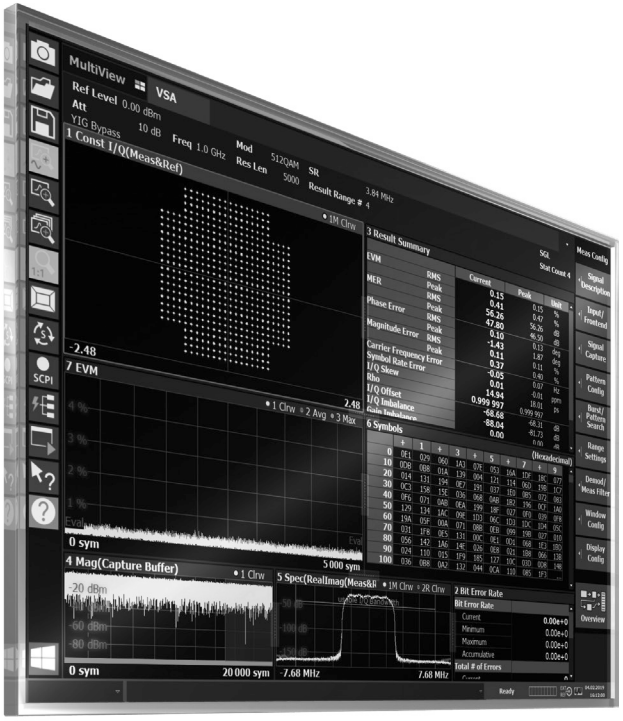
Vector Signal Analysis Application
Specifications

R&S®FPL1/FPS/FSV/FSV3/FSW/FSWP-K70/VSE-K70 Vector Signal Analysis Application
R&S®FPL1/FSV3/FSW/VSE-K70M Multi-Modulation Analysis Application
R&S®FPL1/FSV3/FSW/VSE-K70P BER PRBS Measurement Application



ROHDE&SCHWARZ

Data Sheet | Version 08.00

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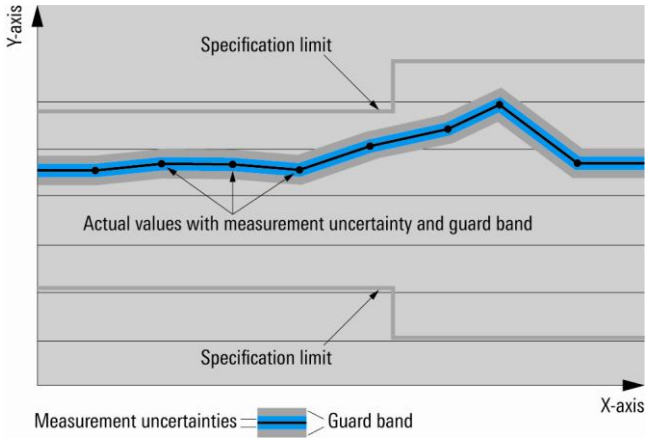
Definitions

General
Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ±, or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Non-traceable specifications with limits (n. trc.)
Represent product performance that is specified and tested as described under “Specifications with limits” above. However, product performance in this case cannot be warranted due to the lack of measuring equipment traceable to national metrology standards. In this case, measurements are referenced to standards used in the Rohde & Schwarz laboratories.

Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: “parameter: value”.

Non-traceable specifications with limits, typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

In line with the 3GPP/3GPP2 standard, chip rates are specified in Mcps (million chips per second), whereas bit rates and symbol rates are specified in Mbps (million bits per second), kbps (thousand bits per second) or ksps (thousand symbols per second), and sample rates are specified in Msample/s (million samples per second). Mcps, kbps, ksps and Msample/s are not SI units.

Specifications

The specifications of the R&S®VSE-K70/R&S®FSx-K70 vector signal analysis application are based on the data sheet specifications of the R&S®FSW, R&S®FSWP, R&S®FSVA3000, R&S®FSV3000, R&S®FSVA, R&S®FSV, R&S®FPS, R&S®FSL, R&S®FPL1000 signal and spectrum analyzers and the R&S®RTO oscilloscope. They have not been checked separately and are not verified during instrument calibration. Measurement uncertainties are given as 95 % confidence intervals. The specified level measurement errors do not take into account systematic errors due to reduced signal-to-noise ratio (SNR).

General remarks

This data sheet covers the R&S®FSW-K70, the R&S®FSWP-K70, the R&S®FSV3-K70, the R&S®FSV-K70, the R&S®FPS-K70, the R&S®FPL1-K70 and the R&S®VSE-K70.
The R&S®FSW-K70, the R&S®FSWP-K70, R&S®FSV3-K70, R&S®FSV-K70, the R&S®FPS-K70 and the R&S®FPL1-K70 are summarized with the term R&S®FSx-K70.

