT;*WAI"               'starts a sweep and waits for the
                          'end
"CALC:MARK:FUNC:CPO:DATA?" 'query of results
```

Characteristics:

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value. The numeric suffix for MARKer has no meaning with this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEMod:RESult?

This command queries the results of the error measurement carried out for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC) in manual operation. Marker values can be read with the `CALCulate<1|2>:MARKer<1...4>:Y?` command; trace data with the `TRACe[:DATA` command.

Parameter

MERM	Magnitude error in %rms	FERR	Frequency error in Hz.
MEPK	Magnitude error maximum in %pk	FEPK	Frequency error maximum in Hz.
MEPS	Symbol number for which the magnitude error maximum has occurred.	ADR	Amplitude droop in dB/symbol.
PERM	Phase error in deg.	RHO	Rho-Factor
PEPK	Phase error maximum in deg.		
PEPS	Symbol number for which the	DEV	FSK deviation in Hz.

	dphase error maximum has occurred.		
EVRM	Vector error in %rms.	FSRM	FSK deviation error in Hz.
EVPK	Vector error maximum in %pk.	FSPK	FSK deviation error maximum in Hz.
EVPS	Symbol number for which the vector error maximum has occurred.	FSPS	Symbol number for which the error maximum has occurred.
IQOF	I/Q offset error in %.	DTTS	Trigger delay to sync seq.
IQIM	I/Q imbalance in %		

Important: *This command is available only to ensure compatibility with the R&S FSE and will no longer be supported in later versions. Use the new commands under CALC:MARK:FUNC:DDEM:STAT*

Example

```
CALC:MARK:FUNC:DDEM:RES? EVRM     'Queries the vector error in
                                  '%rms
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.
The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:ADRoop?

This command queries the results of the amplitude droop error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Amplitude droop in dB/symbol.
RMS	Amplitude droop in dB/symbol, evaluating the rms over several sweeps.
AVG	Amplitude droop in dB/symbol, evaluating the linear average value over several sweep
SDEV	Standard deviation of amplitude droop

Example

```
CALC:MARK:FUNC:DDEM:STAT:ADR?
'Queries the amplitude droop
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:CFERror?

This command queries the results of the carrier frequency error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Frequency error in Hz.
RMS	Frequency error in Hz, evaluating the rms over several sweeps.
AVG	Frequency error in Hz, evaluating the linear average value over several sweeps
SDEV	Standard deviation of frequency error maximum
TPEak	Extreme value of all frequency error maxima

Example

```
CALC:MARK:FUNC:DDEM:STAT:CFER?
'Queries the frequency error
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:DTTStart?

This command queries the results of the trigger delay having an effect on the sync sequence of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Trigger delay in s
RMS	Trigger delay in s, evaluating the rms over several sweeps.
AVG	Trigger delay in s, evaluating the linear average value over several sweeps
SDEV	Standard deviation of trigger delay

Example

```
CALC:MARK:FUNC:DDEM:STAT:DTTS?  'Trigger delay
```

Characteristics:

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:EVM?

This command queries the results of the error vector magnitude measurement of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Vector error in %rms
PEAK	Vector error maximum in %pk
ASYM	Symbol number for which the vector error maximum has occurred.
RMS	Vector error in %, evaluating the rms over several sweeps
AVG	Vector error in %, evaluating the linear average value over several sweeps
SDEV	Standard deviation of vector error in %
PCTL	95% of cumulative distribution function
TPEak	Extreme value of all vector error maxima

For FSK demodulation, this command is not available.

Example

```
DDEM:FORM MSK
'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:EVM?
'Queries the error vector magnitude
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:FSK:CFDRift?

This command queries the results of the frequency error maximum of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Frequency error maximum in Hz.
RMS	Frequency error maximum in Hz, evaluating the rms over several sweeps.
AVG	Frequency error maximum in Hz, evaluating the linear average value over several sweeps.
SDEV	Standard deviation of frequency error maximum

This command is only available for FSK demodulation.

Example

```
DDEM:FORM FSK
 'Modulation mode FSK
CALC:MARK:FUNC:DDEM:STAT:FSK:CFDR?
'Frequency error maximum
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:FSK:DERRor?

This command queries the results of the FSK deviation error of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	FSK deviation error in Hz
PEAK	FSK deviation error maximum in Hz
ASYM	Symbol number for which the maximum has occurred
RMS	FSK deviation error in Hz, evaluating the rms over several sweeps
AVG	FSK deviation error in Hz, evaluating the linear average value over several sweeps.
SDEV	Standard deviation of FSK deviation error
TPEak	Extreme value of all FSK deviation errors

This command is only available for FSK demodulation.

Example

```
DDEM:FORM FSK
'Modulation mode FSK
CALC:MARK:FUNC:DDEM:STAT:FSK:DERR?
'Queries the FSK deviation error
```

Characteristics

*RST value: -SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:FSK:MDEViation?

This command queries the results of the FSK deviation of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	FSK deviation in Hz
RMS	FSK deviation in Hz, evaluating the rms over several sweeps.
AVG	FSK deviation in Hz, evaluating the linear average value over several sweeps
SDEV	Standard deviation of FSK deviation

This command is only available for FSK demodulation.

Example

```
DDEM:FORM FSK
'Modulation mode FSK
CALC:MARK:FUNC:DDEM:STAT:FSK:MDEV?
'FSK Hub
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:GIMBalance?

This command queries the results of the Gain Imbalance error measurement of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Gain Imbalance imbalance in %
RMS	Gain Imbalance in %, evaluating the rms over several sweeps
AVG	Gain Imbalance in %, evaluating the linear average value over several sweeps.
SDEV	Gain Imbalance in %, evaluating the linear average value over several sweeps

For FSK demodulation, this command is not available.

Example

```
DDEM:FORM MSK
'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:GIMB?
'Queries the Gain Imbalance error
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:IQIMbalance?

This command queries the results of the I/Q imbalance error measurement of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	I/Q imbalance in %
RMS	I/Q imbalance in %, evaluating the rms over several sweeps
AVG	I/Q Imbalance in %, evaluating the linear average value over several sweeps
SDEV	Standard deviation of I/Q imbalance

For FSK demodulation, this command is not available.

Example

```
DDEM:FORM MSK                  'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:IQIM? 'Queries the imbalance error
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:MERRor?

This command queries the results of the magnitude error measurement of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Magnitude error in %rms
PEAK	Magnitude error maximum in %pk
ASYM	Symbol number for which the magnitude error maximum has occurred.
RMS	Magnitude error in %, evaluating the rms over several sweeps.
AVG	Magnitude error in %, evaluating the linear average value over several sweeps.
SDEV	Standard deviation of magnitude error in %
TPEak	Extreme value of all magnitude error maxima

Example

```
CALC:MARK:FUNC:DDEM:STAT:MERR? PEAK
'Queries the magnitude error maximum
```

Characteristics

*RST value:

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:MPOWer?

This command queries the results of the power measurement of digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC)

Parameter

<none>	Power in dBm
PEAK	Power maximum in dBm
ASYM	Symbol number for which the power maximum has occurred
RMS	Power in dBm, evaluating the rms over several sweeps
AVG	Power in dBm, evaluating the linear average value over several sweeps
SDEV	Standard deviation of power in dBm
TPEak	Extreme value of all power maxima

Example

```
CALC:MARK:FUNC:DDEM:STAT:MPOW? PEAK
'queries the power maximum
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:OOFFset?

This command queries the results of the origin offset error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC). This command is not available for FSK demodulation.

<none>	Offset error in dB
RMS	Offset error in dB, evaluating the rms over several sweeps
AVG	Offset error in dB, evaluating the linear average value over several sweeps
SDEV	Standard deviation of offset error

Important: *The IQ offset was calculated instead of the origin offset for the R&S FSE. The interrelation between the origin offset and the IQ offset is as follows: Origin-Offset = 20 * log(IQ-Offset)*

Example

```
DDEM:FORM MSK
'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:OOFF?
'Queries the origin offset error
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:PERRor?

This command queries the results of the phase error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC)

Parameter

none>	Phase error in deg
PEAK	Phase error maximum in deg
ASYM	Symbol number for which the phase error maximum has occurred
RMS	Phase error in deg, evaluating the rms over several sweeps
AVG	Phase error in deg, evaluating the linear average value over several sweeps.
SDEV	Standard deviation of phase error in deg
TPEak	Extreme value of all phase error maxima

For FSK demodulation, this command is not available.

Example

```
DDEM:FORM MSK                    'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:PERR?  'Queries the phase error
```

Characteristics:

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:PLERror?

This command queries the results of the pilot level error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Pilot level error
RMS	Pilot level error, evaluating the rms over several sweeps
AVG	Pilot level error, evaluating the linear average value over several sweeps
SDEV	Standard deviation of pilot level error

This command is only available for VSB demodulation.

Example

```
DDEM:FORM VSB                    'Modulation mode VSB
CALC:MARK:FUNC:DDEM:STAT:PLER?  'Queries the pilot 'level
                                 'error
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:QERRor?

This command queries the results of the Quadratur error measurement performed for digital demodulation. The output values are the same values as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none>	Quadrature Error Imbalance in %
RMS	Quadrature Error Imbalance in %, evaluating the rms over several sweeps
AVG	Quadrature Error Imbalance in %, evaluating the linear average value over several sweeps
SDEV	Standard deviation of Quadrature error

For FSK demodulation, this command is not available!

Example

```
DDEM:FORM MSK
'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:QERR?
'Queries the Quadratur error
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:DDEM:STATistic:RHO?

This command queries the results of the RHo factor error measurement performed for digital demodulation. The output values are the same as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none> Rho facto

RMS Rho factor, evaluating the rms over several sweeps

AVG Rho factor, evaluating the linear average value over several sweeps

SDEV Standard deviation of Rho factor

For FSK demodulation, this command is not available.

Example

```
DDEM:FORM MSK
'Modulation mode MSK
CALC:MARK:FUNC:DDEM:STAT:RHO?
'Queries the RHO factor
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:STATistic:SNR?

This command queries the results of the SNR error measurement performed for digital demodulation. The output values are the same as those offered when selecting modulation accuracy (softkey SYMBOLS & MOD ACC).

Parameter

<none> SNR value

RMS SNR value, evaluating the rms over several sweeps

AVG SNR value, evaluating the linear average value over several sweeps

SDEV Standard deviation of SNR value

For FSK demodulation, this command is not available!

Example

```
DDEM:FORM MSK
'Modulation mode MSK
ALC:MARK:FUNC:DDEM:STAT:SNR?
'Queries the SNT value
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffixes under CALCulate and MARKer are irrelevant for this command.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary[:STATe]

This command switches on or off the summary marker function. Thus one or several measurements can be first selected and then switched on and off together with `CALC:MARK:FUNC:SUMMary:STATe`. The function is independent of the marker selection, i.e. the suffix of MARKer is irrelevant. It is only available in the time domain (span = 0).

Parameter

ON | OFF

Example

`CALC:MARK:FUNC:SUMM OFF`

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum[:STATe]

This command switches on or off the measurement of the maximum of the absolute value.

Parameter

ON | OFF

Example

`CALC:MARK:FUNC:SUMM:MAX ON`

Characteristics

*RST value: OFF

SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:RESult?

This command queries the results of the measurement of the maximum of the absolute value. Results of average calculation and peak hold are queried with commands `to :MAXimum:AVERage:RESult?` and `to :MAXimum:PHOLd:RESult?`.

Example

`CALC:MARK:FUNC:SUMM:MAX:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:AVERage:RESult?

This command is used to query the results of the measurement of the maximum of the absolute value if the average is calculated using the command `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:AVERage.`

Example

`CALC:MARK:FUNC:SUMM:MAX:AVER:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:PHOLd:RESult?

This command is used to query the results of the measurement of the maximum of the absolute value when the peak hold function is switched on with command `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PHOLd.`

Example

`CALC:MARK:FUNC:SUMM:MAX:PHOL:RES?`

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak[:STATe]

This command switches on or off the measurement of the positive peak value in the selected measurement window. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of MARKer is irrelevant. It is only available in the time domain (span = 0).

Parameter

ON | OFF

Example

```
CALC:MARK:FUNC:SUMM:PPE ON
'Switches on the function in screen A.
```

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:RESult?

This command is used to query the result of the measurement of the positive peak value in the selected measurement window. The measurement may have to be switched on previously. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode

CALC:MARK:FUNC:SUMM:PPE ON
'Switches on the function in 'screen A

INIT;*WAI
'Starts a sweep and waits for the end

CALC:MARK:FUNC:SUMM:PPE:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

This command is used to query the result of the measurement of the averaged positive peak value in the selected measurement window. The query is only possible if averaging has been activated previously using `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> in MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
```

```
CALC:MARK:FUNC:SUMM:PPE ON
'Switches on the function in screen A
```

```
CALC:MARK:FUNC:SUMM:AVER ON
'Switches on the calculation of average 'in screen A
```

```
INIT;*WAI
'tarts a sweep and waits for the end
```

```
CALC:MARK:FUNC:SUMM:PPE:AVER:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

This command is used to query the result of the measurement of the positive peak value with active peak hold function. The query is only possible if the peak hold function has been activated previously using `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:PHOLd`. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'witches to single-sweep mode
```

```
CALC:MARK:FUNC:SUMM:PPE ON
'Switches to single-sweep mode
```

```
CALC:MARK:FUNC:SUMM:PHOL ON
'Switches on the measurement of the 'peak value in screen A
```

```
INIT;*WAI
'Starts a sweep and waits for the end
```

```
CALC:MARK:FUNC:SUMM:PPE:PHOL:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak[:STATe]

This command switches on or off the measurement of the negative peak value.

Parameter

ON | OFF

Example

`CALC:MARK:FUNC:SUMM:MPE ON`

Characteristics

*RST value: OFF

SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:RESult?

This command queries the result of the measurement of the negative peak value in the selected measurement window. Results of average calculation and peak hold are queried with commands `to :MPEak:AVERage:RESult?` and `to :MPEak:PHOLd:RESult?`.

Example

`CALC:MARK:FUNC:SUMM:MPE:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:AVERage:RESult?

This command queries the result of the measurement of the negative peak value in the selected measurement window if the average is calculated using the command `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`.

Example

`CALC:MARK:FUNC:SUMM:MPE:AVER:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:PHOLd:RESult?

This command queries the result of the measurement of the negative peak value in the selected measurement window if the peak hold function is switched on with command `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:PHOLd`.

Example

`CALC:MARK:FUNC:SUMM:MPE:PHOL:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle[:STATe]

This command switches on or off the measurement of the arithmetical mean between positive and negative peak value in the selected measurement window.

Parameter

ON | OFF

Example

`CALC:MARK:FUNC:SUMM:MIDD ON`

Characteristics

*RST value: OFF

SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:RESult?

This command queries the result of the measurement of the arithmetical mean between positive and negative peak value in the selected measurement window. Results of average calculation and peak hold are queried with commands `...:MIDDle:AVERage:RESult?` and `...:MIDDle:PHOLd:RESult?`

Example

`CALC:MARK:FUNC:SUMM:MIDD:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:AVERage:RESult?

This command queries the result of the measurement of the arithmetical mean between positive and negative peak value in the selected measurement window if the average is calculated using the command `CALCulate<1|2>: MARKer<1 to 4>:FUNCtion:SUMMary:AVERage`.

Example

`CALC:MARK:FUNC:SUMM:MIDD:AVER:RES?`

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:PHOLd:RESult?

This command queries the result of the measurement of the arithmetical mean between positive and negative peak value in the selected measurement window if the peak hold function is switched on using the command `CALCulate<1|2>:MARKer<1 to4>:FUNCtion:SUMMary:PHOLd`.

Example

`CALC:MARK:FUNC:SUMM:MIDD:PHOL:RES?`

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS[:STATe]

This command switches on or off the measurement of the effective (RMS) power in the selected measurement window. If necessary the function is switched on previously. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

Parameter

ON | OFF

Example

```
CALC2:MARK:FUNC:SUM:RMS ON
'Switches on the function in screen B.
```

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:RESult?

This command queries the result of the measurement of the RMS power value in the selected measurement window. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode.

CALC:MARK:FUNC:SUMM:RMS ON
'Switches on the function in screen A

INIT;*WAI
'Starts a sweep and waits for the end

CALC:MARK:FUNC:SUMM:RMS:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:AVERage:RESult?

This command queries the result of the measurement of the averaged RMS value in the selected measurement window. The query is only possible if averaging has been activated previously using `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode

CALC:MARK:FUNC:SUMM:RMS ON
'Switches to single-sweep mode

CALC:MARK:FUNC:SUMM:AVER ON
'Switches on the average value calculation in screen A
```

```
INIT;*WAI
'Starts a sweep and waits for the end
```

```
CALC:MARK:FUNC:SUMM:RMS:AVER:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

This command queries the result of the measurement of the RMS value with active peak hold in the selected measurement window. The query is only possible only if the peak hold function has been activated previously using `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:PHOLd`. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
```

```
CALC:MARK:FUNC:SUMM:RMS ON
'Switches on the function in screen A
```

```
CALC:MARK:FUNC:SUMM:PHOL ON
'Switches on the peak value measurement in screen A
```

```
INIT;*WAI
'Starts a sweep and waits for the end.
```

```
CALC:MARK:FUNC:SUMM:RMS:PHOL:RES?
'Outputs the result of screen A.
```

Characteristics

*RST value: -

SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN[:STATe]

This command switches on or off the measurement of the mean value in the selected measurement window. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

Note:
The measurement is performed on the trace on which marker 1 is positioned. In order to evaluate another trace, marker 1 must be positioned on another trace with `CALC:MARK:TRAC 1|2|3`.

Parameter

ON | OFF

Example

```
CALC:MARK:FUNC:SUMM:MEAN ON
'Switches on the function in screen A
```

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:RESult?

This command queries the result of the measurement of the mean value in the selected measurement window. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
```
'Switches to single-sweep mode

```
CALC:MARK:FUNC:SUMM:MEAN ON
'Switches on the function in screen A

INIT;*WAI
'Starts a sweep and waits for the end.

CALC:MARK:FUNC:SUMM:MEAN:RES?
'Outputs the result of screen A.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

This command queries the result of the measurement of the averaged mean value in the selected measurement window. The query is only possible if averaging has been activated previously using `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0)..

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
CALC:MARK:FUNC:SUMM:MEAN ON
'Switches on the function in screen A
CALC:MARK:FUNC:SUMM:AVER ON
'Switches on the average value 'calculation in screen A
 INIT;*WAI
'Starts a sweep and waits for the end.
CALC:MARK:FUNC:SUMM:MEAN:AVER:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

This command queries the result of the measurement of the mean value with active peak hold in the selected measurement window. The query is only possible if the peak hold function has been switched on previously using `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary: PHOLd`. The query is possible only if the peak hold function is active. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
CALC:MARK:FUNC:SUMM:MEAN ON
'Switches on the function in screen A
```

```
CALC:MARK:FUNC:SUMM:PHOL ON
'Switches on the peak value 'measurement in screen A
INIT;*WAI
'Starts a sweep and waits for the end.
CALC:MARK:FUNC:SUMM:MEAN:PHOL:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation[:STATe]

This command switches on or off the measurement of the standard deviation in the selected measurement window. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).
On switching on the measurement, the mean power measurement is switched on as well.

Parameter

ON | OFF

Example

```
CALC2:MARK:FUNC:SUMM:SDEV ON
'Switches on the measurement of the standard deviation in
screen B
```

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:RESult?

This command queries the results of the standard deviation measurement. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
CALC:MARK:FUNC:SUMM:SDEV ON
'Switches on the function in screen A
```

```
INIT;*WAI
'Starts a sweep and waits for the end.
```

```
CALC:MARK:FUNC:SUMM:SDEV:RES?
'Outputs the result of screen A
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

This command queries the result of the averaged standard deviation determined in several sweeps in the selected measurement window. The query is possible only if averaging is active. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode
```

```
CALC:MARK:FUNC:SUMM:SDEV ON
'Switches on the function in screen A
```

```
CALC:MARK:FUNC:SUMM:AVER ON
'Switches on the calculation of average in screen A
```

```
INIT;*WAI
'Starts a sweep and waits for the end.
```

```
CALC:MARK:FUNC:SUMM:MEAN:SDEV:RES?
'Outputs the result of screen A.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

This command queries the maximum standard deviation value determined in several sweeps in the selected measurement window. The query is possible only if the peak hold function is active. The function is independent of the marker selection, i.e. the numeric suffix <1 to 4> of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end must be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in single sweep mode.

