ROHDE&SCHWARZ

Test and Measurement
Division

Release Notes

R&S FSQ-K70

Vector Signal Analysis Application Firmware

Release 4.61

for R&S FSU, FSQ, FSG, FMU, FSUP
Analyzer Firmware 4.6x

New Features:

- **Magnitude Error calculation:**
  Selectable normalization method "Max Symbol / Signal Mean Power" available.
- **Magnitude Error calculation:**
  Additional signed grid scaling supported.

Release Note Revision: 1

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History

Date	Rel Note Rev	Changes
20 November 2012	1	First revision for Vector Analysis Application Firmware 4.61.

General Topics

Hardware Requirements

The option R&S FSQ-K70 requires certain minimum board revisions of the Wideband Detector Board.

For R&S FSUP at least model 08 of Wideband Detector Board is required for R&S FSQ-K70:
This can be checked in the SPECTRUM -> SETUP -> SYSTEM INFO menu with softkey HARDWARE INFO. For component WBDET with order number 1130.3086 is required at least:

Model	Revision	Sub Revision	for	
3	4	≥ 8	R&S FSQ (with CPU-Board 1091.2520)	**or**
3	≥ 5		R&S FSQ (with CPU-Board 1091.2520)	**or**
5			R&S FSQ (with CPU-Board 1091.2520), R&S FSU (with CPU-Board 1091.2520)	**or**
8			R&S FSU (with CPU-Board 1091.3104), R&S FSQ (with CPU-Board 1091.3104), R&S FSUP, R&S FSG, R&S FMU	

Compatibility of the R&S FSQ-K70 Vector Analysis Application Firmware with other Firmware Releases

The following table shows the compatible versions of the basic analyzer firmware and the Vector Analysis Application Firmware:

Table of compatible versions:

R&S FSQ-K70 Application Firmware	R&S FSU Basic Firmware	R&S FSQ Basic Firmware	R&S FSMR Basic Firmware	R&S FSUP Basic Firmware	R&S FMU Basic Firmware	R&S FSG Basic Firmware
4.61	-	-	-	Please refer to the FSUP release notes	-	-
4.60	4.61	4.65	-		-	4.69
4.50 SP3	4.51 SP1	4.55 SP2	-		-	4.59 SP1
4.50 SP2	4.51	-	-		-	-
4.50 SP1	-	4.55 SP1	-		-	4.59
4.50	-	-	-		-	4.59
4.40 SP1	-	-	-		-	-
4.40	4.41	4.45	-		-	4.49
4.30 SP1	4.31 SP1	4.35 SP1	4.36		4.38	4.39 SP2
4.30	4.31	4.35	-		-	4.39
4.20 SP2	4.21 SP1	4.25 SP1	4.26		-	4.29 SP3
4.20 SP1	4.21	4.25	-		-	4.29
4.20	4.21	4.25	-		-	4.29
4.10	4.11	4.15	4.16		-	-
4.01	-	-	-		4.08	-
4.00 SP2	4.01 SP3	4.05 SP3	-		-	-
4.00 SP1	-	-	4.06		-	-
4.00	4.01	4.05	-		-	-
3.90 SP1	-	3.95 SP2	-		-	-
3.90	-	3.95	3.96		-	-
3.80	-	3.85				
3.70	-	3.75	-		-	-
3.60	-	3.65	-		-	-
3.50 SP1	-	3.55 SP2	-		-	-
3.50	-	3.55	-		-	-
3.40	-	3.45	-		-	-
3.30	-	3.35	-		-	-
3.28	-	3.25	-		-	-
3.24	-	3.15	-		-	-
3.21	-	3.05 SP1	-		-	-

R&S FSQ-K70 Application Firmware	R&S FSU Basic Firmware	R&S FSQ Basic Firmware	R&S FSMR Basic Firmware	R&S FSUP Basic Firmware	R&S FMU Basic Firmware	R&S FSG Basic Firmware
3.20	-	3.05	-		-	-
2.30	-	2.35	-		-	-
2.28	-	2.25	-		-	-
2.24	-	2.15	-		-	-
1.21	-	2.05	-		-	-
1.00	-	1.85	-		-	-
-	-	1.65	-		-	-
-	-	1.55	-		-	-

The FSQ-K70 application firmware versions 3.xx or 4.xx requires Windows XP. For NT based instruments a Windows-XP upgrade kit FSQ-U2, order # 1162.9696.02 is available.