The R&S®FSx-K70 runs on the device itself.
The R&S®VSE-K70 runs on a PC that can be connected to the analyzers and oscilloscopes as specified below.

If not stated otherwise, the data sheet values are device-specific, e.g. the same value applies to the R&S®FSW-K70 and the R&S®VSE-K70 with connected R&S®FSW.

For feature tables the following convention applies:

•	feature always supported i.e. with the R&S®VSE-K70 connected to the device and with the corresponding R&S®FSx-K70 option when running directly on the device
• (VSE)	feature supported only with the R&S®VSE-K70 connected to the device; not with the corresponding R&S®FSx-K70 option when running directly on the device
• (FSx-K70)	feature supported only when running directly on the device with the corresponding R&S®FSx-K70 option; not supported in the R&S®VSE-K70
–	feature not supported with this device

Overview

		R&S®FSW	**R&S®FSWP** [1]	**R&S®FSVA3000/ R&S®FSV3000**	**R&S®FSVA/ R&S®FSV**	**R&S®FPS**	**R&S®FPL1000**	**R&S®FSL**	**R&S®RTO**
R&S®FSx-K70	software that runs on device	• FSW-K70	• FSWP-K70	• FSV3-K70	• FSV-K70	• FPS-K70	• FPL1-K70	–	–
R&S®VSE-K70	PC software that can be connected to device	•	•	•	•	•	•	• [2]	•

[1] R&S®FSWP-B1 option required.

[2] Only R&S®FSL with motherboard order number 2112.1800.xx supported.

Vector signal analysis

Inputs

	R&S®FSW	R&S®FSWP	R&S®FSVA3000/ R&S®FSV3000	R&S®FSVA/ R&S®FSV	R&S®FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO (VSE)
RF input	●	●	●	●	●	●	●	●
Digital baseband input	● (FSW-K70) [3]	–	–	● (FSV-K70) [4]	–	–	–	–
Analog baseband input	● (FSW-K70) [5]	–	–	–	–	–	–	–
File	●	●	●	●	●	●	●	●

Signal acquisition

		R&S®FSW	R&S®FSWP	R&S®FSVA3000/ R&S®FSV3000	R&S®FSVA/ R&S®FSV	R&S®FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO (VSE)
Capture length	maximum [6]	100 000 000 [7] symbol (VSE)	100 000 000 symbol VSE)	100 000 000 symbol (VSE)	100 000 000 symbol (VSE)	100 000 000 symbol	12 000 000 symbol (VSE)	128 000 symbol	19 000 000 symbol
		230 000 000 [7] symbol (FSW-K70)	230 000 000 symbol (FSWP-K70)	50 000 000 [8] symbol (FSV3-K70)	50 000 symbol (FSV-K70)		128 000 symbol (FPL1-K70)		
Sample rate	standard	100 Hz to 10 GHz	100 Hz to 10 GHz	100 Hz to 128 MHz	100 Hz to 45 MHz [9]	100 Hz to 10 GHz	100 Hz to 16 MHz	10 kHz to 10 GHz	100 Hz to 10 GHz
	up to [10]	10 GHz	10 GHz	512 MHz	640 MHz [9]	10 GHz	100 MHz	10 GHz	10 GHz
Capture oversampling		2, 4, 8, 16, 32, 64, 128 [11]							
Symbol rate [12, 13, 14]	depends on capture oversampling	sample rate/capture oversampling							

[3] Only with R&S®FSW-B17 option.

[4] Only with R&S®FSV-B17 option.

[5] Only with R&S®FSW-B71 option.

[6] The upper limit of the capture length applies to the minimum capture oversampling, i.e. 4 for the R&S®FSV-K70 and 2 otherwise. If the capture oversampling is larger, the maximum capture length is reduced proportionally, e.g. for capture oversampling = 8, it is 25 000 000 symbol for the R&S®FSW. The capture length may be restricted by the available RAM.
For additional restrictions and hardware requirements, see R&S®FSW/FSWP/FSVA3000/FSV3000/FSVA/FSV/FPS/FPL1000/VSE and R&S®RTO data sheets.

[7] If the R&S®FSW-B2000 or R&S®FSW-B5000 is active, the maximum capture length is limited to 128 000 symbols.

[8] Firmware version 1.20 or higher required.

[9] For R&S®FSV40 model .39, the maximum sample rate is 12.5 MHz.

[10] Depends on the hardware configuration. For details, see R&S®FSW/FSWP/FSVA3000/FSV3000/FSVA/FSV/FPS/FPL1000 and R&S®RTO data sheets.