Example

```
INIT:CONT OFF
'Switches to single-sweep mode

CALC:MARK:FUNC:SUMM:SDEV ON
'Switches on the function in screen A

CALC:MARK:FUNC:SUMM:PHOL ON
'Switches on the peak value measurement in screen A

INIT;*WAI
'Starts a sweep and waits for the end.

CALC:MARK:FUNC:SUMM:SDEV:PHOL:RES?
'Outputs the result of screen A.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is a query only and thus has no *RST value.

CALCulate<1|2>:MARKer<1 ... 4>:X:CONVersion:ABSolute?

This command returns the absolute X marker position for AM & PM conversion measurement. The value is returned in dBm. This function is only available for marker 1.

Example

```
CALC1:MARK1:X:CONV?
'Returns the absolute horizontal marker position.
```

Characteristics

*RST value: -
SCPI: device-specific

6.1.6 CALCulate:STATistics - Subsystem

The CALCulate:STATistics subsystem controls the statistical measurement functions in the unit. With these measurement functions, the measurement window cannot be selected. The numeric suffix is therefore ignored under CALCulate.

CALCulate:STATistics:CCDF[:STATe] ON | OFF

This command switches the measurement of the statistical distribution of MAGNITUDE on or off.

Example

```
CALC:STAT:CCDF ON
'Switches the STATISTIC measurements on.
```

Characteristics

*RST value: OFF
SCPI: device-specific

CALCulate:STATistics:SCALe:X:BCOunt <numeric_value>

This command defines the number of bars for the statistical functions.

Example

```
CALC:STAT:SCAL:X:BCO 10
'Defines the number of bars to 10
```

Characteristics

*RST value: 101
SCPI: device-specific

6.1.7 CALCulate:TRACe - Subsystem

The CALCulate:TRACe subsystem defines the display of the trace within the measurement window.

CALCulate<1|2>:TRACe<1..3>:ADJust

This command defines the reference point for the display.

Parameter

AUTO	The unit selects the reference point and the alignment.
TRIGger	The reference point is the trigger time.
BURSt	The reference point is the burst.
PATTern	The reference point is the pattern

Example

```
CALC:TRAC:ADJ TRIG
'Defines the reference point as trigger time
```

Characteristics

*RST value: AUTO
SCPI: device-specific

CALCulate<1|2>:TRACe<1..3>:ADJust:ALIGnment

This command defines where the relevant event (reference point) is to appear in the diagram.

Parameter

LEFT	The reference point is displayed at the left edge of the display.
CENTer	The reference point is displayed in the middle of the display.
RIGHt	The reference point is displayed at the right edge of the display.

Example

```
CALC:TRAC:ADJ:ALIG LEFT
'Defines the reference point as trigger time
```

Characteristics

*RST value: CENTer
SCPI: device-specific

CALCulate<1|2>:TRACe<1..3>:ADJust:ALIGnment:OFFset

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.

Parameter

<numeric value>

Example

```
CALC:TRAC:ADJ:ALIG:OFF 5
'The display range is shifted by '5 symbols towards the
right.
```

Characteristics

*RST value: 0
SCPI: device-specific

CALCulate<1|2>:TRACe<1..3>:ADJust:ALIGnment:VALue

This command allows a shift of the reference point in the displayed range. The setting is made in percent relative to the size of the display range. This display range is normalized to 0% (left edge) and 100% (right edge). If the result length is changed, the percentage remains valid, and the absolute value in symbols for this shift is modified correspondingly.

Parameter

0 ... 100%

Example

```
CALC:TRAC:ADJ:ALIG:VAL 50
'The display is shifted by half the RESULT LENGTH to the
right. The reference point is not changed
```

Characteristics

*RST value: 0
SCPI: device-specific

6.1.8 CALCulate:UNIT - Subsystem

The UNIT subsystem is used to switch the basic unit of setting parameters. A distinction is made between UNIT1 (screen A) and UNIT2 (screen B).

CALCulate<1|2>:X:UNIT:TIME

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

Parameter

S | SYM

Example

```
CALC:X:UNIT:TIME S
```

Characteristics

*RST value: _S
SCPI: device-specific

CALCulate<1|2>: UNIT:ANGLe

This command selects the default unit for angles.

Parameter

DEG | RAD

Example

```
CALC:UNIT:ANGL DEG
```

Characteristics

*RST value: RAD
SCPI: device-specific

CALCulate<1|2>:UNIT:POWer

This command selects the unit for power in the selected measurement window.

Parameter

DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere |DBUV_M | DBUA_M

Example

```
CALC:UNIT:POW DBM
'Sets the power unit for screen A to dBm
```

Characteristics

*RST value: dBm
SCPI: device-specific

6.2 DISPlay - Subsystem

The DISPLay subsystem controls the selection and presentation of text-specific and graphics-specific information as well as measurement data on the screen.

The measurement window is selected via WINDow1 (SCREEN A) or WINDow2 (SCREEN B).

DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE

This command defines the type of display and the evaluation of the traces in the selected measurement window. WRITE corresponds to the Clr/Write mode of manual operation. The trace is switched off (= BLANK in manual operation) with the DISPlay[:WINDow<1|2>]:TRACe<1 to 3>[:STATe] command. The number of measurements for AVERage, RMS, MAXHold and MINHold is defined with the [SENSe<1|2>:]AVERage:COUNt or [SENSe<1|2>:]SWEep:COUNt command. Synchronization to the end of the indicated number of measurements is only possible in single-sweep mode.

Parameter

WRITe:	Activates the overwrite mode for the collected measured values, i.e. the trace is overwritten by each sweep.
MAXHold:	Saves for each sweep the maximum of the previously stored/currently measured values in the trace memory.
MINHold:	Saves for each sweep the smallest of the previously stored/currently measured values in the trace memory.
AVERage:	Activates the linear averaging function. The average is formed over several sweeps.
RMS:	Activates the root square averaging function. The average is formed over several sweeps

Example

```
*RST
INST:SEL DDEM
'enter VSA option configure Screen A result

CALC1:FEED 'XTIM:DDEM:ERR:MPH'
‘select error signal

CALC1:FORMat PHAS
‘select format phase
DISP:WIND1:TRAC:MODE RMS
'select RMS Averaging.
```

Characteristics

*RST value: --
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:X[:SCALe]:PDIVision

This command defines the scaling of the X axis.

Parameter

<numeric_value>

Example

```
DISP:TRAC:X:PDIV 20SYM
'Sets the scaling of the Y axis to 20 symbols/DIV.
```

Characteristics

*RST value: --
SCPI: device-specific

The numeric suffix under TRACe<1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:X[:SCALe]:RPOSition

This command defines the position of the reference value for the X axis. . The default value depends on the selected measurement result and format (e.g. Meas Signal – Magnitude at 100%, Meas Signal – Phase at 50%).

Parameter

0...100PCT

Example

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

Characteristics

*RST value: --
SCPI: device-specific

The numeric suffix under TRACe<1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:X[:SCALe]:RVALue

This command defines the reference value for the X axis of the measurement diagram.

Parameter

<numeric_value>

Example

```
DISP:TRAC:X:RVAL 20SYM
Sets the reference value to 20 symbols.
```

Characteristics

*RST value: 0
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>: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 "Fit Trace" menu (or with the CALC:TRAC:ALIG commands), the burst on the screen is shifted; the X axis thus no longer begins on the right at 0 symbols but at a selectable value

Example

```
CALC:TRAC:ADJ BURST
'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
```

Characteristics

*RST value: -
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:X[:SCALe]:VOFFset

This command defines how to number the symbols for the X axis of the measurement diagram. This value is the symbol number at the right edge of the X axis.

Parameter

<numeric_value>

Example

```
DISP:TRAC:X:VOFF 20
'Sets the value at the right edge of the X axis to 20
symbols.
```

Characteristics

*RST value: 0
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:SYMBol

This command defines the display of the decision instants on the trace.

Parameter

DOTS | BARS | OFF

Example

```
DISP:WIND1:TRAC:SYMB DOTS
'Defines that the decision instants are displayed in the form
'of dots.
```

Characteristics

*RST value: OFF
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision

This command defines the scaling of the y-axis in the current unit. The default value depends on the selected measurement result and format (e.g. Meas Signal – Magnitude).
The numeric suffix under TRACe<1...3> is irrelevant.

Parameter

<numeric_value>

Example

```
*RST
INST:SEL DDEM
'enter VSA option
CALC1:FEED 'XTIM:DDEM:MEAS'
'select meas signal
CALC1:FORMat PHAS
'select format phase
DISP1:TRAC:Y:PDIV 10.0
'sets y-axis /div to 10 deg
```

Characteristics

*RST value: -
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]: RPOSition

This command defines the position of the reference value for the y-axis. The default value depends on the selected measurement result and format (e.g. Meas Signal – Magnitude at 100 %, Meas Signal – Phase at 50 %).
The numeric suffix under TRACe<1...3> is irrelevant.

Parameter

0...100PCT

Example

```
*RST
INST:SEL DDEM
'enter VSA option
CALC1:FEED 'XTIM:DDEM:MEAS'
'select meas signal
CALC1:FORMat PHAS
'select format phase
DISP1:TRAC:Y:PDIV 10.0"
'sets y-axis /div to 10 deg
DISP1:TRAC:Y:RPOS 50.0
'ref value position at 50 %
```

Characteristics

*RST value: LOGarithmic
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RVALue

This command defines the reference value for the y-axis of the measurement diagram.
The numeric suffix under TRACe<1...3> is irrelevant.

Parameter

<numeric_value>

Example

```
*RST
INST:SEL DDEM
'enter VSA option
CALC1:FEED 'XTIM:DDEM:MEAS'
'select meas signal
CALC1:FORMat PHAS
'select format phase
DISP1:TRAC:Y:PDIV 10.0"
'sets y-axis /div to 10 deg
DISP1:TRAC:Y:RPOS 50.0
'ref value position at 50 %
DISP1:TRAC:Y:RVAL 20.0
'sets ref value to 20 deg
```

Characteristics

*RST value: LOGarithmic
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y:SPACing

This command is used to allow switchover between a linear and a logarithmic scale in the selected measurement window. On a linear scale, switchover between the unit % (command `DISP:WIND:TRAC:Y:SPAC LIN`) and the unit dB (command `DISP:WIND:TRAC:Y:SPAC LDB`) is also possible.

The numeric suffix under TRACe<1...3> is irrelevant.

Parameter

LINear | LOGarithmic | LDB

Example

`DISP:WIND1:TRAC:Y:SPAC LIN`

Characteristics

*RST value: LOGarithmic
SCPI: conforming

6.3 FORMat -Subsystem

The INSTrument subsystem selects the operating mode of the unit either via text parameters or fixed numbers.

FORMat[:DATA]

This command specifies the data format for the data transmitted from the instrument to the control PC.
The data format is either ASCII or one of the formats REAL or UINT (Unsigned Integer). ASCII data are transmitted in plain text, separated by commas. REAL data are transmitted as 32-bit IEEE 754 floating-point numbers in the "definite length block format".
The format UINT is only used in operating mode vector signal analysis, for the symbol table.
The FORMat command is valid for the transmission of trace data. The data format of trace data received by the instrument is automatically recognized, regardless of the format which is programmed.
Format setting for the binary transmission of trace data (see also `TRACE:DATA?`):

Analyzer mode:	REAL, 32	
Vector analyzer:	UINT, 8	with digital demodulation, symbol table
	REAL, 32	otherwise

Note:
Incorrect format setting will result in numerical conversion, which may lead to incorrect results.

Parameter

ASCii | REAL | UINT [, 8 | 32]

Example

```
FORM REAL,32
FORM ASC
FORM UINT,8
```

Characteristics

*RST value: ASCii
SCPI: conforming

FORMat:DEXPort:DSEParator

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.

Parameter

POINt | COMMa

Example

```
FORM:DEXP:DSEP POIN
'Sets the decimal point as separator.
```

Characteristics

*RST value: -- factory setting is POINt; *RST does not affect setting)
SCPI: device-specific

FORMat:DEXPort:HEADer

This command defines if a file header (including start frequency, sweep time, detector, etc.) is created or not. A small header with the instrument model, the version and the date is always transferred.

Parameter

ON | OFF

Example

```
FORM:DEXP:HEAD OFF
'only a small file header is transferred.
```

Characteristics

*RST value: ON
SCPI: device-specific

FORMat:DEXPort:MODE

This command defines which data are transferred, raw I/Q data or trace data

Parameter

RAW | TRACe

Example

```
FORM:DEXP:MODE RAW
'raw measurement data are transferred
```

Characteristics

*RST value: TRACe
SCPI: device-specific

FORMat:DEXPort:RAW:FORMat

This command defines the output format of the RAW data file export function. Format WAV can be read e.g. by signal generator R&S SMIQ or R&S SMU.

Parameter

ASCii	ASCII file format
WAVeform	Format WAV can be read e.g. by signal generator R&S SMU.
BINary	Exports the I/Q RAW data and the VSA user parameter settings in a binary format. Files saved with this format are loadable by function MMEM:LOAD:TRAC. **Note:** The required harddisk space to store the I/Q RAW data depends on the RECORD LENGTH specified.

Example

```
FORM:DEXP:MODE RAW
'select RAW data export
FORM:DEXP:RAW:FORM WAV
'select format waveform
MMEM:STOR:TRAC 1,'D:\rawdat.wv'
'start data export to file 'D:\rawdat.wv
```

Characteristics

*RST value: ASCii
SCPI: device-specific

6.4 INSTrument - Subsystem

The INSTrument subsystem selects the operating mode of the unit either via text parameters or fixed numbers.

INSTrument:NSELect

This command switches between the operating modes by means of numbers.

Parameter

1 Spectrum analysis
2 Vector signal analysis

Example

```
INST:NSEL 1
'Switches the instrument to Spectrum Analyzer Mode.
```

Characteristics

*RST value: 1
SCPI: conforming

INSTrument[:SELect]

This command switches between the operating modes by means of text parameters.

Parameter

DDEMod Vector signal analysis
SANalyzer Spectrum analysis

Example

```
INST SAN
'Switches the instrument to Spectrum Analyzer Mode.
```

Characteristics

*RST value: SANalyzer
SCPI: conforming

6.5 MMEMory - Subsystem

MMEMory: LOAD:TRACe 1,<file_name>

This command loads I/Q RAW data files. The file name includes indication of the path and the drive name. The path name complies with DOS conventions. This command is only available if RAW data with binary format is selected (":FORM:DEXP:MODE RAW", ":FORM:DEXP:RAW:FORM BIN").
The command needs two different files, created with the MMEM:STOR:TRAC command).

Parameter

<file_name>.VAV VSA settings
<file_name>.bin I/Q RAW data

The import of the I/Q RAW data requires the MULTI mode to be active (refer to HOME VSA → MEAS RESULT → CAPTURE BUFFER → ZOOM → MULTI for more details). This mode is automatically switched on with start of the load process.

Example

```
INST:SEL DDEM
'enter VSA optrion additional commands to configure the
'measurement

FORM:DEXP:MODE RAW
'select I/Q RAW data to import

FORM:DEXP:RAW:FORM BIN
'select binary format

MMEM:STOR:TRAC 1,'D:\vsa_raw'
'exports I/Q RAW data into two files: 'vsa_raw.vav (VSA
settings) vsa_raw.bin (I/Q 'RAW data)

*RST'
INST:SEL DDEM
'enter VSA

FORM:DEXP:MODE RAW
'select RAW data to import

FORM:DEXP:RAW:FORM BIN
'select binary format

MMEM:LOAD:TRAC 1, 'D:\vsa_raw'
'import the I/Q RAW data files vsa_raw.vav (VSA settings)
'vsa_raw.bin (I/Q RAW data)) vsa_raw.bin ((I/Q RAW data))
```

Characteristics

*RST value: -
SCPI: device-specific

This command is an event and therefore has no *RST value and no query.

MMEMory: STORE:TRACe 1,<file_name>

This command stores I/Q RAW data files. The file name includes indication of path and drive name. The path name complies with DOS conventions. This command is only available if RAW data with binary format is selected (“:FORM:DEXP:MODE RAW”, “:FORM:DEXP:RAW:FORM BIN”).

The import of the I/Q RAW data requires the MULTI mode to be active (refer to HOME VSA → MEAS RESULT → CAPTURE BUFFER → ZOOM → MULTI for more details). This mode is automatically switched on with start of the load process.

Parameter

<file_name> := DOS file name

Example

```
INST:SEL DDEM
'enter VSA optrion additional commands to configure the
'measurement

FORM:DEXP:MODE RAW
'select binary format

FORM:DEXP:RAW:FORM BIN
'select binary format

MMEM:STOR:TRAC 1,'D:\vsa_raw'
'exports I/Q RAW data into two files: ‘vsa_raw.vav (VSA
'settings) vsa_raw.bin (I/Q ‘RAW data)

*RST‘

INST:SEL DDEM
'enter VSA

FORM:DEXP:MODE RAW
'select RAW data to import

FORM:DEXP:RAW:FORM BIN
'select binary format

MMEM:LOAD:TRAC 1, 'D:\vsa_raw'
'import the I/Q RAW data files vsa_raw.vav (VSA settings)
'vsa_raw.bin (I/Q RAW data)
```

Characteristics

*RST value: -
SCPI: device-specific

This command is an event and therefore has no *RST value and no query.

6.6 SENSe - Subsystem

SENSe:DDEMod-Subsystem
SENSe:FREQuency - Subsystem

6.6.1 SENSe:DDEMod-Subsystem

This subsystem controls the parameters for digital Demodulation.

[SENSe<1|2>:]DDEMod:ECALc

This command defines the calculation formula for EVM.

Parameter

SYMBol Calculation normalized to the maximum power at symbol times.
SIGNal Calculation normalized to the average power within the measurement range.

Example

```
DDEM:ECAL SIGN
'EVM is normalized to the average power.
```

Characteristics

*RST value: for PSK, MSK, QAM: SYMB
for EDGE: SIGN
SCPI: device-specific

[SENSe<1|2>:]DDEMod:ECALc:OFFSet

This command controls the calculation of the error vector magnitude trace for Offset-QPSK only. It has . It has no effect for all other modulations. It has no effect on results based on the MEAS or the REF signal.

Parameter

ON: The error vector magnitude is calculated at the symbol instants of the I-part and the symbol instants of the Q-part of the Offset-QPSK signal.
In other words: The half symbol duration delay of the Q-part is compensated. In firmware versions prior to the introduction of this softkey, this was method was always used for Offset-QPSK.

OFF: The error vector magnitude is calculated at the symbol instants of the I-part and the corresponding sample of the Q-part of the signal. But the latter is not a symbol instant.
In other words: The Offset-QPSK signal is treated like a QPSK signal for the error vector magnitude calculation, the Q-delay is not compensated.

Refer to the manual operation section for additional details.
This command is only available for Offset-QPSK-Modulation.

Example

```
DDEM:QPSK:FORM OFFS
'Selection Offset-QPSK demodulation
DDEM:ECAL:OFFS OFF
'Deactivation of EVM CALC Offset
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize[:STATe]

This command switches the equalizer in or off.

Parameter

ON | OFF

Example

```
DDEM:EQU ON
'switches on equalize
```

Characteristics

*RST value: OFF
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:ADAPt

This command switches the learning phase of the equalizer on or off. Each sweep between commands `DDEM:EQU ON` and `DDEM:EQU OFF` are used for the calculation of the adaptive filter. This command is only available when the equalizer is switched on using command `DDEM:EQU ON`.

Parameter

ON | OFF

Example

```
DDEM:EQU ON
'switches on equalizer
DDEM:ADAP ON
'switches on learning phase
DDEM:ADAP OFF
'switches off learning phase
```

Characteristics

*RST value: OFF
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:CNVRange

This command defines the speed of conversion of the adaptive filter .

Parameter

0 to 1

Example

```
DDEM:EQU:CNVR 0.1
'sets the convergence to 1/10
```

Characteristics

*RST value: 1/100
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:DELete

This command deletes a previously stores equalizer.

Parameter

<Equalizer_Name>

Example

```
DDEM:EQU ON
'switches on equalizer

DDEM:ADAP ON
'switches on learning phase

DDEM:ADAP OFF
'switches off learning phase

DDEM:EQU:SAVE 'EQU_1'
'stores the equalizers

DDEM:EQU:DEL 'EQU_1'
'deletes the equalizer
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:LENGth

This command defines the length of the equalizer in terms of symbols.

Parameter

1...100

Example

```
DDEM:EQU:LEN 20
'sets the resolution to 20 symbols
```

Characteristics

*RST value: 20
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:LOAD

This command loads a previously stored equalizer.

Parameter

<Equalizer_Name>

Example

```
DDEM:EQU:LOAD 'EQU_1'
'loads the equalizer 'EQU_1
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:RESet

This command deletes the data of the currently selected equalizer. . After deletion, a new adaptive filter can be calculated using command `EQU:ADAP ON`.

Example

```
DDEM:EQU ON
'switches on equalizer

DDEM:ADAP ON
'switches on learning phase

DDEM:ADAP OFF
'switches off learning phase

DDEM:EQU:RES
'deletes the data of the equalizer
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EQUalize:SAVE

This command loads an equalizer that was previously stored.

Parameter

<Equalizer_Name>

Example

```
DDEM:EQU ON
'switches on equalizer

DDEM:ADAP ON
'switches on learning phase

DDEM:ADAP OFF
'witches off learning phase
```

```
DDEM:EQU:SAVE
'saves the equalizers
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:EXPort:EQUalizer

This command copies the selected internal equakizer file to the specified directory.

Parameter

<file_name>:	Name of internal equalizer file
<path>:	Path to which the internal files are copied

Example

```
DDEM:EXP:EQU ‘EQUAL1‘,‘A:\TEMP‘
'Equalizer EQUAL1 is copied to a:\temp
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:EXPort:STANdard

This command copies the selected internal modulation standard file to the specified directory. The associated patterns, mappings, filters and limit lines are saved along with the standard.

Parameter

<file_name>:	Name of internal standard file. The file name is specified without a file extension. The file names of the predefined standards can be found using the `SENS:DDEM:STAND:CAT?` command.
<path>:	Path to which the internal files are copied.

Example

```
DDEM:EXP:STAN ‘NADC_FWD‘,‘A:\TEMP‘
'Standard NADC_FWD is copied to a:\temp
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:EXPort:MAPPing

This command copies the selected internal mappings file to the specified directory.

Parameter

<file_name>: Name of internal mappings file The file name is specified without a file extension. The file names of the predefined standards can be found using the `SENS:DDEM:STAND:CAT?` command.