Note:

Applications with version number 3.xx or 4.xx are only compatible with basic firmware 3.yy or 4.yy (see table above). Do not install them on basic firmware versions below 3.00!

Firmware Update of the R&S FSQ-K70 Vector Analysis Application Firmware

Since basic firmware version 4.2x a ZIP file with the update sets of the basic system firmware and all available applications is provided. This ZIP file is available in the instruments FIRMWARE section, e.g. R&S FSU of the Service Board on GLORIS.

Please follow the steps described in the instrument's basic firmware release note to perform a complete firmware update.

Enabling the Application Firmware via License Key Code Entry

This section can be skipped if the option key was entered once.

After installing the application firmware package a license key for validation must be entered. The license key is printed either on a label on the rear panel of the R&S FSQ or delivered as a part of the R&S FS-K70 Vector Analysis Application Firmware package.

The key sequence for entering the license key is:

SETUP - GENERAL SETUP – OPTIONS - INSTALL OPTION

Use the numeric keypad to input the license key number and press ENTER.

- On a successful validation the message 'option key valid' will appear.

- If the validation failed, the application firmware is not installed.

  The most probable reason will be that the instrument is not equipped with the correct basic firmware version. Therefore a message box will appear asking for installation of the correct basic firmware version.

  If the application firmware package was not installed prior to entering the license key code, a message will appear asking for installation of the application firmware package.

  In any case please make sure that the correct basic firmware version <u>and</u> the application firmware package is installed prior to entering the license key code.

New Functions in Version 4.61

- **Magnitude Error calculation:**
  Selectable normalization method "Max Symbol / Signal Mean Power" available.
- **Magnitude Error calculation:**
  Additional signed grid scaling supported.

Improvements with Version 4.61

The version numbers in brackets indicate the version in which the issue was observed for the first time.

None

Known Issues with option R&S FSQ-K70 Vector Analysis

The version numbers in brackets indicate the version in which the error was observed for the first time.

1) (V4.50) Selection of User QAM Mapping files does not work in remote operation.

Work around: Define a define a new generic standard using this demodulation and mapping in manual operation and select this generic standard in remote operation.

Modified Functions

The behaviour of the following functions changed compared to earlier versions [the number in brackets indicates the firmware version that introduced the individual change]:

1. **(V3.60) EXPORT STANDARD: Query before overwriting existing file in manual operation.**
2. **(V3.60) Menu HOME VSA - FACTORY DEFAULTS now support PATTERNS, too.**
3. **(V3.60) Expanded range for Symbol Rate. The lower limit is now 100 Hz.**
4. **(V3.60) A trace in VIEW state in analyzer mode is set to CLR/WRITE when leaving the vector analysis mode.**
5. **(V3.80) Expanded range for FSK Ref. Deviation. The upper limit is now 1.5 * Symbol Rate.**
6. **(V3.80) Measurements at low frequencies using baseband inputs of option FSQ-B71 by a digital down conversion are now supported.**
7. **(V3.80) Absolute marker position for marker 1 added for measurement result AM/AM - AM/PM conversion.**
8. **(V3.80) SAVE AS STANDARD additionally stores statistics parameter settings (X-AXIS QUANTIZE, X-axis and Y-axis scaling).**
9. **(V3.80) Default focus for NEW PATTERN dialog is change to pattern name.**
10. **(V3.90) Support of option FSQ-B100: Extended Record Length.**
11. **(V4.00) External trigger level in steps 0.1V over the complete range of 0.5V to 3.5V.**
12. **(V4.20) Support for instrument R&S FSG.**
13. **(V4.20) Result SYMBOLS & MOD ACC: Calculation of SNR (signal-to-noise ratio) changed.**

Before version 4.20, the SNR calculation is dependent on the EVM CALC setting (MAX SYMBOL / SIGNAL MEAN POWER). Since version 4.20 the SNR value is only referenced to the mean power. EVM CALC setting is ignored for SNR calculation.