[11] For large symbol rates, restricted by the maximum sample rate. Capture oversampling of 2 is only supported for PSK and QAM, for R&S®FSV-K70 limited to 4, 8, 16, 32.

[12] RF input: the maximum symbol rate a measured signal is allowed to have is also limited by the usable I/Q bandwidth of the analyzer, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha)), and any frequency offset (FO). The following condition has to be met for an example with a raised cosine filter: [symbol rate × (1+alpha) + 2 × FO < usable I/Q bandwidth].

[13] Digital baseband input with R&S®FSW-B17/R&S®FSV-B17 option: the maximum symbol rate a measured signal is allowed to have is also limited by the digital input sample rate, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha), and any frequency offset (FO). The following condition has to be met for an example with a raised cosine filter: [symbol rate × (1+alpha) + 2 × FO < 0.8 × digital input sample rate/capture oversampling].

[14] Analog baseband input with R&S®FSW-B71 option: the maximum symbol rate a measured signal is allowed to have is also limited by the analyzer's frequency range, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha)), and any frequency offset (FO). The following condition has to be met for an example with a raised cosine filter: [0.5 × symbol rate × (1+alpha) + FO < half frequency range].

			R&S®FSW	R&S®FSWP	R&S®FSVA3000/ R&S®FSV3000	R&S®FSVA/ R&S®FSV	R&S®FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO (VSE)
Usable I/Q bandwidth	depends on set symbol rate		about 0.8 × capture oversampling × symbol rate							
	standard		10 MHz	10 MHz	28 MHz [15]	28 MHz [16]	28 MHz	12.8 MHz	28 MHz	600 MHz
	up to [10]		2 GHz (VSE) 5 GHz (FSW-K70)	80 MHz	200 MHz [15]	160 MHz [16]	160 MHz	40 MHz	28 MHz	6 GHz
Trigger modes	RF input	free run	•	•	•	•	•	•	•	•
		external	•	•	•	•	•	•	•	•
		IF power [17]	•	•	•	•	•	•	•	–
		I/Q power	• [18]	•	•	–	–	•	–	–
	baseband input	baseband power	• (FSW-K70)	–	–	• (FSV-K70)	–	–	–	–
	burst search [19]		•	•	•	•	•	•	•	•
	predefined or user-defined patterns [20]		•	•	•	•	•	•	•	•

[15] For f > 7.5 GHz, R&S®FSV3-B11 option is required and YIG preselector = off must be set.

[16] For R&S®FSV40 model .39, the maximum usable I/Q bandwidth is 10 MHz.

[17] Restricted functionality at carrier frequencies < 50 MHz.

[18] Not available for analysis bandwidth > 80 MHz, if R&S®FSW-B512 is installed.

[19] Checks captured data for power bursts and performs analysis only on detected burst.

[20] Checks captured data for patterns and performs analysis only on detected pattern.

Modulation formats

Two different PSK and QAM modulations can be measured within the same result range for R&S®FSW-K70, R&S®FSV3-K70, R&S®FPL1-K70 and R&S®VSE-K70. Rotating PSKs/QAMs, such as π/4-16QAM, need to have the same additional phase shift in both modulation ranges. E.g., a π/4-16QAM can be combined with a π/4-QPSK, but not with a 3π/8-8PSK. [21]

Type	Order
FSK	2FSK
	4FSK
	8FSK
	16FSK [22]
	32FSK [22]
	64FSK [22]
MSK	MSK, including GMSK
	DMSK
PSK	BPSK, π/2-BPSK, –π/2-BPSK, π/2-DBPSK
	QPSK, DQPSK, π/4-QPSK, 3π/4-QPSK, π/4-DQPSK
	offset QPSK
	shaped offset QPSK [22]
	8PSK, 3π/8-8PSK, D8PSK, π/8-D8PSK
QAM	16QAM, π/4-16QAM
	32QAM, –π/4-32QAM
	64QAM
	128QAM
	256QAM
	512QAM [22]
	1024QAM [22]
	2048QAM [23]
	4096QAM [23]
ASK	2ASK
	4ASK
APSK	16APSK (DVB-S2 configurations for different code rates)
	32APSK (DVB-S2 configurations for different code rates)
User modulation (QAM, PSK) [22] (with external MAPWIZ [24] tool)	user-definable constellation 2-ary, 4-ary, 8-ary, 16-ary, 32-ary, 64-ary, 128-ary, 256-ary (static and differential)

[21] Requires R&S®FSW-K70M, R&S®FSV3-K70M, R&S®FPL1-K70M or R&S®VSE-K70M, respectively.