<path>: Path to which the internal files are copied

Example

```
DDEM:EXP:MAPP 'CDMA2K_FWD','A:\TEMP'
'Mapping CDMA2K_FWD is copied to a:\temp
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:EXPort:PATTern

This command copies the selected internal Pattern file to the specified directory.

Parameter:

<file_name>: name of internal pattern file. The file name is specified without a file extension. The file names of the predefined standards can be found using the `SENS:DDEM:STAND:CAT?` command.

<path>: Path to which the internal files are copied

Example

```
DDEM:EXP:PATT 'GSM_AB0','A:\TEMP'
'Pattern GSM_AB0 is copied to a:\temp
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:EXPort:FILTer

This command copies the selected internal filter file to the specified directory.

Parameter

<name>: name of internal filter file. The file name is specified without a file extension. The file names of the predefined standards can be found using the `SENS:DDEM:STAND:CAT?` command.

<path>: Path to which the internal files are copied

Example

```
DDEM:EXP:FILT ‘EDGE_ISI‘,‘A:\TEMP‘
'Filter EDGE_ISI is copied to 'a:\temp
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:FACTory

The FACTORY DEFAULTSS softkey restores the factory settings of the parameters GENERIC STANDARDS, STANDARDS, MAPPINGS, PATTERN, FILTER and ALL for the R&S FSQ-K70/FSMR-B73/FSU-B73 option.

Parameter

ALL | GSTandard | STANdard | MAPPing | PATTern | FILTer

Example

```
SENS:DDEM:FACT GST
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:FILTer[:STATe]

This command defines whether the input signal that is used to evaluate the measurement is filtered. If the filter is switched off, the input signal is only corrected in frequency and time.

Parameter

ON | OFF

Example

```
DDEM:FILT OFF
'The input signal is not filtered.
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:FILTer:ALPHa

This command determines the filter characteristic (ALPHA/BT). The resolution is 0.05.

Parameter

0.2 to 1

Example

```
DDEM:FILT:ALPH 0.5
'Sets ALPHA/BT to 0.5
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:FILTer:CATalog?

This command reads the names of all available filters.

The file names are output without file extension. Syntax of output format: filter_1,filter_2, ... ,filter_n

Example

```
DDEM:FILT:CAT?
'Reads all filter names.
```

Characteristics

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod:FILTer:MODulation

This command selects the TX, ISI and MEAS filter. The names of the filters correspond to the file names; a query of all available filters is possible by means of the "`DDEM:FILT:CAT?`" command.

Parameter

<TX Filter>,<ISI Filter>, <MEAS Filter>

Example

```
DDEM:FILT:MOD ‘GAUSS‘,‘RC‘,‘RRC‘
'GAUSS is selected for the TX filter, RC for the ISI filter
'and RRC for the Meas. filter
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

[SENSe<1|2>:]DDEMod:FORMat

This command selects the digital demodulation mode.

Parameter

QPSK	Quad Phase Shift Key
PSK	Phase Shift Key
MSK	Minimum Shift Key
QAM	Quadrature Amplitude Modulation
FSK	Frequency Shift Key
VSB	Vestigial Sideband
UQAM	User QAM, only available with user mapping files

Example

```
DDEM:FORM QPSK
'Switch QPSK demodulation on.
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

[SENSe<1|2>:]DDEMod:FSK:NSTate

This command defines the specific demodulation mode for FSK.

Parameter

2	2 FSK
4	4 FSK

Example

```
DDEM:FORM FSK
'Switch FSK demodulation on.
DDEM:FSK:NST 2
'Switch 2FSK demodulation on
```

Characteristics

*RST value: -
SCPI: device-specific.

This command is only available for FSK demodulation.

[SENSe<1|2>:]DDEMod:IMPort:EQUalizer

This command copies the selected external equalizer file from the specified directory to the internal hard disk.

Parameter

<name>: Name of external equalizer file

<path>: Path to which the internal files are copied

Example

```
DDEM:IMP:EQU 'EQUAL1','A:\TEMP'
'Equalizer EQUAL1 which is located on a:\temp, is copied to
'the hard disk
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:IMPort:FILTer

This command copies the selected external filter file from the specified directory to the internal hard disk.

Parameter

<name>: Name of external filter file

<path>: Path where the external files are located.

Example

```
DDEM:IMP:FILT 'EDGE_ISI','A:\TEMP'
'Filter EDGE_ISI wwhich is 'located on a:\temp, 'is copied
'to the hard disk.
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:IMPort:MAPPing

This command copies the selected external mappings file from the specified directory to the internal hard disk.

Parameter:

<name>: Name of external mapping file
<path>: Path where the external files are located.

Example

```
DDEM:IMP:MAPP 'CDMA2K_FWD','A:\TEMP'
'Mapping CDMA2K_FWD which is located on a:\temp, 'is copied
to the hard disk
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:IMPort:PATTern

This command copies the selected external pattern file from the specified directory to the internal hard disk.

Parameter

<name>:	Name of external pattern file
<path>:	Path where the external files are located.

Example

```
 "DDEM:IMP:PATT 'GSM_AB0','A:\TEMP'"
'Pattern GSM_AB0'which is 'located on a:\temp, is copied 'to
the hard disk
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:IMPort:STANdard

This command copies the selected external modulation standard file from the specified directory to the internal hard disk. The associated patterns, mappings, filters and limit lines are saved along with the standard.

Parameter

<name>:	Name of the external standard file. The file name is specified without a file extension.
<path>:	Path where the external files are located.

Example

```
DDEM:IMP:STAN 'NADC_FWD','A:\TEMP'
'The file with the settings of the standard 'DECT_USER',
which is located on a:\temp is copied to the hard disk
```

Characteristics

*RST value: -
SCPI: device-specific

The numeric suffix under SENSe<1|2> is irrelevant.

[SENSe<1|2>:]DDEMod:MAPPing

This command selects the mapping designated by <mapping_name> for the digital demodulation. The mapping describes the assignment of constellation points to symbols. The mapping names used here correspond to the mapping names given in the table of the predefined standard. (see "List of Predefined Standards and Standard Groups")

Parameter

<file_name>::= Name of mapping

Example

```
DDEM:MAPP 'GSM'
'Set mapping GSM
```

Characteristics

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod:MAPPing:CATalog?

This command reads out the names of all mappings stored on the hard disk of the modulation currently set. A mapping describes the assignment of constellation points to symbols. The file names are output without file extension.

Syntax of output format:
mapping_1,mapping_2, ... ,mapping_n

Example

```
DDEM:MAPP:CAT?
'Reading all mapping file names.
```

Characteristics

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod: MEABs

This command switches the calculation formula for Magnitude Error between:

Parameter

ON Calculates the absolute value of the Magnitude Error. Therefore the result is always positive.
OFF Calculates the Magnitude Error as a signed value

Note:
To get comparable results as for FSW-K70, *OFF* should be used. *MAGER CALC* has also to be set to *SIGNAL MEAN POWER* with "SENS:DDEM:MEC SIGN".

Example

```
DDEM:MEAP OFF
'selected signed error calculation'for Magnitude Error
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod: MECalc

This command switches the calculation formula for Magnitude Error between. This setting affects **only** the display of Magnitude Error as a function of time and the display of *RMS Magnitude Error* in the modulation summary.

Parameter

SYMBol	*MAX SYMBOL* Normalizes the magnitude error to the square root of the power of the symbol with the highest magnitude.
SIGNal	*SIGNAL MEAN PWR* Normalizes the magnitude error to the square root of the average signal power in the considered period of time.

Note:
To get comparable results as for FSW-K70, setting *SIGNal* should be used and *MAGER ABS* has olso to be switched off with "SENS:DDEM:MEABS OFF".

Example

```
DDEM:MEP SIGN
'selected the signal power normalization for the Magnitude
Error calculation
```

Characteristics

*RST value: SYMBol
SCPI: device-specific

The availability of this command depends on the selected modulation. SYMBol is used, if the command is not available.

[SENSe<1|2>:]DDEMod:MSK:FORMat

This command defines the specific demodulation mode for MSK.

Parameter:

TYPE1, NORMal	MSK
TYPE2, DIFFerential	DMSK

Example

```
DDEM:FORM MSK
'Switch MSK demodulation on.
DDEM:MSK:FORM TYPE2
'Switch DMSK demodulation on.
```

Characteristics

*RST value: TYPE2 | DIFFerential
SCPI: device-specific

This command is only available for MSK demodulation.

[SENSe<1|2>:]DDEMod:NORMalize

This command switches the compensation of the IQ offset on or off.

Parameter

ON | OFF

Example

```
DDEM:NORM OFF
'Switches the normalization off
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:PRATe

This command determines the number of points per symbol.

Parameter:

1 | 2 | 4 | 8 | 16

Example

```
DDEM:PRAT 8
'Sets 8 points per symbol.
```

Characteristics

*RST value: 4
SCPI: device-specific

[SENSe<1|2>:]DDEMod:PRESet[: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 unit (predefined standard).

The transmission methods are set via a file name without extension (string data with quotation marks). Some predefined transmission methods can be set via a value also (character data without quotation marks) for reasons of compatibility with former instrument models.

Example

```
DDEM:PRES TETR
'Switches the predefined digital standard Tetra on.
```

```
DDEM:PRES 'USER_GSM'"
'Switches the user defined digital standard 'USER_GSM'on.
```

Characteristics

*RST value: GSM
SCPI: device-specific

The following predefined standards are available:

File name	Description	Value
APCO25_C4FM	APCO25, Coded 4FSK	APCO25C4FM
APCO25_CQPSK	APCO25, Coded QPSK	APCO25CQPSK
APCO25_F4FM	APCO25, Filtered 4FM (4FSK)	-
GSM_NB	GSM, Normal Burst	GSM
GSM_SB	GSM, Synchronization Burst	-
GSM_FB	GSM, Frequency Correction Burst	-
GSM_AB	GSM, Access Burst	-
EDGE_NB	Edge	EDGE
3G_WCDMA_FWD	3GPP Wcdma forward	FW3Gppcdma
3G_WCDMA_REV	3GPP Wcdma reverse	RW3Gppcdma
CDMAONE_FWD	Cdma One forward according to standard IS95	FQCDma
CDMAONE_REV	Cdma One reverse according to standard IS95	RQCDma
CDMA2K_1X_FWD	Cdma 2000 forward, spreading rate 1	F1CDma2000
CDMA2K_1X_REV	Cdma 2000 reverse, spreading rate 1	R1CDma2000
IS95_FWD	IS95 forward according to standard IS95	F95Cdma
IS95_REV	IS95 reverse according to standard IS95	R95Cdma
NADC_FWD	Nadc forward	FNADc
NADC_REV	Nadc reverse	RNADc
PDC_DOWN	Pdc down	PDCDown
PDC_UP	Pdc up	PDCup
PHS_COMM	PHS (data burst)	PHS
PHS_CTRL	PHS (control burst)	-
TETRA_NDDOWN	Tetra (data burst)	TETRa
TETRA_NCDOWN	Tetra (control burst)	-
DECT_FP	DECT	DECT
GSM_NB	DCS 1800	DCS1800
GSM_NB	PCS 1900	PCS1900
BLUETOOTH_DH1	Bluetooth, High data rate, slot length 1	-
BLUETOOTH_DH3	Bluetooth, High data rate, slot length 3	-
BLUETOOTH_DH5	Bluetooth, High data rate, slot length 5	-

[SENSe<1|2>:]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 by means of *WAI, *OPC or *OPC?, because otherwise the autorange process will be stopped.

The numeric suffix <1|2> has no meaning with this command.

Example

```
DDEM:PRES:RLEV;*WAI
'Performs automatic level setting.
```

Characteristics

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod:PSK:FORMat

This command defines the specific demodulation mode for PSK. The specific demodulation mode (`DDEM:PSK:NST`) must be set to 8.

The following PSK demodulation modes are possible:

DDEMod:PSK:NSTate	DDEMod:PSK:FORMat	Modulation mode
2	any	BPSK
8	NORMal	8PSK
8	DIFFerential	D8PSK
8	N3Pi8	$3\pi/8$-8PSK (EDGE)

Parameter

NORMal | DIFFerential | D1Pi8 | N3Pi8

Example

```
DDEM:FORM PSK
'Switch PSK demodulation on.
DDEMod:PSK:NST 8
DDEM:PSK:FORM DIFF
'Switch D8PSK demodulation on.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is only available for PSK demodulation.

[SENSe<1|2>:]DDEMod:PSK:NSTate

This command defines the specific demodulation mode for PSK. The following PSK demodulation modes are possible:

Parameter

DDEMod:PSK:NSTate	DDEMod:PSK:FORMat	Modulation mode
2	any	BPSK
8	NORMal	8PSK
8	DIFFerential	D8PSK
8	N3Pi8	3π/8-8PSK (EDGE)

```
DDEM:FORM PSK
'Switch PSK demodulation on.
DDEM:PSK:FORM DIFF
DDEMod:PSK:NST 8
'Switch D8PSK demodulation on.
```

Characteristics:

*RST value: -
SCPI: device-specific

This command is only available for PSK demodulation.

[SENSe<1|2>:]DDEMod:QAM:NSTate

This command defines the specific demodulation mode for QAM.

Parameter

16	16QAM
32	32 QAM
64	64 QAM
128	128 QAM
256	256 QAM

Example

```
DDEM:FORM QAM
'Switches QAM demodulation on.
DDEM:QAM:NST 64
'Switches 64QAM demodulation on.
```

Characteristics

*RST value: 16
SCPI: device-specific.

This command is only available for QAM demodulation.

[SENSe<1|2>:]DDEMod:QAM:FORMat

This command defines the specific demodulation mode for QAM.

Parameter

NORMal	QAM
DIFFerential	DQAM

Example

```
DDEM:FORM QAM
'Switches QAM demodulation on.
DDEM:QAM:FORM DIFF
'Switches differential DQAM demodulation on.
```

Characteristics

*RST value: NORM
SCPI: device-specific

This command is only available for QAM demodulation.

[SENSe<1|2>:]DDEMod:QPSK:FORMat

This command defines the specific demodulation mode for QPSK.

Parameter

NORMal	QPSK
DIFFerential	DQPSK
OFFSet	OQPSK
DPI4	π/4 DQPSK

Example

```
DDEM:FORM QPSK
'Switch QPSK demodulation on.
DDEM:QPSK:FORM DPI4
'Switch π/4 DQPSK demodulation on.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is only available for QPSK demodulation.

[SENSe<1|2>:]DDEMod:RLENgth

This command defines the recording length for further processing, e.g. for burst search. The RLENgth is given in time (S) or symbols (SYM).

The value range for SYM is 100 [sym] to 8000000/pointspersymbol [sym].

Parameter

<numeric_value>

Example

```
DDEM:RLEN 1000SYM
'Sets a recording length of 1000 symbols.
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

[SENSe<1|2>:]DDEMod:RLENgth:AUTO

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

Parameter

ON | OFF

Example

```
DDEM:RLEN:AUTO OFF
'Do not set RLENgth automatically.
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SBANd

This command selects the sideband for the demodulation.

Parameter

NORMal	Normal (non-inverted) position
INVerse	inverted position

Example

```
DDEM:SBAN INV
'Selects the inverted position
```

Characteristics

*RST value: NORMal
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:GLENgth[:MINimum]

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

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:GLEN 3US
'At least 3 us must elapse between two bursts so that the
'second burst can be recognized as a separate burst.
```

Characteristics

*RST value: 2 symbols for PSK, GSM, EDGE
1 symbol for FSK, MSK
4 symbols for QAM
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:HYSTeresis[:LEVel]

This command defines the trigger hysteresis to ensure that the end of the burst is reliably detected.

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:HYST 12DB
'Set 12 dB hysteresis
```

Characteristics

*RST value: 5 dB for QAM, otherwise 9 dB
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:LENGth[:MINimum]

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

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:LENG 140US
'The minimum burst length is 140 us.
```

Characteristics

*RST value: 16 symbols for PSK, FSK, MSK, QAM
130 symbols for GSM, EDGE
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:LENGth:MAXimum

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

Parameter

<numeric_value>

Example

```
 DDEM:SEAR:BURS:LENG:MAX 156US
'The maximum burst length is 156 µs
```

Characteristics

*RST value: 6400 symbols for PSK, FSK, MSK, QAM
160 symbols for GSM, EDGE
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:MODE

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 with the `DDEM:SEARch:BURSt:STATe = ON` command.

Parameter

MEAS | BURSt

Example

```
DDEM:SEAR:BURS:MODE BURS
'Sweep only if burst is found
```

Characteristics

*RST value: MEAS
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:SKIP:FALLing

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

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:SKIP:FALL 5US
'5 us of the rising burst edge are not 'considered.
```

Characteristics

*RST value: 1 symbol for PSK, FSK
4 symbols for MSK
2 symbols for QAM
5 symbols for GSM, EDGE
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:SKIP:RISing

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

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:SKIP:RIS 5US
'5 us of the rising burst edge are not considered.
```

Characteristics

*RST value: 1 symbol for PSK, FSK
4 symbols for MSK
2 symbols for QAM
5 symbols for GSM, EDGE
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt[:STATe]

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

Parameter

ON | OFF

Example

```
DDEM:SEAR:BURS OFF
'Switch burst search off.
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:AUTO

This command defines which value is to be used as the threshold. ON corresponds to a relative threshold value defined by the standard. The value entered via `DDEM:SEAR:BURS:HYST` is used as the threshold when OFF is selected.

Parameter

ON | OFF

Example

```
DDEM:SEAR:BURS:THR:AUTO OFF
'se manual value for burst search
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold[:LEVel]

This command defines the threshold for the burst search. The value can either be given relative to the reference level (in dB) or as absolute value (in dBm). With Auto (ddem:sear:burs:thr:auto on) selected, a query or setting is not possible and an execution error is returned.

Parameter

<numeric_value>

Example

```
DDEM:SEAR:BURS:THR -20DB
'-20 dB dB difference during burst search.
```

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:MODE

This command defines whether the threshold is absolute or relative (to the reference level).

Parameter

RELative | ABSolute

Example

```
DDEM:SEAR:BURS:THR:MODE REL
'Threshold is relative
```

Characteristics

*RST value: REL
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst:CAPTure:AUTO

This command defines the mode for writing to the capture RAM. If the state is ON, a new data capture operation will be initiated when the end of the capture RAM is reached (and `DDEM:SEAR:MBUR:FIND:NEXT` occurs again). This command is available only in single sweep mode.

Parameter

ON | OFF

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:MBUR:CAP:AUTO OFF
'do not overwrite capture RAM.
```

Characteristics

*RST value: ON
SCPI: device-specific.

[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:NEXT

This command searches the next burst/sync pattern in the Capture Ram.

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:BURS ON
'switch on burst search
DDEM:SEAR:MBUR:FIND:NEXT
'find next burst
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:FIRSt

This command searches the first burst/sync pattern in the Capture Ram.

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:BURS ON
'switch on burst search
DDEM:SEAR:MBUR:FIND:FIRS
'ind first burst
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:STARt

This command searches for the first burst/sync pattern that occurs starting at the position that was defined via the command DDEM:SEAR:MBUR:STAR. This is the position starting at which the signal is demodulated in the capture RAM.

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:SYNC ON
'switch on pattern search
DDEM:SEAR:MBUR:STAR 500SYM
'start at 500 symbols
DDEM:SEAR:MBUR:FIND:STAR
'find first sync patt starting at start pos
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst:LENGth

This command defines the length of the visible range in the Magnitude Capture display.

Parameter

10 to 32000

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:BURS ON
'switch on burst search
DDEM:SEAR:MBUR:STAR 500SYM
'start of demodulation
DDEM:SEAR:MBUR:LENG 1000SYM
'length of demodulation
```

Characteristics

*RST value: Record Length, depends on standard
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst:STARt

This command defines the start of the visible range in the Magnitude Capture display.

Parameter

<numeric_value>

Example

```
DDEM:SEAR:MBUR ON
'switch on multi burst search
DDEM:SEAR:BURS ON
'switch on burst search
DDEM:SEAR:MBUR:STAR 500SYM
'start at symbol 500
```

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:MBURst[:STATe]

This command sets the multi-burst search. First, a large amount of data is captured in the capture RAM. This data can then be demodulated and measured. The visible area in the magnitude capture displays is defined with the commands `DDEM:SEAR:MBUR:STAR` and `DDEM:SEAR:MBUR:LENG`. The commands `DDEM:SEAR:BURS` and `DDEM:SEAR:SYNC` are used to define whether to search for bursts or sync patterns (commands `DDEM:SEAR:MBUR:FIND:FIRS`, `DDEM:SEAR:MBUR:FIND:NEXT`, `DDEM:SEAR:MBUR:FIND:STAR`).

Parameter

ON | OFF

Example

```
DDEM:SEAR:MBUR ON
'Switch on multi burst search
```

Characteristics

*RST value: ON
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:CATalog?

This command reads the names of all patterns stored on the hard disk. Either all patterns are read out or only those patterns that belong to the current standard.

Parameter

CURRent	Reading out patterns that belong to the current standard
ALL	Reading out all patterns available on hard disk

The file names are output without file extension. Syntax of output format: pattern_1,pattern_2, ... ,pattern_n

Example

```
DDEM:PRES TETR
'Digital standard Tetra
DDEM:SEAR:SYNC:PATT:ADD PGSM_1
'Add PGSM_1 to standard.
DDEM:SEAR:SYNC:CAT? CURR
'Read out all patterns belong to the standard.
```

Characteristics

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:COMMent

This command defines a comment to a sync pattern. The pattern must have been selected before with the `DDEM:SEARch:SYNC:NAME` command.

Parameter

1<string>

Example

```
DDEM:SEAR:SYNC:NAME GSM_1
'Name of pattern
DDEM:SEAR:SYNC:DATA 0001 0000 0000 0001
'Data of pattern 1001
DDEM:SEAR:SYNC:COMM PATTERN FOR PPSK
'Comment
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:COPY

This command copies a pattern file. The pattern to be copied must have been selected before with the `DDEM:SEARch:SYNC:NAME` command.