14. **(V4.20) Trace Export of I/Q Data (RAW DATA) in WAVEFORM format.**
15. **(V4.30) Softkeys Signal Source Type (I+j*Q, I Only, Q Only) are only available if baseband input is selected.**
16. **(V4.30) Multi Mode: Changing the Zoom Start window has no effect.**

The Capture Buffer Trace is not updated according to the new zoom window position, if the zoom start position is changed at the current zoom window is located at the end of the I/Q capture buffer.

17. **(V4.30) Statistics measurement: New function field indicates voltage/level interval.**

The interval used for the statistics evaluation is indicated with a new function field at the left top corner of the grid replacing the reference level indication.

18. **(V4.30) New windows dialogs available for File Import/Export functions.**

New dialog with browser functions are now available to export traces or configure the import / export path for Standards, Pattern, Filters, Equalizers.

19. (V4.40) Export and Import of I/Q RAW data.

20. (V4.50) Extended maximum FSK Reference Deviation (8 * Symbol Rate).

21. (V4.50) Additional Trace ASCII Export information (Preamplifier, Transducer).

22. (V4.50) Direct Ex-IQ-Box Configuration Dialog access.

23. (V4.50) New sub menus for signal path dependent softkeys with option R&S FSQ-B71 (Analog Baseband Input) and R&S FSQ-B17 (Digital baseband Input).

24. (V4.60) New filter set "HALF SINE" supporting ZigBee (IEEE 802.15.4).

25. (V4.60) New modulation type π/8-D8PSK.

26. (V4.60) Additional Symbol Mappings available for TETRA and APCO-25 Phase 2.

For	**π/4-DQPSK:**	**"APCO25 Phase 2"**
	π/8-D8PSK:	**"APCO25 Phase 2"**
		"TETRA"

Modifications to the Operating Manual and Supplements

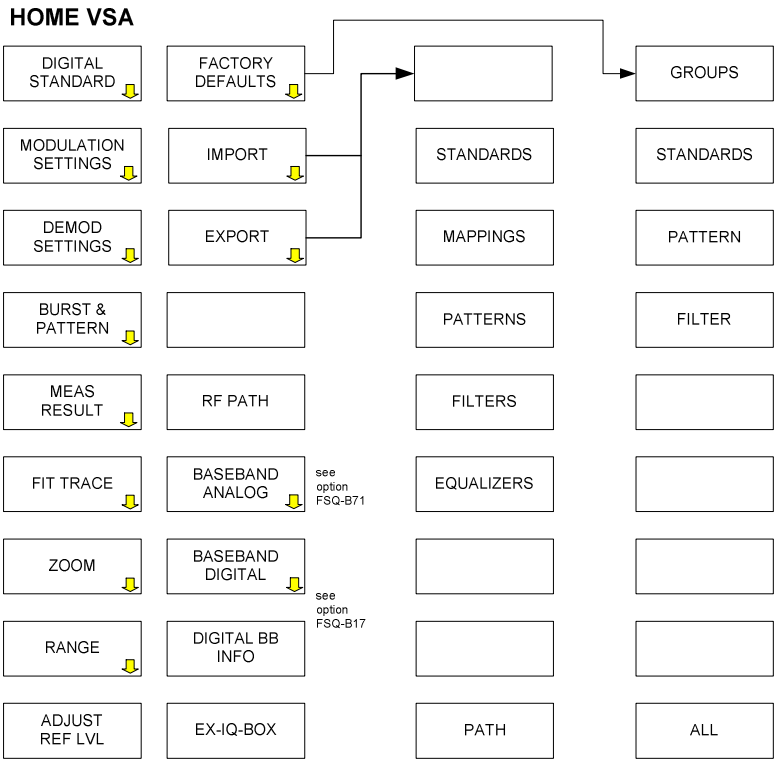
The R&S FSQ-K70 analyzer functions are included in a separate new manual set. Please refer to the following order numbers:

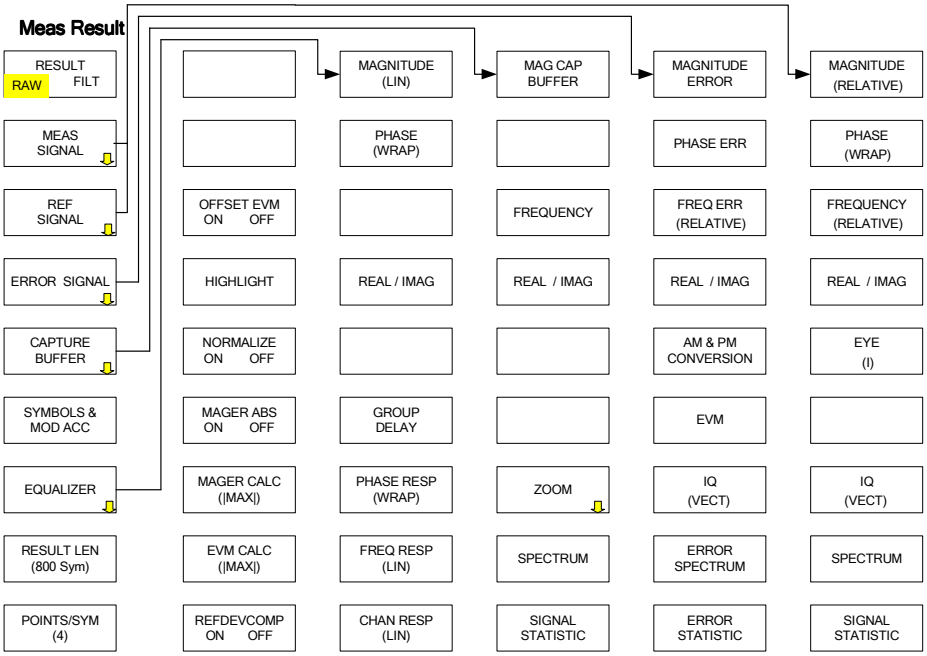
- 1161.8073.42-12 (English)
- 1161.8073.41-12 (German)

The corresponding PDF-Files are separately available on the service board.

Last minute changes to the operating manual

Menu Overview - Softkeys





Setting Parameters – MODULATION SETTINGS Softkey

MODULATION FILTER

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

As of firmware version 4.60 an additional user filter set "*HALF SINE*" is available. 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.

MEAS RESULT softkey

RESULT RAW/FILT
MEAS SIGNAL 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
REFDEVCOM ON/OFF

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 Formulae).

ON is used as a default.

Hint: 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:MEABs 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 Formulae).

MAX SYMBOL is used as a default.

Hint: To get comparable results as for FSW-K70, setting *MEAN PWR* should be used and *MAGER ABS* should be also set to OFF.

```
Remote          SENS:DDEM:MECalc SYMBol | SIGNal
```

Menu TRACE – NEXT

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.

Trace Export:

Since version 4.50 the additional lines "Preamplifier" and "Transducer" are added to the export file.

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;`
	`Receive Filter;NONE;`
	`Measurement Filter;NONE;`
	`Raw Data Filter;ON;`
	`Alpha BT;0.300000;`
		Filter settings

	`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` `x Axis Stop;150.750000;symbols`	Scaling of x-axis

	`y per div;1.000000;deg`
	`Ref Value y-Axis;0.000000;deg`
	`Ref Value Position;50.000000;%`
		Scaling of y-axis

	`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 / Screen A**	`Trace;1;`	Trace
	`Screen;A;`	Screen A
	`Meas Result;Error;` `Meas Signal;Phase;`	Measurement: Error Signal, Phase Error
	`Demodulator;DMSK;`	
	`ResultMode;Trace;`	Trace mode
	`x Unit;symbols;` `y Unit;deg;`	Unit of x and y values
	`Trace Mode;CLR/WRITE;`	Display mode of trace: CLR/WRITE, AVERAGE, MAXHOLD, MINHOLD
	`Values;640;`	Number of measurement points

	`1.834240`
	`1.662848`
	`.......`
	`-0.127578`
	`-0.889226`
		Measured values::
		<real>, <imag>
		<imag> being available only with Real/Imag, Polar- and Constellation diagrams.