[22] Not available for R&S®FSV-K70, but for R&S®VSE-K70 with R&S®FSVA/R&S®FSV connected.

[23] Only available for R&S®FSW/FSWP.

[24] MAPWIZ is a free Rohde & Schwarz tool that can be downloaded at www.rohde-schwarz.com. It requires MATLAB®.

Predefined standards

Predefined standards can be loaded in order to preset the measurement parameters, filters and display format. Predefined standards can be changed and resaved.

3GPP CDMA	QPSK	CPICH (without descrambling and despreading)
GSM, EDGE, EDGE Evolution	GMSK	normal burst
		access burst
		frequency correction burst
		synchronization burst
	3π/8-8PSK	normal burst
	3π/4-QPSK	higher symbol rate burst with narrow and wide pulse filter
	π/4-16QAM	normal burst
		higher symbol rate burst with narrow and wide pulse filter
	–π/4-32QAM	normal burst
		higher symbol rate burst with wide pulse filter
TETRA	π/4-DQPSK	discontinuous downlink
		continuous downlink
APCO25	QPSK	CQPSK
	4FSK	C4FM
	CPM [22]	H-CPM
	DQPSK [22]	H-DQPSK
Bluetooth®	2FSK	DH1
		DH3
		DH5
		low energy
		5.0 low energy
	π/4-DQPSK [22]	2-DH1
		2-DH3
		2-DH5
	D8PSK [22]	3-DH1
		3-DH3
		3-DH5
DOCSIS 3.0 Downlink [22]	64QAM	J83B
		Euro DOCSIS
	256QAM	J83B
		Euro DOCSIS
DECT	2FSK	P32, fixed part
		P32, portable part
DVB-S2	QPSK	
	8PSK	
	16APSK	only XFECFRAME
	32APSK	only XFECFRAME
DVB-S2X [22]	up to 256APSK	Supported via a free Rohde & Schwarz tool that preconfigures R&S®FSx-K70 and R&S®VSE-K70, respectively. The tool can be started from the MEAS menu (R&S®FSx-K70) or the Windows start menu (R&S®VSE-K70).

CDMA2000®	QPSK	1 × forward link (without descrambling and despreading)
	offset QPSK	1 × reverse link (without descrambling and despreading)
ZigBee (IEEE 802.15.4)	offset QPSK	PHY for 2450 MHz band (without descrambling and despreading)
	BPSK	PHY for 915 MHz band (without descrambling and despreading)
		PHY for 868 MHz band (without descrambling and despreading)
SOQPSK [22]	shaped offset QPSK	shaped offset QPSK TG (IRIG 106-13) (without differential precoding)
Others		user-definable standards

Filtering

Filter types	transmit filter	RC (raised cosine)
		RRC (root raised cosine)
		Gaussian
		GMSK
		linearized GMSK
		EDGE narrow pulse shape
		EDGE wide pulse shape
		CDMA2000® 1x forward
		CDMA2000® 1x reverse
		APCO25 C4FM
		APCO25 H-CPM
		APCO25 H-DQPSK
		APCO25 H-D8PSK narrow
		APCO25 H-D8PSK wide
		half sine
		rectangular
		shaped offset QPSK TG [22]
		none
		user-definable filters designed with FILTWIZ [25]
	measurement filter	RRC
		Gaussian
		EDGE NSR
		EDGE HSR (narrow pulse)
		EDGE HSR (wide pulse)
		rectangular
		low ISI measurement filter [26]
		narrow lowpass
		wide lowpass
		none
		user-definable filters designed with FILTWIZ [25]
	receive filter	appropriate receive filters are automatically selected
User-selectable filter parameters		
Alpha (rolloff factor)	for RC and RRC filters	0.030 [27] to 1
B × T	for Gaussian and GMSK filters	0.030 [27] to 1

[25] FILTWIZ is a free Rohde & Schwarz tool that can be downloaded at www.rohde-schwarz.com. It requires MATLAB®.

[26] Not available for shaped offset QPSK.

[27] R&S®FSV-K70 only allows for a two-digit precision, e.g. 0.05 is possible, 0.055 is not.