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

Parameter

<string>

Example

```
DDEM:SEAR:SYNC:NAME GSM_1
'Name of pattern
```

```
DDEM:SEAR:SYNC:COPY GSM_2
'Copy GSM_1 to GSM_2
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:DATA

This command defines a sync sequence for the sync pattern. Four values represent a symbol. The value range of a symbol depends on the degree of modulation. FFFF entries are interpreted as "Don't Care Bits". The pattern must have been selected before with the `DDEM:SEARch:SYNC:NAME` command.

Important: *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.*

The degree of modulation belongs to the pattern and is set with the `DDEM:SEAR:SYNC:NST` command.

Parameter

<string>

Example

```
DDEM:SEAR:SYNC:NAME GSM_1
'Name of pattern
DDEM:SEAR:SYNC:DATA 00010000FFFF
'Data of pattern
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:DELete

This command deletes a sync sequence. The sync sequence to be deleted must have been selected before with the `DDEM:SEARch:SYNC:NAME` command.

Example

```
DDEM:SEAR:SYNC:NAME GSM_1
'Name of pattern
DDEM:SEAR:SYNC:DEL
'Delete GSM_1 pattern
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:FOUNd?

This command queries whether one of the selected sync patterns (`DDEM:SEAR:SYNC:SEL`) is available in the signal. Up to 16 sync pattern files can be selected.

Example

```
DDEM:SEAR:SYNC:SEL 'GSM1',1,'GSM2',2
'Selects the sync patterns which are to be searched in the
signal.
DDEM:SEAR:SYNC:STAT ON
'Starts the search.
DDEM:SEAR:SYNC:FOUN?
'Queries which sync patterns were found
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:MODE

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 with the `DDEM:SEARch:BURSt:STATe = ON` command.

Parameter

MEAS | SYNC

Example

```
DDEM:SEAR:SYNC:MODE SYNC
'The measurement is performed only with successful
'synchronization.
```

Characteristics

*RST value: MEAS
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:NAME

This command selects a sync pattern for editing or for a new entry.

Parameter

<string>

Example

```
DDEM:SEAR:SYNC:NAME PATT_1
'Selects the pattern Patt_1
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:NSTate

This command selects the degree of modulation (number of permitted states). The pattern must have been selected before with the `DDEM:SEAR:SYNC:NAME` command.

Parameter

MSK	2
PSK	2, 4, 8
QAM	16...1024
FSK	2, 4

Example

```
DDEM:SEAR:SYNC:NAME GSM_1
'Selects the "GSM_1" pattern.
DDEM:SEAR:SYNC:DATA 1001
'Enters 1001 as data.
DDEM:SEAR:SYNC:NST 4
'Sets the degree of modulation.
```

Characteristics

*RST value: --
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:PATTern:ADD

This command adds a pattern to the current standard. With the `DDEM:SEAR:SEL` command, only those patterns can be selected which belong to the current standard.

Parameter

<string>

Example

```
DDEM:PRES TETR
'Add digital standard Tetra
DDEM:SEAR:SYNC:PATT:ADD PGSM_1
'PGSM_1 to the 'standard.
```

Characteristics

*RST value: --
SCPI: device-specific

This command is an event and thus has no *RST value and no query.

[SENSe<1|2>:]DDEMod:SEARch:SYNC:PATTern:REMove

This command deletes one or all patterns from the current standard.

Parameter

<string> | ALL

Example

```
DDEM:PRES TETR
'Select digital standard Tetra
DDEM:SEAR:SYNC:PATT:REM ALL
'Remove all patterns from the Tetra standard.
```

Characteristics

*RST value: --
SCPI: device-specific

This command is an event and thus has no *RST value and no query.

[SENSe<1|2>:]DDEMod:SEARch:SYNC:SELect

This command selects a predefined sync pattern file. Up to 16 sync pattern files may be given.

Parameter

<string>,<string>,...

Example

```
DDEM:SEAR:SYNC:SEL PAT_GSM_1,PAT_GSM_5
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC[:STATe]

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

Parameter

ON | OFF

Example

```
DDEM:SEAR:SYNC ON
'Switches the sync search on
```

Characteristics

*RST value: OFF
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SEARch:SYNC:TEXT

This command defines a text to explain the pattern. The text is displayed only in the selection menu (manual control). This text is supposed to be short and concise. Detailed information about the pattern is given in the comment.

Parameter

<string>

Example

```
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.
```

Characteristics

*RST value: ""
SCPI: device-specific

[SENSe<1|2>:]DDEMod:SRATe

This command defines the symbol rate.

Parameter

100 Hz to max.

Example

```
DDEM:SRAT 18kHz
'Sets the symbol rate to 18 kHz.
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard:CATalog?

This command reads the names of all digital standards.
The file names are output without file extension. Syntax of output format:
standard_1,standard_2, ... ,standard_n

Example

```
DDEM:STAN:CAT?
'Reads all digital standards
```

Characteristics:

*RST value: -
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard: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.

Parameter

<string>

Example

```
DDEM:STAN:GRO 'GSM'
'Selects group GSM for the new standard
DDEM:STAN:COMM 'FOR TEST'
'Enters the comment
DDEM:STAN:PREF 'GSM_NB'
'Enters the prefix of the Sync patterns
DDEM:STAN:SAVE 'XG_2000'
'Stores the current settings including group, comment and
prefix as 'XG_2000 standard. 'The strings of the above
commands are cleared.
```

Characteristics

*RST value: "
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard:DELete

This command deletes the selected digital standard. The file names of the predefined standards can be determined with the query `SENS:DDEM:STAND:CAT?` (see below).

Note:
The standards predefined by Rohde & Schwarz can be restored using the FACTORY DEFAULTS softkey (HOME VSA menu).

Parameter

<file_name>

Example

```
DDEM:STAN:DEL 'STD_GSM'
'Deletes the STD_GSM standard.
```

Characteristics

*RST value: "
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard:GROup

This command enters the group for a new standard. The group 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 group to be entered for the next standard. In this case a blank string is returned when a query is made.

Parameter

<string>

Example

```
DDEM:STAN:GRO 'GSM'
'Selects group GSM for the new standard
DDEM:STAN:COMM 'FOR TEST'
'Enters the comment   "DDEM:STAN:PREF
DDEM:STAN:PREF 'GSM_NB'
'Enters the prefix of the Sync patterns
DDEM:STAN:SAVE 'XG_2000'
'Stores the current settings including group, comment and
'prefix as 'XG_2000 standard. The strings of the above
'commands are cleared.
```

Characteristics

*RST value: “
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard:PREfix

This command defines the prefix of the sync pattern for a standard. When a sync pattern for the standard is selected later, the patterns containing this string at the start are offered with priority in the selection table (only relevant to manual operation). When Remote: control is used, the string is deleted after the standard has been stored, allowing a new prefix to be entered for the next standard. In this case a blank string is returned when a query is made.

Parameter

<string>

Example

```
DDEM:STAN:GRO 'GSM'
'Selects group GSM for the new standard
DDEM:STAN:COMM 'FOR TEST'
'Selects group GSM for the new standard
DDEM:STAN:PREF 'GSM_NB'
'Enters the prefix of the Sync patterns
DDEM:STAN:SAVE 'XG_2000'
'Stores the current settings including group, comment and
prefix as 'XG_2000 standard. The strings of the above
commands are cleared.
```

Characteristics

*RST value: “
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANdard:PREset

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

Example

```
DDEM:STAN:PRE
'Restores the default settings of the currently selected
standard.
```

Characteristics

*RST value: --
SCPI: device-specific

This command is an event and thus has no *RST value and no query.

[SENSe<1|2>:]DDEMod:STANdard:SAVE

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 to define a group, a comment and a prefix before storing the standard (see example).

Parameter

<file_name>

Example

```
DDEM:STAN:GRO 'GSM'
'Selects group GSM for the new standard
DDEM:STAN:COMM 'FOR TEST'
'Enters the comment for the new standard
DDEM:STAN:PREF 'GSM_NB'
'Enters the prefix of the Sync patterns
DDEM:STAN:SAVE 'XG_2000'
```

```
'Stores the current settings including group, comment and
'prefix as 'XG_2000 standard. The strings of the above
'commands are cleared.
```

Characteristics

*RST value: “
SCPI: device-specific

[SENSe<1|2>:]DDEMod:STANDard:SYNC:OFFSet

This command defines the number of bits to be reoffset of the pattern in symbols with reference to the start of the burst.

Parameter

<numeric_value>

Example

```
DDEM:SEAR:SYNC:OFFS 10
'The sync offset comprises 10 symbols before 'the start of
the burst.
```

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe<1|2>:]DDEMod:TIME

The command determines the number of displayed symbols (result length).

Parameter

10 to 8000

Example

```
DDEM:TIME 80
'Sets result length to 80 symbols.
```

Characteristics

*RST value: Depends on the demodulation standard.
SCPI: device-specific

[SENSe<1|2>:]DDEMod:UQAM:FORMat

This command selects the specific demodulation mapping for UQAM.
The available User QAM demodulation modes are listed in the column USER-QAM of table MODULATION & MAPPING and depend on the contents of the available User QAM mapping files.

If several mappings are available for selected demodulation mode, it is additionally required to select the mapping to be used.

"`SENS:DDEM:MAPP:CAT?`" ?" returns the available mappings for the currently selected demodulation mode.

Parameter

<UQAM_demod_mode>

Example

```
DDEM:FORM UQAM
'Switch UQAM demodulation on
DDEM:UQAM:FORM ’UQAM_demod_mode’
'Select the UQAM demodulation mode
DDEM:MAPP ’UQAM_mapping_file’
'Select the User QAM mapping if needed
```
(s. above)

Characteristics

*RST value: -
SCPI: device-specific

This command is only available for UQAM demodulation. Related mapping files have to be imported.

[SENSe<1|2>:]DDEMod:UQAM:NSTate?

This command returns the specific modulation level for FQAM.

Example

```
DDEM:FORM UQAM
'Switch User QAM demodulation on.

DDEM:UQAM:FORM 'special'
'Selects user mapping 'special.

DDEM: UQAM:NST?
'Returns the modulation level.
```

Characteristics

*RST value: -
SCPI: device-specific

This command is only available for UQAM demodulation.

[SENSe<1|2>:]DDEMod:VSB:NSTate

The command determines the specific demodulation type for VSB. The numeric suffix <1|2> has no meaning with this command.

Parameter

8 8VSB

Example

```
DDEM:FORM VSB
'Switch on VSB demodulation
DEM:VSB:NST 8
'Select 8VSB demodulation
```

Characteristics

*RST value: -
SCPI: device-specific.

This command is only available for VSB demodulation.

[SENSe<1|2>:]DDEMod:WBANd[:STATe]

This command switches the use of option “Bandwidth Extension R&S FSQ-B72” signal path below 100 MHz on or off. Option “Bandwidth Extension R&S FSQ-B72” is automatically activated when using sample rates above 100 MHz (= symbol rate * points/symbol). If the state is set to ON the B72 signal path is also used below 100MHz.The command is available if the symbol rate is ≥ 5.1MHz (at 4 points/symbol). Reducing the symbol rate below 5.1 MHz will automatically switch off this function.

Parameter

ON | OFF

Example

```
DDEM:WBAN ON
'Switches the use of B72 signal path below 100 MHz on.
```

Characteristics

*RST value: OFF
SCPI: device-specific.

This command is only available for R&S FSQ and if R&S FSQ-B72 is installed.

6.6.2 SENSe:FREQuency - Subsystem

The SENSe:FREQuency subsystem controls the frequency axis of the active measurement window. The measurement window is selected via SENSe1 (SCREEN A) and SENSe2 (SCREEN B).

[SENSe<1|2>:]FREQuency:CENTer:STEP:AUTO

This command links the step width to the current standard (ON) or sets the step width entered with the `FREQ:CENT:STEP` command (OFF).

Parameter

ON | OFF

Example

```
FREQ:CENT:STEP:AUTO ON
'Activates the linking of the step width to the current
'standard.
```

Characteristics

*RST value: ON
SCPI: device-specific

6.7 TRACe – Subsystem

The TRACe subsystem controls access to the instrument's internal trace memory. The numeric suffix is used in TRACe to make the distinction between the two measurement windows SCREEN A and SCREEN B:

- TRACe1 = Screen A
- TRACe2 = Screen B.

In Vector Analyzer mode, the numeric suffixes 3 and 4 are used in addition to make the distinction between the two measurement windows SCREEN C and SCREEN D in SPLIT SCREEN mode:

- TRACe3 = Screen C
- TRACe4 = Screen D.

For commands without suffix, screen A is selected automatically.

Full Screen	The settings are valid for the measurement window selected with the numeric suffix. They become effective as soon as the corresponding measurement window has been selected as active measurement window using the command `DISPlay[:WINDow<1|2>]:SELect`. Triggering measurements and querying measured values is possible only in the active measurement window.
Split Screen	The settings are valid for the measurement window selected by means of the numeric suffix and become effective immediately.

TRACe<1|2>[:DATA]

Parameter

TRACE1 | TRACE2 | TRACE3 | TRACE4 , <block> | <numeric_value>

This command transfers trace data from the control computer to the instrument, the query reads trace data out of the instrument. The associated measurement window is selected with the numeric suffix of TRACe<1|2>.

Number and format of the measurement values for operating mode Vector Signal Analysis

Cartesian diagrams

In all cartesian diagrams (Magnitude, Phase, Frequency, Real/Imag, Eye) only the Y-values are transferred. The number of Y-valiues is the product of RESULT LENGTH and POINTS PER SYMBOL. The X-value related to the first Y-value is queried with command DISP:TRAC:X:START?.
The test data are transferred in the unit selected for display. FORMAT REAL,32 is to be used for binary transmission.

Note:
In the case of the eye pattern, results are simply superimposed in the display, ie the EYE representation is the same as the REAL/IMAG representation.

Polar diagrams

In the polar diagrams (Polar Constellation, Polar Vector) the real and the imaginary component are transferred as a pair for each result. The number of value pairs is the product of RESULT LENGTH and POINTS PER SYMBOL for POLAR VECTOR, and the RESULT LENGTH for POLAR CONSTELLATION.
FORMAT REAL,32 is to be used for binary transmission.

Symbols & Modulation Accuracy
Symbol Table:
The displayed symbols can be read out as TRACE1. The data is transferred in symbols in UINT16 format. The value range depends on the specific demodulation mode (for 8PSK the value range for a symbol is 0..7)

Modulation Accuracy:
The symbol accuracy is read out as TRACE2.

Modulation type FSK, number of measurement values for FSK: 42, format:

<1: FSK Dev Error (Result)>,<2: FSK Dev Error (Peak)>,
<3: FSK Dev Error (atSym)>,<4: FSK Dev Error (Rms)>,
<5: FSK Dev Error (Avg)>,<6: FSK Dev Error (StdDev)>,
<7: FSK Dev Error (Total Peak)>,<8: FSK Meas Dev (Result)>,
<9: FSK Meas Dev (Rms)>,<10: FSK Meas Dev (Avg)>,
<11: FSK Meas Dev (StdDev)>,<12: FSK Rev Dev (Result)>,
<13: Carrier Freq Err (Result)>,<14: Carrier Freq Err (Rms)>,
<15: Carrier Freq Err (Avg)>,<16: Carrier Freq Err (StdDev)>,
<17: Carrier Freq Drift (Result)>,<18: Carrier Freq Drift (Rms)>,
<19: Carrier Freq Drift (Avg)>,<20: Carrier Freq Drift (StdDev)>,
<21: Mag Err (Result)>,<22: Mag Err (Peak)>,
<23: Mag Err (atSym)>,<24: Mag Err (Rms)>,
<25: Mag Err (Avg)>,<26: Mag Err (StdDev)>,

<27: Mag Err (Total Peak)>,<28: Ampt Droop (Result)>,
<29: Ampt Droop (Rms)>,<30: Ampt Droop (Avg)>,
<31: Ampt Droop (StdDev)>,<32: Mean Power (Result)>,
<33: Mean Power (Peak)>,<34: Mean Power (atSym)>,
<35: Mean Power (Rms)>,<36: Mean Power (Avg)>,
<37: Mean Power (StdDev)>,<38: Mean Power (Total Peak)>,
<39: Trigger to Sync (Result)>,<40: Trigger to Sync (Rms)>,
<41: Trigger to Sync (Avg)>,<42: Trigger to Sync (StdDev)>,

Modulation type VSB, number of measurement values: 57

<1: EVM (Result)>,<2: EVM (Peak)>,
<3: EVM (atSym)>,<4: EVM (Rms)>,
<5: EVM (Avg)>,<6: EVM (StdDev)>,
<7: EVM (95Pctl)>,<8: EVM (Total Peak)>,
<9: Mag Err (Result)>,<10: Mag Err (Peak)>,
<11: Mag Err (atSym)>,<12: Mag Err (Rms)>,
<13: Mag Err (Avg)>,<14: Mag Err (StdDev)>,
<15: Mag Err (Total Peak)>,<16: Phase Err (Result)>,
<17: Phase Err (Peak)>,<18: Phase Err (atSym)>,
<19: Phase Err (Rms)>,<20: Phase Err (Avg)>,
<21: Phase Err (StdDev)>,<22: Phase Err (Total Peak)>,
<23: Carrier Freq Err (Result)>,<24: Carrier Freq Err (Rms)>,
<25: Carrier Freq Err (Avg)>,<26: Carrier Freq Err (StdDev)>,
<27: Ampt Droop (Result)>,<28: Ampt Droop (Rms)>,
<29: Ampt Droop (Avg)>,<30: Ampt Droop (StdDev)>,
<31: Origin Offset (Result)>,<32: Origin Offset (Rms)>,
<33: Origin Offset (Avg)>,<34: Origin Offset (StdDev)>,
<35: IQ Imbalance (Result)>,<36: IQ Imbalance (Rms)>,
<37: IQ Imbalance (Avg)>,<38: IQ Imbalance (StdDev)>,
<39: Mean Power (Result)>,<40: Mean Power (Peak)>,
<41: Mean Power (atSym)>,<42: Mean Power (Rms)>,
<43: Mean Power (Avg)>,<44: Mean Power (StdDev)>,
<45: Mean Power (Total Peak)>, <46: RHO (Result)>,
<47: RHO (Rms)>,<48: RHO (Avg)>,
<49: RHO (StdDev)>, <50: Trigger to Sync (Result)>,
<51: Trigger to Sync (Rms)>,<52: Trigger to Sync (Avg)>,
<53: Trigger to Sync (StdDev)>, <54: Pilot Level Error (Result)>,
<55: Pilot Level Error (Rms)>,<56: Pilot Level Error (Avg)>,
<57: Pilot Level Error (StdDev)>

Modulation types other than FSK and VSB, number of measurement values: 53

<1: EVM (Result)>,<2: EVM (Peak)>,
<3: EVM (atSym)>,<4: EVM (Rms)>,
<5: EVM (Avg)>,<6: EVM (StdDev)>,
<7: EVM (95Pctl)>,<8: EVM (Total Peak)>,
<9: Mag Err (Result)>,<10: Mag Err (Peak)>,
<11: Mag Err (atSym)>,<12: Mag Err (Rms)>,
<13: Mag Err (Avg)>,<14: Mag Err (StdDev)>,
<15: Mag Err (Total Peak)>,<16: Phase Err (Result)>,
<17: Phase Err (Peak)>,<18: Phase Err (atSym)>,
<19: Phase Err (Rms)>,<20: Phase Err (Avg)>,
<21: Phase Err (StdDev)>,<22: Phase Err (Total Peak)>,
<23: Carrier Freq Err (Result)>,<24: Carrier Freq Err (Rms)>,
<25: Carrier Freq Err (Avg)>,<26: Carrier Freq Err (StdDev)>,
<27: Ampt Droop (Result)>,<28: Ampt Droop (Rms)>,

<29: Ampt Droop (Avg)>,<30: Ampt Droop (StdDev)>,
<31: Origin Offset (Result)>,<32: Origin Offset (Rms)>,
<33: Origin Offset (Avg)>,<34: Origin Offset (StdDev)>,
<35: IQ Imbalance (Result)>,<36: IQ Imbalance (Rms)>,
<37: IQ Imbalance (Avg)>,<38: IQ Imbalance (StdDev)>,
<39: Mean Power (Result)>,<40: Mean Power (Peak)>,
<41: Mean Power (atSym)>,<42: Mean Power (Rms)>,
<43: Mean Power (Avg)>,<44: Mean Power (StdDev)>,
<45: Mean Power (Total Peak)>, <46: RHO (Result)>,
<47: RHO (Rms)>,<48: RHO (Avg)>,
<49: RHO (StdDev)>, <50: Trigger to Sync (Result)>,
<51: Trigger to Sync (Rms)>,<52: Trigger to Sync (Avg)>,
<53: Trigger to Sync (StdDev)>,

6.8 TRIGger - Subsystem

The TRIGger subsystem controls the trigger characteristics of the active measurement window.

TRIGger[:SEQuence]:LEVel[:EXTernal]

This command activates an external TTL trigger signal, which is applied to the EXT TRIGGER /GATE input on the rear of the instrument. The external trigger level can be adjusted in the range from 0.5V to 3.5V.

Parameter

0.5 V to 3.5 V

Example