Data part of the file **Trace 1 / Screen B**	`Trace;1;`	Trace
	`Screen;B;`	Screen B

	`Meas Result;Meas;`
	`Meas Signal;Magnitude;`
	`Demodulator;DMSK;`
		Measurement:
		Meas Signal, Magnitude

	`ResultMode;Trace;`
	`x Unit;symbols;`
	`y Unit;deg;`
	`Trace Mode;CLR/WRITE;`
	`Values;640;`	

	`0.681856`
	`0.680534`
	`....`
	`0.682217`	

Glossary and Formulae

Trace-based Evaluations

Test parameter	Formula
Magnitude	$MAG_{MEAS}(t) = \lvert MEAS(t) \rvert;$ $MAG_{REF}(t) = \lvert REF(t) \rvert;$
Phase	$PHASE_{MEAS}(t) = \arg(MEAS(t));$ $PHASE_{REF}(t) = \arg(REF(t));$
Magnitude error	With softkey *"MAGERABS"* is set to *"ON"*: $MAG\_ERR(t) = \frac{\lVert MEAS(t) \rvert - \lvert REF(t) \rVert}{C};$ With softkey *"MAGERABS"* is set to *"OFF"*: $MAG\_ERR(t) = \frac{\lvert MEAS(t) \rvert - \lvert REF(t) \rvert}{C};$
Phase error	$PHASE\_ERR(t) = \arg(MEAS(t) \cdot REF^{*}(t));$
Error Vector = EV	$EV(t) = MEAS(t) - REF(t);$
Error Vector Magnitude = EVM	$EVM(t) = \frac{\lvert EV(t) \rvert}{C};$ 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)	$FREQ\_ERR(t) = FREQ_{MEAS}(t) - FREQ_{REF}(t);$
	$t = n \cdot Ta;\ \_where\_Ta = sampling\,period$

Summary - Evaluations

RHO (correlation coefficient)	$\rho = \frac{\left\lvert \sum_n REF^{*}(k) \cdot MEAS(k) \right\rvert^2}{\sum_n \lvert REF(k) \rvert^2 \cdot \sum_n \lvert MEAS(k) \rvert^2} = \frac{KKF(MEAS, REF)}{AKF(REF) \cdot AKF(MEAS)}$

Normalization constant C (not VSB)	$C = \sqrt{\frac{1}{K}\sum_{K}\left\|REF(k)\right\|^2}$ = sqrt(mean power of the symbol decision instants) But if the softkey *"EVM CALC"* for EMV or "MAGER CALC" for Magnitude Error 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 for the EVM calculation.
Normalization constant C (VSB only)	$C = \sqrt{\frac{1}{K}\sum_{K}\left\|\mathrm{Re}\{REF(k)\}\right\|^2}$ = sqrt(mean power of the symbol decision instants). But if the softkey *"EVM CALC"* for EMV or "MAGER CALC" for Magnitude Error 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	$RMS\_MagErr = \sqrt{\frac{1}{K}\sum_{K}\left\|MAG\_ERR(k)\right\|^2}$;
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)	$RMS\_EVM = \sqrt{\frac{\frac{1}{K}\sum_{K}\left\|\mathrm{Re}\{EV(k)\}\right\|^2}{C^2}}$
RMS_Phase_Error	$RMS\_PhaseErr = \sqrt{\frac{1}{K}\sum_{K}\left\|PHASE\_ERR(k)\right\|^2}$;
RMS_Frequency_Error	$RMS\_FreqErr = \sqrt{\frac{1}{K}\sum_{K}\left\|FREQ\_ERR(k)\right\|^2}$;
Origin_Offset (logarithmic measure for IQ_Offset)	$OriginOffset = 10\log_{10}\left(\frac{\left\|IQ\_Offset\right\|^2}{C^2}\right)$ **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:	$Min\left\{\left\|MEAS(t)-\left(a\cdot REF(t)+b\cdot t+c\right)\right\|^2\right\}$ $FSK\_Meas\_Dev = reference\_deviation\cdot a;[Hz]$ $Carrier\_Freq\_Drift = b;[Hz]$ $Carrier\_Freq\_Err = c;[Hz]$ $FSK\_Dev\_Error = MEAS(t)-\left(a\cdot REF(t)+b\cdot t+c\right);[Hz]$ $RMS\_FSK\_DEV\_Error = \sqrt{\frac{1}{M}\sum_m FSK\_Dev\_Error_m^2};[Hz]$
	.k = symbol decision instant Ts = symbol duration