```
TRIG:LEV 2.5
'sets the external trigger level to 2.5 V
```

Characteristics

*RST value: 1.4V
SCPI: device-specific

6.9 Table of Softkeys Assigned to IEC/IEEE Bus Commands

6.9.1 Hotkey VSA

VSA	`INST:SEL DDEM` or `INST:NSEL 2`

6.9.2 Hotkeys of Option

EXIT VSA	`INST:SEL SAN` or `INST:NSEL 1` .
PRESET VSA	In Remote: control, all device settings are reset by means of the *RST command.
SETTINGS	-
HOME VSA	The Hotkey HOME VSA opens the menu selection for Option R&S FSQ-K70/FSMR-B73/FSU-B73. The ADJUST REF LEVEL softkey directly results in a setting. It is therefore described first. Then, the menus are described in the order of the softkeys occurring in the menus.
ADJUST REF LEVEL	`:SENSe:DDEMod:PRESet:RLEVel`

6.9.2.1 Menu DIGITAL STANDARD

DIGITAL STANDARD	--
GENERIC STD LIST	No function in the IEC/IEEE bus operation.

STANDARD LIST	Queries all available standards.
	`[SENSe<1|2>:]DDEMod:STANdard:CATalog?`
	
	`[SENSe<1|2>:]DDEMod:PRESet[:STANdard]...<file_name > | GSM | EDGE | FW3Gppcdma | RW3Gppcdma | FQCDma | F95Cdma | RQCDma | R95Cdma | CDMa2000 | F1CDma2000 | R1CDma2000 | FNADc | RNADc | PDCDown | PDCup | PHS | TETRa | DECT | DCS1800 | PCS1900`
	
	<file_name > = Standards are selected via the file name.
	<standard > = Some standards can be selected via a parameter value (character data) also.

DELETE STANDARD	`[SENSe<1|2>:]DDEMod:STANdard:DELete <file_name>`

SAVE AS STANDARD	`[SENSe<1|2>:]DDEMod:STANdard:GROup <string>`
	`[SENSe<1|2>:]DDEMod:STANdard:COMMent <string>i`
	`[SENSe<1|2>:]DDEMod:STANdard:PREFix <string>`
	`[SENSe<1|2>:]DDEMod:STANdard:SAVE <file_name>`

CANCEL	No function in the IEC/IEEE bus operation.
SAVE	See softkey SAVE AS STANDARD
STANDARD DEFAULTS	`[SENSe<1|2>:]DDEMod:STANdard:PRESet`
NEW GENERIC..	No function in the IEC/IEEE bus operation.
EDIT GENERIC..	No function in the IEC/IEEE bus operation.
EDIT GENERIC STD	No function in the IEC/IEEE bus operation.
SHOW ALL STANDARDS	Automatically performed in the IEC/IEEE bus operation.
INSERT STANDARD	Automatically performed in the IEC/IEEE bus operation.
REMOVE STANDARD	Automatically performed in the IEC/IEEE bus operation.
CANCEL	**No function in the IEC/IEEE bus operation.**
SAVE	No function in the IEC/IEEE bus operation.
DELETE GENERIC STD	No function in the IEC/IEEE bus operation.

6.9.2.2 Menu MODULATION SETTINGS

MODULATION SETTINGS	--
SYM RATE (270.833kHz)	`:[SENSe<1|2>:]DDEMod:SRATe <num_value>`

`MODULATION & MAPPING`

Einstellen von vordefinierten Standard-Mappings:

Modulation BPSK
```
:[SENSe<1|2>:]DDEMod:FORMat  PSK
:[SENSe<1|2>:]DDEMod:PSK:NSTate  2
```
Modulation QPSK
```
:[SENSe<1|2>:]DDEMod:FORMat  QPSK
:[SENSe<1|2>:]DDEMod:QPSK:FORMat  NORMal
```
Modulation OQPSK
```
:[SENSe<1|2>:]DDEMod:FORMat  QPSK
:[SENSe<1|2>:]DDEMod:QPSK:FORMat  OFFSet
```
Modulation 8PSK
```
:[SENSe<1|2>:]DDEMod:FORMat  PSK
:[SENSe<1|2>:]DDEMod:PSK:FORMat NORMal
:[SENSe<1|2>:]DDEMod:PSK:NSTate  8
```
Modulation DQPSK
```
:[SENSe<1|2>:]DDEMod:FORMat  QPSK
:[SENSe<1|2>:]DDEMod:QPSK:FORMat DIFFerential
```
Modulation D8PSK
```
:[SENSe<1|2>:]DDEMod:FORMat  PSK
:[SENSe<1|2>:]DDEMod:PSK:FORMat DIFFerential
:[SENSe<1|2>:]DDEMod:PSK:NSTate  8
```
Modulation P1/4-DQPSK
```
:[SENSe<1|2>:]DDEMod:FORMat QPSK
:[SENSe<1|2>:]DDEMod:QPSK:FORMat DPI4
```
Modulation 3P/8-8PSK
```
:[SENSe<1|2>:]DDEMod:FORMat  PSK
:[SENSe<1|2>:]DDEMod:PSK:FORMat N3Pi8
:[SENSe<1|2>:]DDEMod:PSK:NSTate  8
```
Modulation DMSK
```
:[SENSe<1|2>:]DDEMod:FORMat  MSK
:[SENSe<1|2>:]DDEMod:MSK:FORMat  TYPE2 | DIFFerential
```
Modulation MSK
```
:[SENSe<1|2>:]DDEMod:FORMat  MSK
:[SENSe<1|2>:]DDEMod:MSK:FORMat  TYPE1 | NORMal
```
Modulation 2FSK
```
:[SENSe<1|2>:]DDEMod:FORMat  FSK
:[SENSe<1|2>:]DDEMod:FSK:NSTate  2
```
Modulation 4FSK
```
:[SENSe<1|2>:]DDEMod:FORMat  FSK
:[SENSe<1|2>:]DDEMod:FSK:NSTate  4
```
Modulation 16QAM
```
:[SENSe<1|2>:]DDEMod:FORMat  QAM
:[SENSe<1|2>:]DDEMod:QAM:NSTate  16
```
Modulation 32QAM
```
:[SENSe<1|2>:]DDEMod:FORMat  QAM
:[SENSe<1|2>:]DDEMod:QAM:NSTate  32
```
Modulation 64QAM
```
:[SENSe<1|2>:]DDEMod:FORMat  QAM
:[SENSe<1|2>:]DDEMod:QAM:NSTate  64
```
Modulation 128QAM
```
:[SENSe<1|2>:]DDEMod:FORMat  QAM
:[SENSe<1|2>:]DDEMod:QAM:NSTate  128
```
Modulation 256QAM
```
:[SENSe<1|2>:]DDEMod:FORMat  QAM
:[SENSe<1|2>:]DDEMod:QAM:NSTate  256
```

Selecting the mappings:
```
:[SENSe<1|2>:]DDEMod:MAPPing <mapping_name>
```

Queries the available mappings for the modulation type:
```
:[SENSe<1|2>:]DDEMod:MAPPing:CATalog?
```

`MODULATION FILTER`

```
:[SENSe<1|2>:]DDEMod:FILTer:MODulation
.....<TX-Filter>,<ISI-Filter>,<MEAS-FILTER>
```
Queries the available filters:
```
:[SENSe<1|2>:]DDEMod:FILTer:CATalog?
```

EQUALIZER SETTINGS

EQUALIZER ON OFF — :[SENSe<1|2>:]DDEMod:EQUalizer[:STATe] ON | OFF

EQUALIZER TRAIN — :[SENSe<1|2>:]DDEMod:EQUalizer:ADAPt ON

EQUALIZER FREEZE — :[SENSe<1|2>:]DDEMod:EQUalizer:ADAPt OFF

EQUALIZER RESET — :[SENSe<1|2>:]DDEMod:EQUalizer:RESet

EQUALIZER LENGTH — :[SENSe<1|2>:]DDEMod:EQUalizer:LENGth <num_value>

EQUALIZER STEP — :[SENSe<1|2>:]DDEMod:EQUalizer:CNVR <num_value>

EQUALIZER LOAD — :[SENSe<1|2>:]DDEMod:EQUalizer:LOAD <name>

EQUALIZER SAVE — :[SENSe<1|2>:]DDEMod:EQUalizer:SAVE <name>

EQUALIZER DELETE — :[SENSe<1|2>:]DDEMod:EQUalizer:DELete <name>

ALPHA/BT (0.3) — :[SENSe<1|2>:]DDEMod:FILTer:ALPHa <num_value>

FSK DEV (123.4 kHz) — :CALCulate<1|2>:FSK:DEViation:REFerence <num_value>

POINTS /SYMB (4) — :[SENSe<1|2>:]DDEMod:PRATe 1| 2| 4| 8| 16

NEW USER SET — No function in the IEC/IEEE bus operation.

DELETE USER SET — No function in the IEC/IEEE bus operation.

SAVE USER SET — No function in the IEC/IEEE bus operation.

6.9.2.3 Menu DEMOD SETTINGS

DEMOD SETTINGS	--
RECORD LENGTH	
RECORD LEN (AUTO)	`:[SENSe<1|2>:]DDEMod:RLENgth:AUTO ON | OFF`
RECORD LEN (8 kSym)	`:[SENSe<1|2>:]DDEMod:RLENgth <num_value> SYM` Query returns value in seconds
RECORD LEN (1.234 ms)	`:[SENSe<1|2>:]DDEMod:RLENgth <num_value> S` Query returns value in seconds.
RESULT LENGTH	`:[SENSe<1|2>:]DDEMod:TIME <num_value>`
EVAL LINES	-- Both evaluation lines are always switched on/off.
EVAL LINE 1	`:CALCulate<1|2>:ELIN:STATe ON` `:CALCulate<1|2>:ELIN<1> <num_value>`
EVAL LINE 2	`:CALCulate<1|2>:ELIN:STATe ON` `:CALCulate<1|2>:ELIN<2> <num_value>`
FORCE WB PATH	`:[SENSe<1|2>:]DDEMod:WBANd[:STATe] ON | OFF`
MULTI ON OFF	`:[SENSe<1|2>:]DDEMod:MBURst ON | OFF`
FORCE WB PATH	`:[SENSe<1|2>:]DDEMod:WBANd[:STATe] ON | OFF`
NORMALIZE ON OFF	`:[SENSe<1|2>:]DDEMod:NORMalize ON | OFF` Normalize for PSK / MSK / QAM
SIDEBAND NORM INV	`:[SENSe<1|2>:]DDEMod:SBANd NORMal|INVerse`
POINTS/SYM (4)	`:[SENSe<1|2>:]DDEMod:PRATe 1| 2| 4| 8| 16`

6.9.2.4 Menu BURST & PATTERN

BURST & PATTERN	--
BURST SRCH ON OFF	:[SENSe<1|2>:]DDEMod:SEARch:BURSt[:STATe] ON | OFF
THRESHOLD (-20dBRef)	--
THRESHOLD AUTO	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:AUTO ON
THRESHOLD RELATIVE	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:AUTO OFF :[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:MODE REL :[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold <num_value>
THRESHOLD ABSOLUTE	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:AUTO OFF :[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold:MODE ABS :[SENSe<1|2>:]DDEMod:SEARch:BURSt:THReshold[:LEVel] <num_value>
HYSTERESIS MAN	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:HYSTeresis[:LEVel] <num_value>
EXPERT SETTINGS	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:LENGth[:MINimum] <num_value> :[SENSe<1|2>:]DDEMod:SEARch:BURSt:LENGth:MAXimum <num_value> :[SENSe<1|2>:]DDEMod:SEARch:BURSt:SKIP:RISing <num_val> :[SENSe<1|2>:]DDEMod:SEARch:BURSt:SKIP:FALLing <num_value> :[SENSe<1|2>:]DDEMod:SEARch:BURSt:GLENgth[:MINimum] <num_value>
MEAS ONLY ON BURST	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:MODE BURSt | MEAS
BURST SGL MULTI	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:MBURSt ON | OFF
PAT SRCH ON OFF	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:STATe ON | OFF :[SENSe<1|2>:]DDEMod:SEARch:SYNC:FOUNd?
SELECT PATTERN	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:SELect "pattern_name_1", position_1, "pattern_name_2", position_2, ..., "pattern_name_n", position_n>
PATTERN SETTINGS	--
STD PATT LIST	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:CATalog? CURRent
PATTERN LIST	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:CATalog? ALL
SHRINK PAT LIST	--
ADD PAT TO STD	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:PATTern:ADD <pat_name>
NEW PATTERN	--

PATTERN SETTINGS	Commands for columns of table: :[SENSe<1|2>:]DDEMod:SEARch:SYNC:NAME <pattern_name> :[SENSe<1|2>:]DDEMod:SEARch:SYNC:TEXT <string> :[SENSe<1|2>:]DDEMod:SEARch:SYNC:COMMent <string> :[SENSe<1|2>:]DDEMod:SEARch:SYNC:NSTate 2|4|8|16|32|64|128|256|512|1024
PATTERN SYMBOLS	Commands for columns of table: :[SENSe<1|2>:]DDEMod:SEARch:SYNC:NAME <string>
(*)	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:DATA "FFFF"
INSERT	No function in the IEC/IEEE bus operation.
EDIT	No function in the IEC/IEEE bus operation.
DELETE	No function in the IEC/IEEE bus operation.
SAVE	Automatically performed in the IEC/IEEE bus operation.
CANCEL	No function in the IEC/IEEE bus operation.
EDIT PATTERN	Editing is not possible via IEC/IEEE bus. Only overwriting is possible
DELETE PATTERN	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:SEL "GSM_1 :[SENSe<1|2>:]DDEMod:SEARch:SYNC:DELete
REMOVE PAT FROM STD	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:PATTern:REMove <pattern_name>
REMOVE ALL FROM STD	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:PATTern:REMove ALL
MEAS ONLY ON PATT	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:MODE MEAS | SYNC

6.9.2.5 Menu MEAS RESULTS

MEAS RESULT	--
RESULT RAW FILT	:[SENSe<1|2>:]DDEMod:FILTer[:STATe] ON | OFF
MEAS SIGNAL	:CALCulate<1|2>:FEED 'XTIM:DDEM:MEAS' für Untermenü siehe Ref Signal
REF SIGNAL	:CALCulate<1|2>:FEED 'XTIM:DDEM:REF'

MAGNITUDE (REL/ABS)
```
:CALCulate<1|2>:FORMat MAGNitude
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y[:SCALe]:MODE
                                           ABSolute | RELative
```

PHASE (WRAP/UNWR)
```
:CALCulate<1|2>:FORMat PHASe | UPHase
```

FREQUENCY (REL/ABS)
```
:CALCulate<1|2>:FORMat FREQuency
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y[:SCALe]:MODE
                                           ABSolute | RELative
```

REAL/IMAG
```
:CALCulate<1|2>:FORMat RIMag
```

EYE (I/Q)
```
:CALCulate<1|2>:FORMat IEYE | QEYE
```

IQ (COMP/CONS)
```
:CALCulate<1|2>:FORMat COMP | CONS
```

SPECTRUM
```
:CALCulate<1|2>:DDEM:SPECtrum[:STATe] ON | OFF
```

SIGNAL STATISTIC
```
:CALCulate:STATistics:CCDF[:STATe]  ON | OFF
```

ERROR SIGNAL
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
```

For result query also see SYMBOLS &MOD ACC softkey:

MAGNITUDE ERROR
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
:CALCulate<1|2>:FORMat MAGNitude
```

PHASE ERROR (WRAP/UNWR)
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
:CALCulate<1|2>:FORMat PHASe
```

FREQ ERROR (ABS/REL)
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
:CALCulate<1|2>:FORMat FREQuency
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y[:SCALe]:MODE   ABSolute |
RELative
```

REAL/IMAG
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
:CALCulate<1|2>:FORMat RIMag
```

AM & PM CONVERSION
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:MPH'
:CALCulate<1|2>:FORMat CONVersion
```

EVM
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:VECT'
:CALCulate<1|2>:FORMat MAGNitude
```

IQ ERROR (VECTOR)
```
:CALCulate<1|2>:FEED 'XTIM:DDEM:ERR:VECT'
:CALCulate<1|2>:FORMat COMP | CONS
```

ERROR SPECTRUM
```
:CALCulate<1|2>:DDEM:SPECtrum[:STATe] ON | OFF
```

ERROR STATISTIC
```
:CALCulate:STATistics:CCDF[:STATe]  ON | OFF
```

CAPTURE BUFFER
```
:CALCulate<1|2>:FEED 'TCAP'
```

MAG CAP BUFFER

```
:CALCulate<1|2>:FORMat MAGNitude
```

FREQUENCY ABS REL

```
:CALCulate<1|2>:FORMat FREQuency
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y[:SCALe]:MODE ABSolute |
    RELative
```

REAL/IMAG

```
:CALCulate<1|2>:FORMat RIMag
```

SPECTRUM

```
:CALCulate<1|2>:DDEM:SPECtrum[:STATe] ON | OFF
```

SIGNAL STATISTIC

```
:CALCulate:STATistics:CCDF[:STATe] ON | OFF
```

SYMBOLS & MOD ACC

```
:CALCulate<1|2>:FEED 'XTIM:DDEM:SYMB'

Summary of result query:
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:ADRoop?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:CFERror?
                  <none> | RMS | AVG | SDEV | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:DTTStart?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:EVM?
       <none> | PEAK | ASYM | RMS | AVG | SDEV | PCTL | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:FSK:DERRor?
           <none> | PEAK | ASYM | RMS | AVG | SDEV | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:FSK:MDEViation?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:FSK:CFDRift?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:GIMBalance?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:IQIMbalance?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:MERRor?
           <none> | PEAK | ASYM | RMS | AVG | SDEV | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:MPOWer?
           <none> | PEAK | ASYM | RMS | AVG | SDEV | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:OOFFset?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:PERRor?
           <none> | PEAK | ASYM | RMS | AVG | SDEV | TPEak
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:QERRor?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:RHO?
                     <none> | RMS | AVG | SDEV
:CALCulate:MARKer:FUNCtion:DDEM:STATistic:SNR?
                     <none> | RMS | AVG | SDEV
```

EQUALIZER

```
:CALCulate<1|2>:FEED 'XTIM:DDEM:IMP'
:CALCulate<1|2>:FEED 'XFR:DDEM:RAT'
```

MAGNITUDE (REL/ABS)

```
:CALCulate<1|2>:FEED 'XTIM:DDEM:IMP'
:CALCulate<1|2>:FORMat MAGNitude
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y:SPACing LINear | LOGarithmic
```

PHASE (WRAP/UNWR)

```
:CALCulate<1|2>:FEED 'XTIM:DDEM:IMP'
:CALCulate<1|2>:FORMat PHASe | UPHase
```

REAL/IMAG

```
:CALCulate<1|2>:FEED 'XTIM:DDEM:IMP'
:CALCulate<1|2>:FORMat RIMag
```

GROUP DELAY

```
:CALCulate<1|2>:FEED 'XFR:DDEM:RAT'
:CALCulate<1|2>:FORMat GDELay
```

PHASE RESP (WRAP/UNWR)
```
:CALCulate<1|2>:FEED 'XFR:DDEM:RAT'
:CALCulate<1|2>:FORMat PHASe | UPHase
```

FREQ RESP (LIN)
```
:CALCulate<1|2>:FEED 'XFR:DDEM:RAT'
:CALCulate<1|2>:FORMat MAGNitude
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y:SPACing LINear | LOGarithmic
```

CHAN RESP (LIN)
```
:CALCulate<1|2>:FEED 'XFR:DDEM:RAT'
:CALCulate<1|2>:FORMat MAGNitude
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y:SPACing LINear | LOGarithmic
```

RESULT LENGTH
```
:[SENSe<1|2>:]DDEMod:TIME <num_value>
```

NORMALIZE ON OFF

Normalize for PSK / MSK / QAM
```
:[SENSe<1|2>:]DDEMod:NORMalize ON | OFF
```

POINTS /SYM (4)
```
:[SENSe<1|2>:]DDEMod:PRATe 1| 2| 4| 8| 16
```

OFFSET EVM ON OFF
```
:[SENSe<1|2>:]DDEMod:ECALc:OFFSet  ON | OFF
```

HIGHLIGHT

No function in the IEC/IEEE bus operation.

REFDEVCOMP ON OFF

Normalize für FSK
```
:CALCulate<1|2>:FSK:DEViation:COMPensation ON | OFF
```

EVM CALC 8[MAX])
```
:[SENSe<1|2>:]DDEMod:ECALc SYMBol | SIGNal
```

6.9.2.6 Menu FIT TRACE

FIT TRACE

--

FIT TRIGGER
```
:CALCulate<1|2>:TRACe<1...3>:ADJust  TRIGger
```

FIT BURST
```
:CALCulate<1|2>:TRACe<1...3>:ADJust  BURSt
```

FIT PATTERN
```
:CALCulate<1|2>:TRACe:ADJust  PATTern
```

FIT ALIGN LEFT
```
:CALCulate<1|2>:TRACe<1...3>:ADJust:ALIGnment  LEFT
```

FIT ALIGN CENTER
```
:CALCulate<1|2>:TRACe<1...3>:ADJust:ALIGnment  CENTer
```

FIT ALIGN RIGHT
```
:CALCulate<1|2>:TRACe<1...3>:ADJust:ALIGnment  RIGHt
```

FIT ALIGN (20%)
```
:CALCulate<1|2>:TRACe<1...3>:ADJust:ALIGnment:VALue
                               <num_value>
```

SET SYMB# (-10 SYM)
```
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:X[:SCALe]:VOFFset <num_value>
```

RECORD LEN AUTO	:[SENSe<1|2>:]DDEMod:RLENgth:AUTO ON | OFF
RECORD LEN (8.0kSYM)	:[SENSe<1|2>:]DDEMod:RLENgth <num_value> SYM
RECORD LEN (1.234 ms)	:[SENSe<1|2>:]DDEMod:RLENgth <num_value> S
PAT POS (100 SYM)	:[SENSe<1|2>:]DDEMod:STANdard:SYNC:OFFSet <num_value>
RESULT LENGTH	:[SENSe<1|2>:]DDEMod:TIME <num_value>
FIT OFFSET (57SYM)	:CALCulate<1|2>:TRACe<1...3>:ADJust:ALIGnment:OFFSet <num_value>

6.9.2.7 Menu ZOOM

ZOOM START	--
ZOOM START	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:STARt <num_value>
ZOOM LENGTH	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:LENGth <num_value>
DEMOD NEXT RIGHT	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:NEXT
DEMOD RESTART	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:FIRSt
DEMOD @ ZOOM START	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:STARt
CAPTURE AUTO OFF	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:CAPTure:AUTO ON | OFF
MULTI ON OFF	:[SENSe<1|2>:]DDEMod:SEARch:MBURst:STATe ON | OFF

6.9.2.8 Menu RANGE

RANGE	--
X-AXIS QUANTIZE	CALCulate:STATistics:SCALe:X:BCOunt <num_value>
X-AXIS /DIV	:DISPlay[:WINDow<1|2>]:TRACe<1..3>:X[:SCALe]:PDIVision <num_value>

X-AXIS REF VALUE	`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:RVALue <num_value>`
X-AXIS REF POS	`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:RPOSition 0..100PCT`
Y-AXIS /DIV	`:DISPlay[:WINDow<1|2>]:TRACe<1..3>:Y[:SCALe]:PDIVision <num_value>`
Y-AXIS REF VALUE	`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y[:SCALe]:RVALue <num_value>`
Y-AXIS REF POS	`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y[:SCALe]:RPOSition 0..100PCT`
DEFAULT SETTINGS	--
BIN	No function in the IEC/IEEE bus operation.
OCT	No function in the IEC/IEEE bus operation.
HEX	No function in the IEC/IEEE bus operation.
DEC	No function in the IEC/IEEE bus operation.

6.9.2.9 Menu FACTORY DEFAULTS

FACTORY DEFAULTS	No function in the IEC/IEEE bus operation.
GENERIC STANDARDS	`:[SENSe<1|2>:]DDEMod:FACTory GSTandards`
STANDARDS	`:[SENSe<1|2>:]DDEMod:FACTory STANdards`
MAPPINGS	`:[SENSe<1|2>:]DDEMod:FACTory MAPPings`
PATTERN	`:[SENSe<1|2>:]DDEMod:FACTory PATTerns`
FILTERS	`:[SENSe<1|2>:]DDEMod:FACTory FILTers`
EQUALIZERS	`:[SENSe<1|2>:]DDEMod:FACTory EQUalizer`
ALL	`:[SENSe<1|2>:]DDEMod:FACTory ALL`

6.9.2.10 Menu IMPORT

IMPORT

- GENERIC STANDARDS — `:[SENSe<1|2>:]DDEMod:IMPort:GSTandard <name>,<path>`
- STANDARDS — `:[SENSe<1|2>:]DDEMod:IMPort:STANdard <name>,<path>`
- MAPPINGS — `:[SENSe<1|2>:]DDEMod:IMPort:MAPPing <name>,<path>`
- PATTERN — `:[SENSe<1|2>:]DDEMod:IMPort:PATTern <name>,<path>`
- FILTERS — `:[SENSe<1|2>:]DDEMod:IMPort:FILTer <name>,<path>`
- EQUALIZERS — `:[SENSe<1|2>:]DDEMod:IMPort:EQUalizer <name>,<path>`

6.9.2.11 Menu EXPORT

EXPORT

- GENERIC STANDARDS — `:[SENSe<1|2>:]DDEMod:EXPort:GSTandard <name>,<path>`
- STANDARDS — `:[SENSe<1|2>:]DDEMod:EXPort:STANdard <name>,<path>`
- MAPPINGS — `:[SENSe<1|2>:]DDEMod:EXPort:MAPPing <name>,<path>`
- PATTERN — `:[SENSe<1|2>:]DDEMod:EXPort:PATTern <name>,<path>`
- FILTERS — `:[SENSe<1|2>:]DDEMod:EXPort:FILTer <name>,<path>`
- EQUALIZERS — `:[SENSe<1|2>:]DDEMod:EXPort:EQUalizer <name>,<path>`

6.9.3 FREQ Key

FREQ

CENTER	:[SENSe<1|2>:]FREQuency:CENTer <num_value>
CF STEP AUTO MAN	:[SENSe<1|2>:]FREQuency:CENTer:STEP:AUTO ON|OFF
CF STEP SIZE	:[SENSe<1|2>:]FREQuency:CENTer:STEP <num_value>
FREQUENCY OFFSET	:[SENSe<1|2>:]FREQuency:OFFSet <num_value>

6.9.4 SPAN Key

SPAN

The functions of the SPAN key are irrelevant in the operating mode VSA.

6.9.5 AMPT Key

AMPT

REF LEVEL	DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel <num_value>
REF LEVEL UNIT	:CALCulate<1|2>:UNIT:POWer DBM |DBMV |DBUV |DBUA | DBPW| VOLT| AMPere| WATT
RANGE	--
X-AXIS QUANTIZE	CALCulate:STATistics:SCALe:X:BCOunt <num_value>
X-AXIS /DIV	:DISPlay[:WINDow<1|2>]:TRACe<1..3>:X[:SCALe]:PDIVision <num_value>
X-AXIS REF VALUE	:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:RVALue <num_value>
X-AXIS REF POS	:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:RPOSition 0..100PCT
Y-AXIS /DIV	:DISPlay[:WINDow<1|2>]:TRACe<1..3>:Y[:SCALe]:PDIVision <num_value>
Y-AXIS REF VALUE	:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y[:SCALe]:RVALue <num_value>

Y-AXIS REF POS	`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y[:SCALe]:RPOSition 0..100PCT`
DEFAULT SETTINGS	--
BIN	No function in the IEC/IEEE bus operation.
OCT	No function in the IEC/IEEE bus operation.
HEX	No function in the IEC/IEEE bus operation.
DEC	No function in the IEC/IEEE bus operation.
DISPLAY UNIT	--
Y UNIT LOG DB	`:DISPlay:WINDow:TRACe:Y:SPACing LOG`
Y UNIT LINEAR	`:DISPlay:WINDow:TRACe:Y:SPACing LIN`
Y UNIT DEG	`:CALCulate<1|2>:UNIT:ANGLe DEG`
Y UNIT RAD	`:CALCulate<1|2>:UNIT:ANGLe RAD`
X UNIT TIME	`:CALCulate<1|2>:X:UNIT:TIME S`
X UNIT SYMBOL	`:CALCulate<1|2>:X:UNIT:TIME SYM`
RF INPUT AC DC	`:INPut<1|2>:COUPling AC | DC`
RF ATTEN MANUAL	`:INPut<1|2>:ATTenuation:AUTO OFF` `:INPut<1|2>:ATTenuation <num_value>`
RF ATTEN AUTO	`:INPut<1|2>:ATTenuation:AUTO ON`
ADJUST REF LEVEL	`:SENSe:DDEMod:PRESet:RLEVel`
REF LEVEL OFFSET	`:DISP[:WIND<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel:OFFSet <num_value>`
Mixer	--
MIXER LVL AUTO	`:INPut:MIXer:AUTO ON`
MIXER LVL MANUAL	`:INPut:MIXer:AUTO OFF` `:INPut:MIXer[:POWER] <num_value>`

6.9.6 MKR Key

MKR

MARKER 1..4

```
CALCulate<1|2>:MARKer<1...4>[:STATe]  ON | OFF
CALCulate<1|2>:MARKer<1...4>:X <numeric value>
CALCulate<1|2>:MARKer<1...4>:Y?
CALCulate<1|2>:DELTamarker1[:STATe]  ON | OFF
CALCulate<1|2>:DELTamarker<1...4>:X <numeric value>
CALCulate<1|2>:DELTamarker<1...4>:Y?
```

MARKER NORM DELTA

```
CALCulate<1|2>:DELTamarker<1...4>[:STATe]  ON | OFF;
```

ALL MARKER OFF

```
CALCulate<1|2>:MARKer<1...4>:AOFF
CALCulate<1|2>:DELTamarker<1...4>:AOFF
```

MKR-> TRACE

```
CALCulate<1|2>:MARKer<1...4>:TRACe <num_value>
CALCulate<1|2>:DELTamarker<1...4>:TRACe <num_value>
```

6.9.7 MKR -> Key

MKR->

SELECT MARKER

--

MAX PEAK

```
:CALCulate<1|2>:MARKer<1..4>:MAXimum[:PEAK]
:CALCulate<1|2>:DELTamarker<1..4>:MAXimum[:PEAK]
```

MIN PEAK

```
:CALCulate<1|2>:MARKer<1..4>:MINimum[:PEAK]
:CALCulate<1|2>:DELTamarker<1..4>:MINimum[:PEAK]
```

MAX |PEAK|

```
:CALCulate<1|2>:MARKer<1..4>:MAXimum:APEak
:CALCulate<1|2>:DELTamarker<1..4>:MAXimum:APEak
```

SEARCH LIMITS

--

LEFT LIMIT

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits[:STATe]  ON|OFF
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits:LEFT  <num_value>
```

RIGHT LIMIT

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits[:STATe]  ON|OFF
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits:RIGHt  <num_value>
```

THRESHOLD

```
:CALCulate<1|2>:THReshold[:STATe]  ON|OFF
:CALCulate<1|2>:THReshold <num_value>
```

LIMITS = EVAL LINES

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits[:STATe]  ON
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits:LEFT  <num_value>
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits:RIGHT  <num_value>
```

SEARCH LIM OFF

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits[:STATe]  OFF
:CALCulate<1|2>:THReshold[:STATe]  ON|OFF
```

PEAK EXCURSION

```
:CALCulate<1|2>:MARKer<1..4>:PEXCursion  <num_value>
```

MKR -> TRACE	:CALCulate<1|2>:MARKer<1..4>:TRACe <num_value> :CALCulate<1|2>: DELTamarker <1..4>:TRACe <num_value>

6.9.8 MKR FCTN Key

MKR FUNC

PndB OUT ()	CALCulate<1|2>:MARKer<1..4>:FUNCtion:CPOint[:STATe] ON|OFF CALCulate<1|2>:MARKer<1..4>:FUNCtion:CPOint:VALue <num_value> CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:PHDiff? CALCulate<1|2>:MARKer<1...4>:FUNCtion:CPOint:POWer?
SUMMARY MARKER	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN[:STATe] ON CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation[:STATe]ON
SUM MKR ON OFF	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle[:STATe] ON| OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS[:STATe] ON| OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak[:STATe] ON| OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN[:STATe] ON| OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation[:STATe]ON| OFF
MAX |PEAK|	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:RESult?
+ PEAK	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:RESult?
- PEAK	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:RESult?
-/- PEAK	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:RESult?
RMS	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:RESult?
MEAN	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN[:STATe] ON | OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:RESult?
STANDARD DEVIATION	CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation[:STATe] ON|OFF CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:RESult?
LIMITS ON OFF	CALCulate<1|2>:MARKer<1...4>:SLIMits ON | OFF
START LIMIT	CALCulate<1|2>:MARKer<1...4>:SLIMits:LEFT <num_value>
STOP LIMIT	CALCulate<1|2>:MARKer<1...4>:SLIMits:RIGHt <num_value>

MAX HOLD ON OFF

```
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PHOLd ON | OFF
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?
```

AVERAGE ON OFF

```
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:AVERage ON | OFF
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MAXimum:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MPEak:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MIDDle:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:PPEak:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:RMS:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:MEAN:AVERage:RESult?
CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:SDEViation:AVERage:RES?
```

NUMBER OF SWEEPS

```
[SENSe:]SWEep:COUNt <num_value>
```

6.9.9 BW Key

BW

RES BW MANUAL

```
[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO OFF
[SENSe:]BANDwidth|BWIDth[:RESolution] <num_value>
```

RES BW AUTO

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

6.9.10 SWEEP Key

SWEEP

CONTINUOUS SWEEP

```
INITiate:CONTinuous ON
```

SINGLE SWEEP

```
INITiate:CONTinuous OFF;
INITiate:IMMediate
```

DEMOD NEXT RIGHT

```
:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:NEXT
```

DEMOD RESTART

```
:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:FIRSt
```

DEMOD @ ZOOM START

```
:[SENSe<1|2>:]DDEMod:SEARch:MBURst:FIND:STARt
```

SWEEP COUNT

```
[SENSe:]SWEep:COUNt <num_value>
```

CAPTURE AUTO OFF

```
:[SENSe<1|2>:]DDEMod:SEARch:MBURst:CAPTure ON | OFF
```

MULTI ON OFF

```
:[SENSe<1|2>:]DDEMod:SEARch:MBURst:STATe ON | OFF
```

6.9.11 MEAS Key - not available

6.9.12 TRIG Key

TRIG

FREE RUN	TRIGger[:SEQuence]:SOURce IMMediate
EXTERN	TRIGger[:SEQuence]:SOURce EXTernal TRIGger[:SEQuence]:LEVel[:EXTernal] 05V .. 3.5V [SENSe:]SWEep:EGATe:SOURce EXTernal
IF POWER	TRIGger[:SEQuence]:LEVel:IFPower <numeric value>
TRIGGER OFFSET	TRIGger[:SEQuence]:HOLDoff <num_value>
POLARITY POS/NEG	TRIGger[:SEQuence]:SLOPe POSitive | NEGative or [SENSe:]SWEep:EGATe:POLarity POSitive | NEGative
MEAS ONLY ON PATT	:[SENSe<1|2>:]DDEMod:SEARch:SYNC:MODE MEAS | SYNC
MEAS ONLY ON BURST	:[SENSe<1|2>:]DDEMod:SEARch:BURSt:MODE MEAS | BURSt

6.9.13 TRACE Key

TRACE

SELECT TRACE	--
CLEAR/ WRITE	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE WRITe
MAX HOLD	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE MAXHold or :[SENSe<1|2>:]AVERage:MODE MAX
AVERAGE	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE AVERage
VIEW	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE VIEW
BLANK	:DISPlay[:WINDow<1|2>]:TRACe<1...3>[:STATe] OFF
SWEEP COUNT	:[SENSe<1|2>:]SWEep:COUNt <num_value>

RMS	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE RMS
MIN HOLD	:DISPlay[:WINDow<1|2>]:TRACe<1...3>:MODE MINHold
AVG MODE LIN LOG	:CALCulate<1|2>:MATH:MODE LINear | LOGarithmic
FILE EXPORT	:FORMat:DATA ASCii :MMEMory:STORe:TRACe <numeric_value>, <file_name>
FILE IMPORT	:FORMat:DATA ASCii :MMEMory:LOAD:TRACe <numeric_value>, <file_name>
DATA RAW (ASCII)	:FORMat:DEXPort:MODE RAW | TRACe
HEADER ON OFF	:FORMat:DEXPort:HEADer ON | OFF
DECIM SEP . ,	:FORMat:DEXPort:DSEParator POINt | COMMa

6.9.14 LINES Key

LINES

SELECT LIMIT LINE

Selection:
CALCulate<1|2>:LIMit<1...8>:NAME <string>;
CALCulate<1|2>:LIMit<1...8>:UPPer:STATe ON | OFF
CALCulate<1|2>:LIMit<1...8>:LOWer:STATe ON | OFF
Limit Check:
CALCulate<1|2>:LIMit<1...8>:STATe ON | OFF
.... INITiate[:IMMediate]; WAI*
.... CALCulate<1|2>:LIMit<1...8>:FAIL?
Trace:
... CALCulate<1|2>:LIMit<1...8>:TRACe 1|2|3

NEW LIMIT LINE

NAME

Name: . . . .
CALCulate<1|2>:LIMit<1...8>:NAME <string>;
Domain:
CALCulate<1|2>:LIMit<1...8>:CONTrol:DOMain FREQuency|TIME
Scaling:
CALCulate<1|2>:LIMit<1...8>:CONTrol:MODE RELative | ABSolute
CALCulate<1|2>:LIMit<1...8>:UPPer:MODE RELative | ABSolute
CALCulate<1|2>:LIMit<1...8>:LOWer:MODE RELative | ABSolute
Unit:
CALCulate<1|2>:LIMit<1...8>:UNIT DBM| DBPW| WATT| DBUV| VOLT|DBUA|AMPere| DB| DBUV_MHZ| DBUA_MHZ| DEG| RAD| S| HZ| PCT
Margin:
CALCulate<1|2>:LIMit<1...8>:UPPer:MARGin <num_value>
CALCulate<1|2>:LIMit<1...8>:LOWer:MARGin <num_value>
Threshold for relative y scaling:
CALCulate<1|2>:LIMit<1...8>:UPPer:THReshold <num_value>
CALCulate<1|2>:LIMit<1...8>:LOWer:THReshold <num_value>
Comment:
CALCulate<1|2>:LIMit<1...8>:COMMent <string>

VALUES

CALCulate<1|2>:LIMit<1...8>:CONTrol[:DATA] . . . . <num_value>, <num_value>..
CALCulate<1|2>:LIMit<1...8>:UPPer[:DATA] . . . . <num_value>, <num_value>..
CALCulate<1|2>:LIMit<1...8>:LOWer[:DATA] . . . . <num_value>,<num_value>..

INSERT VALUE

No function in the IEC/IEEE bus operation.

DELETE VALUE

No function in the IEC/IEEE bus operation.

SHIFT X LIMIT LINE

CALCulate<1|2>:LIMit<1...8>:CONTrol:SHIFt <num_value>

SHIFT Y LIMIT LINE

CALCulate<1|2>:LIMit<1...8>:UPPer:SHIFt <num_value>
CALCulate<1|2>:LIMit<1...8>:LOWer:SHIFt <num_value>

SAVE LIMIT LINE

Automatically executed in Remote: control

EDIT LIMIT LINE

s. EDIT LIMIT LINE

COPY LIMIT LINE

CALCulate<1|2>:LIMit<1...8>:COPY 1...8 | <name>

DELETE LIMIT LINE

CALCulate<1|2>:LIMit<1...8>:DELete

X OFFSET

CALCulate<1|2>:LIMit<1...8>:CONTrol:OFFset <num_value>

Y OFFSET

CALCulate<1|2>:LIMit<1...8>:UPPer:OFFset <num_value>
CALCulate<1|2>:LIMit<1...8>:LOWer:OFFset <num_value>

6.9.15 DISP Key

DISP

FULL SCREEN

DISPlay:FORmat SINGle
DISPlay[:WINDow<1|2>]:SELect

SPLIT SCREEN	`DISPlay:FORmat SPLit`
CONFIG DISPLAY	--
SCREEN TITLE	`DISPlay[:WINDow<1|2>]:TEXT[:DATA] <string>` `DISPlay[:WINDow<1|2>]:TEXT:STATe ON | OFF`
TIME/DATE ON OFF	`DISPlay[:WINDow<1|2>]:TIME ON | OFF`
LOGO ON/OFF	`DISPlay:LOGO ON|OFF`
ANNOTATION ON/OFF	`DISPlay:ANNotation:FREQuency ON|OFF`
DATAENTRY OPAQUE	No function in the IEC/IEEE bus operation.
DEFAULT COLORS 1	`DISPlay:CMAP<1...13>:DEFault1`
DEFAULT COLORS 2	`DISPlay:CMAP<1...13>:DEFault2`
DISPLAY PWR SAVE	`DISPlay:PSAVe[:STATe] ON | OFF` `DISPlay:PSAVe:HOLDoff <num_value>`
SELECT OBJECT	--
BRIGHTNESS	`DISPlay:CMAP:HSL <hue>,<sat>,<lum>`
TINT	`DISPlay:CMAP<1...13>:HSL <hue>,<sat>,<lum>`
SATURATION	`DISPlay:CMAP<1...13>:HSL <hue>,<sat>,<lum>`

PREDEFINED COLORS	`DISPlay:CMAP<1...13>:PDEFined BLACk| BLUE| BROWn| GREen| CYAN| RED|`
	`.....MAGenta| YELLow| WHITe| DGRAy| LGRAy|`
	`.......LBLUe| LGREen| LCYan| LRED| MAGenta`

6.9.16 FILE Key

FILE

SAVE	`MMEMory:STORe:STATe 1,<file_name>`
RECALL	`MMEMory:LOAD:STATe 1,<file_name>`

EDIT COMMENT	MMEMory:COMMent <string>
ITEMS TO SAVE/RCL	
SELECT ITEMS	MMEMory:SELect[:ITEM]:HWSettings ON|OFF MMEMory:SELect[:ITEM]:TRACe[:ACTive] ON|OFF MMEMory:SELect[:ITEM]:LINes:ALL ON|OFF MMEMory:SELect[:ITEM]:NONE
DEFAULT CONFIG	MMEMory:SELect[:ITEM]:DEFault
DISABLE ALL ITEMS	MMEMory:SELect[:ITEM]:NONE
ENABLE ALL ITEMS	MMEMory:SELect[:ITEM]:ALL
DATA SET LIST	--
STARTUP RECALL	MMEMory:LOAD:AUTO 1,<file_name>
FILE MANAGER	
EDIT PATH	MMEMory:MSIS <device> MMEMory:CDIRectory <directory_name>
MAKE DIRECTORY	MMEMory:MDIRectory <directory_name>
FORMAT DISK	MMEMory:INITialize <msus>
RENAME	MMEMory:MOVE <file_source>,<file_destination>
SORT MODE	No function in the IEC/IEEE bus operation.
COPY	MMEMory:COPY <file_source>,<file_destination>
DELETE	MMEMory:DELete <file_name> MMEMory:RDIRectory <directory_name>

6.9.17 CAL Key

CAL	
CAL TOTAL	CALibration[:ALL]?