Remote Control Commands

DISPlay subsystem

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE WRITe | VIEW | AVERage | MAXHold | MINHold | RMS

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: WRIT
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision <numeric_value>

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.

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 0...100PCT

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.

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: --
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RVALue <numeric_value>

This command defines the reference value for the y-axis of the measurement diagram.

The numeric suffix under TRACe<1...3> is irrelevant.

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: --
SCPI: device-specific

FORMat subsystem

FORMat:DEXPort:RAW:FORMat ASCii | WAVeform | BINary

This command defines the output format of the RAW data file export function.

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

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.

- <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.

Parameter: <file_name> ::= DOS file name

Example:

```
":INST:SEL DDEM"                          ' enter VSA optrion
 …                                        ' additional commands to
 …                                        ' configure the measurement
                                          ' and perform a measurement
":FORM:DEXP:MODE RAW"                     ' select RAW data to export
":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.

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
                                          ' and perform a measurement
":FORM:DEXP:MODE RAW"                     ' select RAW data to export
":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 file
```

Characteristics: *RST value: -
SCPI: device-specific

This command is an event and therefore has no *RST value and no query.

SENSe subsystem

:[SENSe<1|2>:]DDEMod:MAPPing:CATalog?

This command reads the available mappings for the selected modulation format stored on the hard disk. 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?"                         ' queries the available mappings.
```

Characteristics: *RST value: -
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:MEABs ON | OFF | 0 | 1

This command 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.

Hint: 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:MEAB OFF"                           ' selected signed error calculation
                                          ' for Magnitude Error
```

Characteristics: *RST value: ON
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:MECalc SYMBol | SIGNal

This command switches the calculation formula for Magnitude Error between:

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.

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.

Hint: 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".

The availability of this command depends on the selected modulation. SYMBol is used, if the command is not available.

Example:
```
"DDEM:MEC SIGN"          ' selected the signal power
                         ' normalization for the
                         ' Magnitude Error calculation
```

Characteristics: *RST value: SYMB
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:PSK:FORMat NORMal | DIFFerential | D1Pi8 | N3Pi8

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	D1Pi8	π/8-D8PSK
8	N3Pi8	3π/8-8PSK (EDGE)

This command is only available for PSK demodulation.

Example:
```
"DDEM:FORM PSK"          ' Switch PSK demodulation
                         ' on.
"DDEMod:PSK:NST 8"
                         ' demodulation mode  "
"DDEM:PSK:FORM DIFF"     ' Switch D8PSK demodulation on
```

Characteristics: *RST value: -
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:UQAM:FORMat '<UQAM_demod_mode>'

This command selects the specific demodulation mode for User QAM.

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.

Note: ":SENS:DDEM:MAPP:CAT?" returns the available mappings for the currently selected demodulation mode.

This command is only available for User QAM demodulation.

Parameter: < UQAM_demod_mode > ' User QAM demodulation mode

Example:
```
"DDEM:FORM UQAM"                          ' Switch User QAM 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 (see above)
```

Characteristics: *RST value: -
SCPI: device-specific

:[SENSe<1|2>:]DDEMod:UQAM:NSTate?

This command returns the specific modulation level for User QAM.

This command is only available for User QAM demodulation.

Parameter: -

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.

Remote Control Commands - 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.

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.
```

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
```

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