CAL ABORT
CALibration:ABORt

CAL CORR ON OFF
CALibration:STATe ON | OFF

CAL RESULTS
CALibration:RESults?

6.9.18 SETUP Key

REFERENCE INT/EXT
[SENSe:]ROSCillator:SOURce INTernal|EXTernal

NOISE SCR ON OFF
DIAGnostic:SERVice:NSOurce ON | OFF <num_value>

SIGNAL SOURCE

YIG FILTER ON OFF
INPut<1|2>:FILTer:YIG[:STATe] ON | OFF (R&S FSQ only)

RF PATH
INPut<1|2>:SELect RF
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

BASEBAND ANALOG
INPut<1|2>:SELect AIQ
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

IQ INPUT 50 1k
INPut<1|2>:IQ:IMPedance LOW | HIGH
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

BALANCED ON OFF
INPut<1|2>:IQ:BALanced ON |OFF
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

LOWPASS 36 MHZ
SENSe<1|2>:IQ:LPASs[:STATe] ON|OFF
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

DITHER ON OFF
This softkey is available only if the unit is equipped with Option R&S FSQ-B71 (Baseband Input).

PREAMP
INPut:GAIN:STATe ON | OFF
This softkey is available only if the unit is equipped with Option R&S FSx-B25 (Electronic Attenuator).

GENERAL SETUP
--

GPIB ADDRESS
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 0...30

COM INTERFACE
SYSTem:COMMunicate:SERial[:RECeive:]BAUD <num_value>
SYSTem:COMMunicate:SERial[:RECeive]:BITS 7 | 8
SYSTem:COMMunicate:SERial:RECeive:PARity[:TYPE] EVEN | ODD | NONE
SYSTem:COMMunicate:SERial[:RECeive]:SBITs 1|2
SYSTem:COMMunicate:SERial:CONTrol:DTR IBFull | OFF
SYSTem:COMMunicate:SERial:CONTrol:RTS IBFull | OFF
SYSTem:COMMunicate:SERial[:RECeive]:PACE XON | NONE

TIME+DATE
SYSTem:TIME 0...23, 0...59, 0...59
SYSTem:DATE <num>,<num>,<num>

CONFIGURE NETWORK
--

NETWORK LOGIN	--
OPTIONS	--
SOFT FRONTPANEL	--
SYSTEM INFO	--
HARDWARE INFO	DIAGnostic:SERVice:HWINfo?
STATISTICS	--
SYSTEM MESSAGES	SYSTem:ERRor? SYSTem:ERRor:LIST?
CLEAR ALL MESSAGES	SYSTem:ERRor?
SAVE CHANGES	--
SERVICE	--
INPUT RF	DIAGnostic:SERVice:INPut[:SELect] RF
INPUT CAL	DIAGnostic:SERVice:INPut[:SELect] CALibration DIAGnostic:SERVice:CSOurce[:POWer] <num_value>
SELFTEST	*TST?
SELFTEST RESULTS	DIAGnostic:SERVice:STESt:RESult?
REFERENCE FREQUENCY	[SENSE<1|2>:]ROSCillator[:INTernal]:TUNe 0...4095
CAL SIGNAL POWER	--
SAVE CHANGES	[SENSE<1|2>:]ROSCillator[:INTernal]:TUNe:SAVe
ENTER PASSWORD	SYSTem:PASSword[:CENable] <string>
CAL GEN 128 MHz	DIAGnostic:SERVice:INPut:PULSed OFF
CAL GEN COMB	DIAGnostic:SERVice:INPut:PULSed ON DIAGnostic:SERVice:INPut:PULSed:PRATe 128 MHz
SERVICE FUNCTION	DIAGnostic:SERVice:SFUNction <string>
FIRMWARE UPDATE	--
RESTORE FIRMWARE	--

6.9.19 HCOPY Key

HCOPY

PRINT SCREEN

HCOPy:ITEM:ALL
HCOPy:IMMediate

If the printout is also to be stored in a file, enter the following command.
.... MMEMory:NAME <file_name>

PRINT TRACE

HCOPy:ITEM:WINDow<1|2>:TRACe:STATe ON | OFF
HCOPy:IMMediate

If the printout is also to be stored in a file, enter the following command.
.... MMEMory:NAME <file_name>

PRINT TABLE

HCOPy:ITEM:WINDow<1|2>:TABle:STATe ON | OFF
HCOPy:IMMediate

If the printout is also to be stored in a file, enter the following command.
.... MMEMory:NAME <file_name>

HARDCOPY ABORT

HCOPy:ABORt

DEVICE1

SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?
SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?
SYSTem:COMMunicate:PRINter:SELect <string>
HCOPy:DESTination <string>
HCOPy:DEVice:LANGuage GDI | WMF | EWMF | BMP
HCOPy:PAGE:ORIentation<1|2> LANDscape | PORTrait

DEVICE2

SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?
SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?
SYSTem:COMMunicate:PRINter:SELect "string>
HCOPy:DESTination2 <string>
HCOPy:DEVice:LANGuage GDI | WMF | EWMF | BMP
HCOPy:PAGE:ORIentation<1|2> LANDscape | PORTrait

COLOR

HCOPy:DEVice:COLor ON | OFF
HCOPy:CMAP:DEFault1

COMMENT SCREEN A/B

HCOPy:ITEM:WINDow<1|2>:TEXT <string>

INSTALL PRINTER

6.9.20 Hotkey Bar

SPECTRUM

INSTrument[:SELect] SANalyzer
INSTrument:NSELect 1

NETWORK

This softkey is available only if the unit is equipped with Option R&S FSP-B9 (Tracking Generator) or Option R&S FSP-B10 (Ext. Generator Control); see description of basic unit.
--

SCREEN A/B

FULL SCREEN: Selection of active window: DISPlay[:WINDow<1|2>]:SELect
The window for which the setting is to be valid is selected by the numeric suffix in the command, e.g. SENSe<1|2>

SPLIT SCREEN: Both measurement windows are active
The window for which the setting is to be valid is selected by the numeric suffix in the command, e.g. SENSEe<1|2>.

6.10 STATus-QUEStionable:SYNC Register

This register contains information about the synchronization or burst search, provided that the unit is equipped with Option R&S FSQ-K70/FSMR-B73/FSU-B73 (Vector Signal Analysis). The register can be queried with the commands "`STATus:QUEStionable:SYNC:CONDition?`" or "`STATus:QUEStionable:SYNC[:EVENt]?`"

Table 10 Meaning of bits in the STATus: QUEstionable:SYNC register

Bit No.	Meaning
0	**BURSt not found** This bit is set if a burst could not be clearly found.
1	**SYNC not found** This bit is set if the sync sequence of the midamble could not be found.
6	**DEMod failed** This bit is set if the signal at the R&S FSQ/FSMR/FSU input is invalid.
7	**End of buffer reached** This bit is set in multi mode when the end of capture buffer is reached and insufficient data are available.
15	This bit is always 0.

6.11 STATus-QUEStionable:POWer Register

This register comprises all information about possible overloads of the unit.

It can be queried with commands `STATus:QUEStionable:POWer:CONDition?` and "`STATus :QUEStionable:POWer[:EVENt]?`. In operating mode Vector Signal Analysis only bits 0 to 2 are used.

Table 11 Meaning of bits in the STATus: QUEstionable:POWer register

Bit No	Bedeutung
0	**OVERload** This bit is set if the RF input is overloaded. 'OVLD'will then be displayed
1	**UNDerload** This bit is set if the RF input is underloaded. 'UNLD'will then be displayed.
2	**IF_OVerload** This bit is set if the IF path is overloaded. 'IFOVL'will then be displayed.
3-7	not used
15	This bit is always 0.

7 Programming Examples

The examples below show command sequences to be sent to the instrument or query commands to read data from the instrument. // indicates a comment and gives additional hints to the command used.

7.1 Performing a Measurement with OPC Synchronization

```
*RST                    // reset instrument and enter VSA INST:SEL DDEM
// option
//

// Select a standard, change ConfigurePattern definition

//


:SENS:DDEM:PRES FW3G               // select standard 3G_WCDMA_FWD

:INIT:CONT OFF                     // Set to Single Sweep

                                   // required for OPC Sync and

                                   // improves configration speed

:SENS:FREQ:CENT 1GHz               // Center Frequency 1GHz

DISP:WIND:TRAC:Y:SCAL:RLEV -30.0   // Reference Level -30 dBm

//

// additional/other commands to configure the measurement

// ...

// ...

// Perform the measurement


:INIT:IMM;*OPC?                    // returns 1 when the sweep is

                                   // finished

// no results can be read from the instrument, e.g. marker, modulation
summary,a.s.o.
```

7.2 Creating a Search Pattern

The following command sequence defines a pattern “MY_PAT” for a modulation with 16 states with bit sequence “111100001111000011110000“.

The pattern is added to the standard NONE pattern list to be selectable in the Burst&Pattern selection dialog.

In addition, the QAM16 modulation is configured and the new pattern is selected to be used for the pattern search function and the pattern search is switched on.

The command “SENS:DDEM:SEAR:SYNC:CAT? ALL” lists all available pattern. The command “SENS:DDEM:SEAR:SYNC:CAT?” lists all pattern compatible to the current settings.

How to define the symbol sequence:

The bits has to be arranged as symbols. This depend on the number of states of the modulation, e.g. QAM16 has 16 possible states = 4bits/symbol:

Symbol sequence for a modulation with 16 states of the bit sequence above is:

“1111” = 000F hex

“0000” = 0000 hex

“1111” = 000F hex

“0000” = 0000 hex

“1111” = 000F hex

“0000” = 0000 hex

The command “SENS:DDEM:SEAR:SYNC:DATA” always expected a 4 character hex value for every symbol.

```
*RST                    // reset instrument and enter VSA INST:SEL DDEM
// option
//
// Pattern definition
//
SENS:DDEM:SEAR:SYNC:NAME  'MY_PAT'   // Select pattern name MY_PAT
SENS:DDEM:SEAR:SYNC:DEL          // delete old pattern, if it
                      // exists
SENS:DDEM:SEAR:SYNC:DATA  '000f0000000F0000000F0000'// always 4
                      // characters/symbol in HEX format
                      // 0000 ... 000F for QAM16 possible
SENS:DDEM:SEAR:SYNC:NST 16          // QAM16 has 16 states
SENS:DDEM:SEAR:SYNC:TEXT  'MY_PAT Selection'// This text will be visible
                      // after pressing SELECT PATTERN,
                      // dialog PATTERN SELECT (right
                      // column)
SENS:DDEM:SEAR:SYNC:COMM  'My Comment' // Additional comment
//
```

```
// The pattern is now created and has to be added to the standard
// the pattern will be used for (Standard NONE here).
//
//   Select QAM16 modulation (-> Standard NONE)
//
:SENS:DDEM:FORM QAM
:SENSe1:DDEMod:QAM:NSTate 16
//
// This command queries all available patter, it is not required to
// define the pattern
SENS:DDEM:SEAR:SYNC:CAT? ALL        // returns all available pattern,
                      // just to see the new pattern
                      // exists now
:SENSe1:DDEMod:SEARch:SYNC:PATTern:ADD 'MY_PAT'// add the pattern MY_PAT
                         // to standard NONE
                      // now the new pattern is visible on
                      // the pattern selection list for
                      // standard NONE

:SENSe1:DDEMod:SEARch:SYNC:SEL 'MY_PAT' // select pattern MY_PAT for
                      // pattern search

// switch pattern search ON
:SENSe1:DDEMod:SEARch:SYNC:STATe ON    // activate the pattern search with
                      // previously selected pattern
```

8 Checking the Rated Specifications

- Switch off R&S FSQ/FSMR/FSU prior to removing or inserting modules.
- Prior to switching the unit on, check position of voltage selector (230 V).
- Measure the rated specifications only after a warm-up time of at least 30 minutes and after autocalibration of the R&S FSQ/FSMR/FSU and the R&S SMIQ. Only then can it be ensured that the specifications are complied with.
- Unless otherwise specified, all settings are made based on the PRESET setting.
- The settings for the measurements to be performed on the R&S FSQ/FSMR/FSU are subject to the following:

[***<KEY>***] Press a key on the front panel, e.g. [SPAN].

[<SOFTKEY>] **Press a softkey, e.g. [MARKER -> PEAK].**

Only[<nn unit>] Enter a value + terminate the entry with the unit, e.g. [12 kHz].

{<nn>} Enter values provided in one of the following tables.

- Successive entries are separated by [:], e.g. [***SPAN***:15 kHz].
- The values in the following sections cannot be guaranteed.

8.1 Required Test Equipment and Accessories

Table 12 Messgeräte andHilfsmittel

Item	Type of unit	Recommended characteristics	Recommended unit	R&S Order No.
1	Signal generator	Vector signal generator for WCDMA-signals	SMIQ with options: SMIQB45 SMIQB20 SMIQB11	1125.5555.03 1104.8232.02 1125.5190.02 1085.4502.04

8.2 Test Sequence

The performance test only refers to the results of the vector signal analysis.

Default setup on the R&S SMIQ:

[PRESET]

[LEVEL : -30 dBm]

[FREQ: 2.0 GHz]

DIGITAL MODULATION

STANDARD WCDMA QPSK

STATE: ON

Default setup on the R&S FSQ/FSMR/FSU:

[PRESET]

[CENTER: 2.0 GHz]

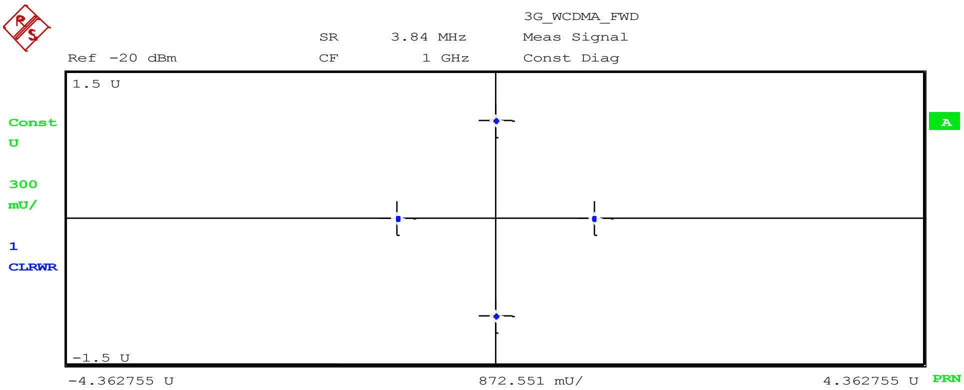
[REF: -20 dBm]

[3GPP_WCDMA_FWD]

[TRIG FREE RUN]

[DISPLAY EVM, MODULATION ERRORS]

The measurement result displayed on the R&S FSQ/FSMR/FSU should have the following values:



FILT

3G_WCDMA_FWD

SR 3.84 MHz Sym&Mod Acc

Ref -20 dBm CF 1 GHz

1 CLRWR

Att 5 dB

B

MODULATION ACCURRACY				
	Result	Peak	atSym	Unit
EVM	0.577	1.418	75	%
Magnitude Error	0.314	1.078	610	%
Phase Error	0.24	0.75	75	deg
CarrierFreq Err	-418.51			Hz
Ampt Droop	-0.01			dB
Origin Offset	-56.98			dB
IQ Imbalance	0.040			%
Mean Power	-31.36	-25.80	579	dBm
RHO	0.999967			
Trigger to Sync				s

SYMBOL TABLE (Hexadecimal)	
00000	0 2 2 0 3 3 0 2 1 3 2 3 0 2 2 2 1 0
00018	3 1 1 1 1 3 2 0 1 0 1 3 2 3 1 0 2 0
00036	1 3 3 0 1 0 3 1 0 1 2 1 2 2 1 1 1 2
00054	2 2 3 2 1 1 0 2 0 0 2 2 3 2 0 3 0 0
00072	0 3 2 3 3 3 2 1 2 1 3 2 1 2 0 1 2 3
00090	2 3 1 3 3 3 1 3 1 2 0 0 0 0 1 2 0 2
00108	0 3 0 1 0 1 2 2 2 1 3 1 3 1 3 2 0 2
00126	0 2 2 1 2 1 1 2 3 1 2 3 1 3 2 1 1 1
00144	1 1 0 1 0 1 3 0 2 3 3 2 3 0 3 3 2 0
00162	2 3 1 0 1 0 2 0 3 3 2 1 3 2 0 0 0 3
00180	2 0 2 2 1 2 1 1 3 2 2 3 3 1 3 2 1 0
00198	0 0 2 2 2 0 1 3 1 3 0 2 2 2 1 0 2 3

The EVM should not exceed 5% (RMS).

9 Utilities /External Programs

9.1 Mapping Editor (MAPWIZ)

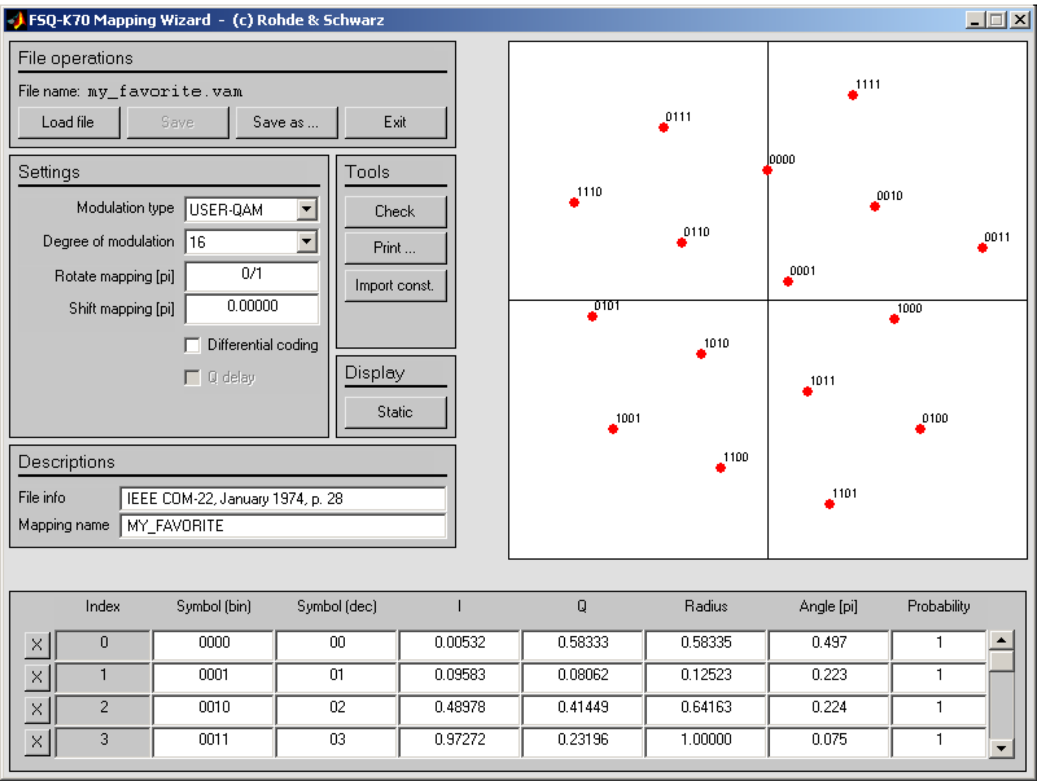


Fig. 257 MAPWIZ -Mapping editor for the R&S FSQ-K70/FSMR-B73/FSU-B73

An external program (MAPWIZ) is offered to create individual constellations (including symbol mappings) or to modify available mapping files. This program generates mapping files (*.vam) which are transmitted to the analyzer via the IMPORT function and by loading the data from a floppy disk.

The program can be downloaded together with a detailed description as precompiled MATLABb® file (MATLAB pcode) on the Internet, page http://www.rohde-schwarz.com (search term "MAPWIZ").

9.2 Filter Tool (FILTWIZ)

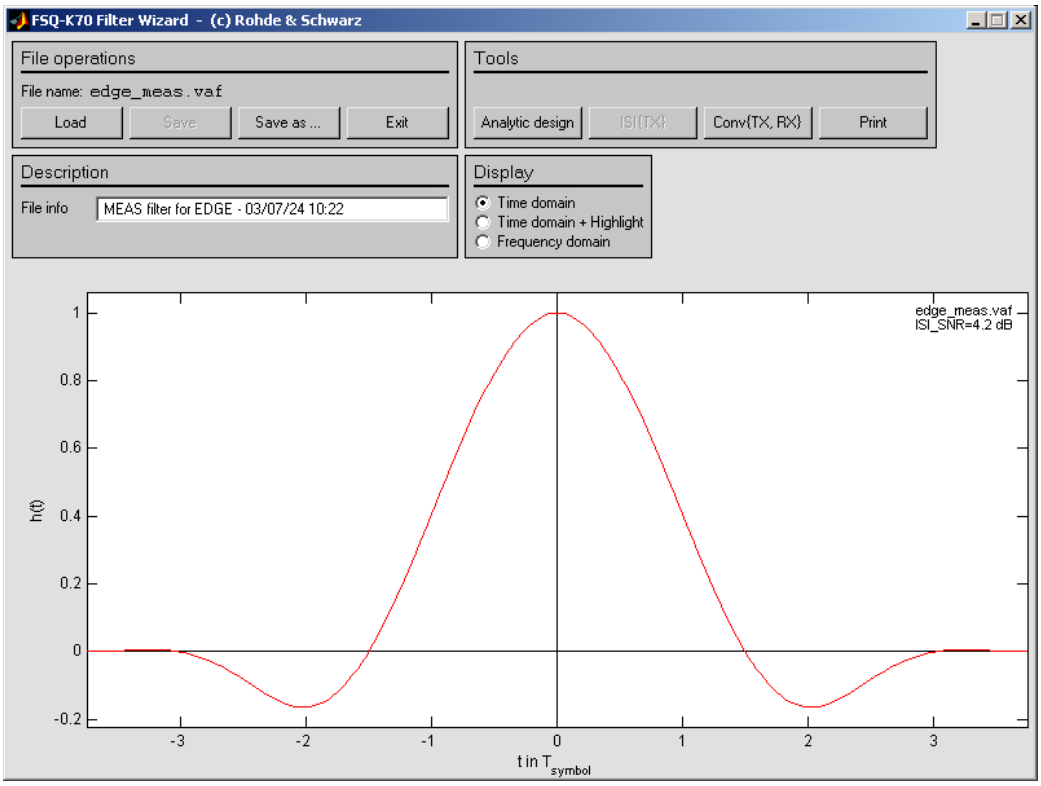


Fig. 258 FILTWIZ - filter tool for the R&S FSQ-K70/FSMR-B73/FSU-B73

An external program (FILTWIZ) is offered to convert user-defined filters. This program generates filter files (*.vaf) which are transmitted to the analyzer via the IMPORT function and by loading the data from a floppy disk.

The program can be downloaded together with a detailed description as precompiled MATLABb® file (MATLAB pcode) on the Internet, page http://www.rohde-schwarz.com (search term "FILTWIZ").

10 Glossary and Formulare

10.1 Trace-based Evaluations

Test parameter	Formula
Magnitude	$MAG_{MEAS}(t) = \|MEAS(t)\|;$ $MAG_{REF}(t) = \|REF(t)\|;$
Phase	$PHASE_{MEAS}(t) = \arg(MEAS(t));$ $PHASE_{REF}(t) = \arg(REF(t));$
Magnitude error	With softkey *"MAGERABS"* is set to *"ON"*: $MAG\_ERR(t) = \frac{\|\|MEAS(t)\| - \|REF(t)\|\|}{C};$ With softkey *"MAGERABS"* is set to *"OFF"*: $MAG\_ERR(t) = \frac{\|MEAS(t)\| - \|REF(t)\|}{C};$
Phase error	$PHASE\_ERR(t) = \arg(MEAS(t) \cdot REF^{*}(t));$
Error Vector = EV	$EV(t) = MEAS(t) - REF(t);$
Error Vector Magnitude = EVM	$EVM(t) = \frac{\|EV(t)\|}{C};$ In case of Offset-QPSK please observe the influence of the softkey "Offset EVM ON/OFF" on nominator an denominator.
Frequency (MSK)	$FREQ_{MEAS}(t) = \frac{d}{dt}(unwrap(\arg(MEAS(t))));$ $FREQ_{REF}(t) = \frac{d}{dt}(unwrap(\arg(REF(t))));$
Frequency error (MSK,FSK)	$FREQ\_ERR(t) = FREQ_{MEAS}(t) - FREQ_{REF}(t);$
	$t = n \cdot Ta;\_where\_Ta = sampling period$

10.2 Summary - Evaluations

RHO (correlation coefficient)	$\rho = \frac{\left\| \sum_n REF^*(k) \cdot MEAS(k) \right\|^2}{\sum_n \|REF(k)\|^2 \cdot \sum_n \|MEAS(k)\|^2} = \frac{KKF(MEAS, REF)}{AKF(REF) \cdot AKF(MEAS)}$
Normalization constant C (not VSB)	$C = \sqrt{\frac{1}{K} \sum_K \|REF(k)\|^2}$ = sqrt(mean power of the symbol decision instants) But if the softkey “EVM CALC” is set to “MAX SYMBOL POWER”, the factor C is not calculated as given above, but set to the constant ideal value of the maximum symbol magnitude. In case of Offset-QPSK please observe the additional influence of the softkey “OFFSET EVM ON/OFF” on the determination of the symbol instants in the I- and Q-part of the REF signal.
Normalization constant C (VSB only)	$C = \sqrt{\frac{1}{K} \sum_K \|\mathrm{Re}\{REF(k)\}\|^2}$ = sqrt(mean power of the symbol decision instants). But if the softkey “EVM CALC” is set to “MAX SYMBOL POWER”, the factor C is not calculated as given above, but set to the constant ideal value of the maximum symbol magnitude.
RMS_Magnitude _Error	$RMS\_MagErr = \sqrt{\frac{1}{K} \sum_K \|MAG\_ERR(k)\|^2}$
RMS_EVM (not VSB)	$RMS\_EVM = \sqrt{\frac{1}{K} \sum EVM(k)^2}$ In case of Offset-QPSK please observe the influence of the softkey “Offset EVM” on the EVM trace.
RMS_EVM (VSB only)	$RMS\_EVM = \sqrt{\frac{\frac{1}{K} \sum_K \|\mathrm{Re}\{EV(k)\}\|^2}{C^2}}$
RMS_Phase_Error	$RMS\_PhaseErr = \sqrt{\frac{1}{K} \sum_K \|PHASE\_ERR(k)\|^2};$
RMS_Frequency_ Error	$RMS\_FreqErr = \sqrt{\frac{1}{K} \sum_K \|FREQ\_ERR(k)\|^2};$
Origin_Offset (logarithmic measure for IQ_Offset)	$OriginOffset = 10 \log_{10}\left(\frac{\|IQ\_Offset\|^2}{C^2} \right)$ Note: For the normalization of the “Origin Offset” the denominator C does not depend on the softkey “EVM CALC” and “OFFSET EVM”. The calculation assumes that they are set to “MEAN SIGNAL POWER” respectively “OFFSET EVM OFF”.

Amplitude Droop (Measure for exponential level modifications within the measurement range)	$MEAS\left(\frac{t}{T_S}\right) = REF\left(\frac{t}{T_S}\right) \cdot e^{-\alpha \frac{t}{T_S}}$ $AMPT\_DROOP = 20\log_{10}(e^{-\alpha})$ α is the level modification/symbol (in [Neper]) AMPT_DROOP is the equivalent value in [dB]
Gain Imbalance	$GAIN\_IMB = 20\log_{10}\left(\frac{c_1\_q}{c_1\_i}\right)\ [dB]$ c_1_q is the gain of the Q modulation branch, c_1_i is the gain of the I modulation branch (see Fig. 95 Modulation error: error model of transmitter and transmission path).
Pilot Level Error (VSB only)	$PilotLevelErr = -20\log_{10}\left(\frac{reference\_pilot\_level - \mathrm{Re}\{IQ\_Offset\}}{reference\_pilot\_level}\right)\ [dB]$ *reference_pilot_level* is the pilot according to standard, for example 1.25/7 for 8VSB (ATSC).
Mean Power (Mean power of the receive signal)	$MEAN\_POWER = 10\log_{10}\left(\frac{1}{M}\sum_m U_m^2\right);[dBm]$ Logarithmized value of the mean power of all samples. If a measurement filter is activated, it also affects the calculation of the mean power.
SNR (MER) (Signal-to-noise ratio)	$SNR = 10\log_{10}\left(\frac{signal\ power}{noise\ power}\right) = \frac{\frac{1}{N}\sum_{n=0}^{N-1}\left\|REF(n \cdot T_{symbol})\right\|^2}{\frac{1}{N}\sum_{n=0}^{N-1}\left\|MEAS(n \cdot T_{symbol}) - REF(n \cdot T_{symbol})\right\|^2}$ The SNR (signal-to-noise ratio) is the quotient of the signal power of the ideal signal (REF signal) and the noise power. The signal power is calculated as the mean power of the ideal signal (REF signal) at symbol decision points. The noise power is calculated as the mean power of the error signal, i.e. the difference of the measured signal and the corresponding ideal signal (MEAS-REF signal), at symbol decision points.For VSB, only the power of the real part is considered. The definition of the SNR has been changed with firmware version 4.20. In older versions the SNR was calculated in the same way as the EVM and did depend on the softkey “EVM CALC”. The parameter "EVM calc" does always influence the calculation of EVM.
FSK method:	$Min\left\{\left\|MEAS(t) - (a \cdot REF(t) + b \cdot t + c)\right\|^2\right\}$ $FSK\_Meas\_Dev = reference\_deviation \cdot a\ [Hz]$ $Carrier\_Freq\_Drift = b\ [Hz]$ $Carrier\_Freq\_Err = c\ [Hz]$ $FSK\_Dev\_Error = MEAS(t) - (a \cdot REF(t) + b \cdot t + c)\ [Hz]$

	$RMS\_FSK\_DEV\_Error = \sqrt{\frac{1}{M}\sum_m FSK\_Dev\_Error_m^2}\ [Hz]$
	.k = symbol decision instant Ts = symbol duration

10.3 Statistical Evaluations

MEAN (Average, AVG)	Voltage, %,° (linear)	$MEAN\_U = \frac{\sum_M U_m}{M};$
	Power (logarithmic)	$MEAN\_lP = 20 * \log 10\left(\frac{1}{M}\sum_M 10^{\frac{lP_m}{20}}\right);$
STD_DEV	Linear	$STDDEV\_R = \sqrt{\frac{1}{M}\sum_M (R_m - MEAN(R_m))^2};$
95 pctl	95 pctl	$x\_0.95 = \{x \mid w_n(x) = 0.95\};$
Total Peak (Extreme value of peak values)	Total Peak (Extreme value of peak values)	$TOTAL\_Pk = \begin{Bmatrix} \max\{Pk1 \quad Pk2 \quad . \quad . \quad Pkn\} & if \max \geq -\min \\ \min\{Pk1 \quad Pk2 \quad . \quad . \quad Pkn\} & if \max < -\min \end{Bmatrix};$

10.4 Trace Averaging and Marker Functions

Linear values	Voltage, % °	$RMS\_U_m = \sqrt{\frac{M-1}{M} RMS\_U_{m-1}^2 + \frac{1}{M} U_m^2};$
	Power W	$RMS\_P_m = \frac{M-1}{M} RMS\_P_{m-1} + \frac{1}{M} P_m;$
Logarithmic values	Voltage dBV, origin offset	$RMS\_lU_m = 20 * \log\left(\frac{M-1}{M} 10^{\frac{RMS\_lU_{m-1}}{20}} + \frac{1}{M} 10^{\frac{lU_m}{20}}\right);$
	Power dBm	$RMS\_lP_m = 10 * \log\left(\frac{M-1}{M} 10^{\frac{RMS\_lP_{m-1}}{10}} + \frac{1}{M} 10^{\frac{lP_m}{10}}\right);$

10.5 Averaging RMS Quantities

RMS	Voltage, %, ° (linear)	$RMS\_U = \sqrt{\frac{1}{M}\sum_M U_m^2}$
RMS	Power (W, mW ...) linear	$RMS\_P = \frac{1}{M}\sum_M P_m$
RMS	Power (logarithmic)	$RMS\_lP = 10 * \log 10\left(\frac{1}{M}\sum_M 10^{\frac{lP_m}{10}}\right)$

10.6 Analytically Calculated Filters

The following filters are calculated during runtime of the unit and as a function of operating parameter ALFA or BT.

Raised cosine filter	**RC** Setting parameter = ALFA	$H(f) = \begin{cases} T & \text{, für } 0 \leq \lvert f \rvert \leq \frac{1-\alpha}{2T} \\ \frac{T}{2}\left[1+\cos\left(\frac{\pi T}{\alpha}\left(\lvert f \rvert - \frac{1-\alpha}{2T}\right)\right)\right] & \text{, für } \frac{1-\alpha}{2T} \leq \lvert f \rvert \leq \frac{1+\alpha}{2T} \\ 0 & \text{, für } \frac{1+\alpha}{2T} \leq \lvert f \rvert \end{cases}$ $h(t) = \mathrm{sinc}\left(\frac{\pi t}{T}\right)\frac{\cos\left(\frac{\pi \alpha t}{T}\right)}{1-4\left(\frac{\alpha t}{T}\right)^2}$; where $\mathrm{sinc}(x) = \frac{\sin(x)}{x}$; **{T} corresponds to symbol period.**
Root raised cosine filter	**RRC** Setting parameter = ALFA	$H(f) = \begin{cases} T & \text{, for } 0 \leq \lvert f \rvert \leq \frac{1-\alpha}{2T} \\ T\sqrt{\frac{1}{2}\left[1-\sin\left(\frac{\pi T}{\alpha}\left(\lvert f \rvert - \frac{1}{2T}\right)\right)\right]} & \text{, for } \frac{1-\alpha}{2T} \leq \lvert f \rvert \leq \frac{1+\alpha}{2T} \\ 0 & \text{, for } \frac{1+\alpha}{2T} \leq \lvert f \rvert \end{cases}$ $h(t) = \frac{1}{c}\frac{\sin\left(\pi\cdot(1-\alpha)\cdot\frac{t}{T}\right)+4\alpha\frac{t}{T}\cdot\cos\left(\pi\cdot(1+\alpha)\cdot\frac{t}{T}\right)}{\pi\cdot\frac{t}{T}\cdot\left(1-\left(4\alpha\frac{t}{T}\right)^2\right)}$; where $c = 1-\alpha+\frac{4\alpha}{\pi}$

Gaussian filter ETSI TS 100 959 (V8.3.0)	**GAUSS** Setting parameter = BT	$h(t) = \frac{\exp\left(\frac{-t^2}{2s^2T^2}\right)}{\sqrt{(2\pi)} \cdot sT}$; **where** $s = \frac{\sqrt{\ln 2}}{2\pi BT}$; $H(f) = \exp\left(\frac{\ln 2}{2B^2} f^2\right)$;

H(f) defines the frequency response, h(t) the coefficients in the time domain. The limit lines have to be checked against the denominator zeros when the filter coefficient is determined. The filter coefficients in the time domain may be normalized in the analyzer, if required, so that the following equation applies: $h(t=0)=1;$.

10.7 Standard-Specific Filters

EDGE-TX filter ETSI TS 300 959 (V8.1.2)	EDGE TX	$c_0(t) = \begin{Bmatrix} \prod_{i=0}^{3} S(t+iT) & for & 0 \le t \le 5T \\ 0 & else & \end{Bmatrix};$ $S(t) = \begin{Bmatrix} \sin(\pi \int_0^t g(t')dt') & for & 0 \le t \le 4T \\ \sin(\frac{\pi}{2} - \pi \int_0^{t-4T} g(t')dt') & for & 4T < t \le 8T \\ 0 & else & \end{Bmatrix};$ $g(t) = \frac{1}{2T}\left(Q\left(2\pi * 0.3 \frac{t-5T/2}{T\sqrt{\ln(2)}}\right) - Q\left(2\pi * 0.3 \frac{t-3T/2}{T\sqrt{\ln(2)}}\right)\right);$ $Q(t) = \frac{1}{\sqrt{2\pi}} \int_t^{\infty} e^{\frac{\tau^2}{2}} d\tau;$ $c_0(t)$ is the impulse response of the EDGE transmit filter.
EDGE measurement filter GSM 05.06 (V8.2.0)	EDGE MEAS	RC filter, ALFA = 0.25, single-side-band 6 dB bandwith = 90 kHz Windowing by multiplying the impulse response according to the following equation: $\mathrm{w}(t) = \begin{cases} 1, & 0 \le \|t\| \le 1.5T \\ 0.5\left(1+\cos\left[\pi(\|t\|-1.5T)/2.25T\right]\right), & 1.5T \le \|t\| \le 3.75T \\ 0, & \|t\| \ge 3.75T \end{cases}$ (T = symbol interval)
CDMA-TX filter	Cdma_one_TX	

10.8 Analytically Calculated Filters

The following filters are calculated during runtime of the unit and as a function of operating parameter ALFA or BT.

Raised cosine filter	**RC** Setting parameter = ALFA	$$H(f)=\begin{cases} T & \text{, für } 0 \le \lvert f \rvert \le \frac{1-\alpha}{2T} \\ \frac{T}{2}\left[1+\cos\left(\frac{\pi T}{\alpha}\left(\lvert f \rvert-\frac{1-\alpha}{2T}\right)\right)\right] & \text{, für } \frac{1-\alpha}{2T} \le \lvert f \rvert \le \frac{1+\alpha}{2T} \\ 0 & \text{, für } \frac{1+\alpha}{2T} \le \lvert f \rvert \end{cases}$$ $$h(t)=\mathrm{sinc}\left(\frac{\pi t}{T}\right)\frac{\cos\left(\frac{\pi\alpha t}{T}\right)}{1-4\left(\frac{\alpha t}{T}\right)^2};\text{where } \mathrm{sinc}(x)=\frac{\sin(x)}{x};$$ **{T} corresponds to symbol period.**
Root raised cosine filter	**RRC** Setting parameter = ALFA	$$H(f)=\begin{cases} T & \text{, for } 0 \le \lvert f \rvert \le \frac{1-\alpha}{2T} \\ T\sqrt{\frac{1}{2}\left[1-\sin\left(\frac{\pi T}{\alpha}\left(\lvert f \rvert-\frac{1}{2T}\right)\right)\right]} & \text{, for } \frac{1-\alpha}{2T} \le \lvert f \rvert \le \frac{1+\alpha}{2T} \\ 0 & \text{, for } \frac{1+\alpha}{2T} \le \lvert f \rvert \end{cases}$$ $$h(t)=\frac{1}{c}\frac{\sin\left(\pi\cdot(1-\alpha)\cdot\frac{t}{T}\right)+4\alpha\frac{t}{T}\cdot\cos\left(\pi\cdot(1+\alpha)\cdot\frac{t}{T}\right)}{\pi\cdot\frac{t}{T}\cdot\left(1-\left(4\alpha\frac{t}{T}\right)^2\right)};$$ $$\text{where } \quad c=1-\alpha+\frac{4\alpha}{\pi}$$
Gaussian filter ETSI TS 100 959 (V8.3.0)	**GAUSS** Setting parameter = BT	$$h(t)=\frac{\exp\left(\frac{-t^2}{2s^2T^2}\right)}{\sqrt{(2\pi)}\cdot sT};\ \textbf{where } s=\frac{\sqrt{\ln 2}}{2\pi BT};$$ $$H(f)=\exp\left(\frac{\ln 2}{2B^2}f^2\right);$$

H(f) defines the frequency response, h(t) the coefficients in the time domain. The limit lines have to be checked against the denominator zeros when the filter coefficient is determined.

The filter coefficients in the time domain may be normalized in the analyzer, if required, so that the following equation applies: $h(t=0)=1;$.

10.9 Standard-Specific Filters

EDGE-TX filter ETSI TS 300 959 (V8.1.2)	EDGE TX	$c_0(t) = \begin{cases} \prod_{i=0}^{3} S(t+iT) & for \quad 0 \le t \le 5T \\ 0 & else \end{cases};$ $S(t) = \begin{cases} \sin(\pi \int_0^t g(t')dt') & for \quad 0 \le t \le 4T \\ \sin(\frac{\pi}{2} - \pi \int_0^{t-4T} g(t')dt') & for \quad 4T < t \le 8T \\ 0 & else \end{cases};$ $g(t) = \frac{1}{2T}\left(Q\left(2\pi * 0.3\frac{t-5T/2}{T\sqrt{\ln(2)}}\right) - Q\left(2\pi * 0.3\frac{t-3T/2}{T\sqrt{\ln(2)}}\right)\right);$ $Q(t) = \frac{1}{\sqrt{2\pi}}\int_t^\infty e^{\frac{\tau^2}{2}} d\tau;$ $c_0(t)$ is the impulse response of the EDGE transmit filter.
EDGE measurement filter GSM 05.06 (V8.2.0)	EDGE MEAS	RC filter, ALFA = 0.25, single-side-band 6 dB bandwith = 90 kHz Windowing by multiplying the impulse response according to the following equation: $w(t) = \begin{cases} 1, & 0 \le \lvert t \rvert \le 1.5T \\ 0.5\left(1+\cos\left[\pi(\lvert t \rvert - 1.5T)/2.25T\right]\right), & 1.5T \le \lvert t \rvert \le 3.75T \\ 0, & \lvert t \rvert \ge 3.75T \end{cases}$ (T = symbol interval)
CDMA-TX filter	Cdma_one_TX	

10.10 Abbreviations Used

Abbreviation	Meaning	See section
VSA	Vector Signal Analysis Measurement at complex modulated RF carriers.	
TX filter	Transmitter Filter Digital impulse shaping filter in signal processing unit of transmitter.	3.1.2.4
ISI-free demodulation	Demodulation structure in which the signal is no longer influenced by adjacent symbols at the decision instants after signal-adapted filtering.	3.1.2.4
ISI filter	InterSymbol Interference Filter Baseband filter in analyzer used for signal-adapted filtering.	3.1.2.4
MEAS filter	Measurement Filter Weighting filter for the measurement.	3.1.2.4
PSK	Phase Shift Keying Modulation mode during which the information lies within the phase or within the phase transitions.	3.2.1.1
FSK	Frequency Shift Keying Modulation mode during which the information is encrypted in the frequency.	3.2.1.6
MSK	Minimum Shift Keying Modulation mode.	3.2.1.7
QAM	Quadrature Amplitude Modulation Modulation mode during which the information is encrypted both in the amplitude and phase.	3.2.1.8
VSB	Vestigial Sideband Modulation Modulation Modulation mode during which one sideband is completely supressed.	3.2.1.11
NDA Demodulator	Non Data Aided Demodulator Demodulation without any knowledge of the sent data contents.	3.3
RMS	Root Mean Square	
Average (Mean)	Linear average value	

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