Measurement parameters

		R&S®FSW	R&S®FSWP	R&S®FSVA3000/ R&S®FSV3000	R&S®FSVA/ R&S®FSV	R&S®FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO (VSE)
Result length	maximum [28]	128 000 symbol	128 000 symbol	128 000 symbol	128 000 symbol (VSE) 20 000 symbol (FSV-K70) [29]	128 000 symbol	128 000 symbol	128 000 symbol	128 000 symbol

Coarse synchronization		data (based on unknown data)
	only if a synchronization pattern is found	pattern (based on synchronization pattern)
Fine synchronization		detected data (based on detected data)
	only if a synchronization pattern is found	pattern (based on synchronization pattern)
	only if known data is provided (see requirements for bit error rate measurement)	known data (based on detected transmit sequence)
EVM normalization	only for PSK, QAM, ASK and APSK	mean reference power
		maximum reference power
		mean constellation power
		maximum constellation power
Optimization [22]		minimize RMS error
		minimize EVM
Offset EVM	only for offset QPSK, shaped offset QPSK	on/off
Equalizer estimation [22]	only for PSK [30], QAM, ASK, APSK and MSK	normal
		tracking
		averaging
		user-defined
Equalizer length [22]	only for PSK [30], QAM, ASK, APSK and MSK	1 symbol to 256 symbol
Error compensation (optional)	PSK, QAM, ASK, APSK and MSK, measured signal	estimated I/Q offset
		estimated I/Q imbalance
		estimated amplitude droop
		estimated symbol rate error [22]
		estimated I/Q skew [22, 30, 31]
		estimated channel response [22, 30]
	FSK, measured signal	estimated carrier frequency drift
	FSK, reference signal	estimated FSK deviation error
Estimation points per symbol	samples per symbol used for fine synchronization and equalizer estimation	1, 2 or capture oversampling
Swap I/Q	captured signal	on/off

[28] Can never be larger than the set capture length. Furthermore, the maximum result length applies to the minimum capture oversampling, i.e. 4 for the R&S®FSV-K70 and 2 otherwise. If the capture oversampling is larger, the maximum result length is reduced proportionally, e.g. for capture oversampling = 8, it is 32 000 symbol for the R&S®FSW.

[29] For the R&S®FSV with FMR7 CPU board, the maximum result length is 10 000 symbol.

[30] Not available for shaped offset QPSK.

[31] Not available for MSK.

Display formats versus time

The following display formats versus time are available.

For this display format, the number of displayed samples per symbol is fixed to the selected capture oversampling.

Captured signal [32]		magnitude versus time
		I/Q versus time
		absolute frequency versus time

For these display formats, the parameter “display points per symbol” (1, 2, 4, 8, 16 or 32) sets the number of displayed samples per symbol.

Measured signal [33]	filtered, carrier locked, symbol locked	absolute/relative magnitude versus time
		I/Q versus time
		wrapped/unwrapped phase versus time
		absolute/relative frequency versus time
Reference signal	ideal, calculated from detected symbols	absolute/relative magnitude versus time
		I/Q versus time
		wrapped/unwrapped phase versus time
		absolute/relative frequency versus time
Error vector signal	vector difference between measured signal and reference signal	EVM versus time (EVM normalization selectable)
		I/Q versus time
Error signal [32, 33]	difference between the measured signal’s magnitude/phase/frequency and the reference signal’s magnitude/phase/ frequency	magnitude error versus time
		phase error versus time
		absolute and relative frequency error versus time

For all the listed results, spectrum and statistics (probability density function (PDF), cumulative probability density function (CDF), 95th percentile) are also available.

[32] Except for the R&S®FSV-K70, the spectrum of the I/Q captured signal and the spectrum of the I/Q error vector can additionally be displayed together in one screen.

[33] Except for the R&S®FSV-K70, the spectrum of the I/Q measured signal and the spectrum of the I/Q error vector can additionally be displayed together in one screen.

Additional display formats

For this display format, the number of displayed samples per symbol is fixed to the selected capture oversampling.

I/Q vector	captured signal	polar diagram

For these display formats, only results at symbol times are displayed.

I/Q constellation	measured signal, reference signal	polar diagram
		I/Q samples
I/Q constellation (rotated)	measured signal, reference signal	polar diagram
		I/Q samples (only for rotated constellations, e.g. 3π/8-8PSK)
Frequency constellation	measured signal, reference signal	absolute frequency

For these display formats, the parameter “display points per symbol” (1, 2, 4, 8, 16 or 32) sets the number of displayed samples per symbol.

I/Q vector	measured signal, reference signal, error vector signal	polar diagram, display of trajectory between symbol times
Frequency vector	measured signal, reference signal	absolute frequency
Eye diagram	measured signal, reference signal	I eye diagram
		Q eye diagram
Eye diagram frequency	measured signal, reference signal	eye diagram of absolute frequency

Display formats regarding the equalizer/channel

These display formats are not available for the R&S®FSV-K70.

Impulse response		magnitude
		phase
		I/Q versus time
Frequency response		magnitude
		phase
		group delay
Channel		frequency response magnitude
		group delay

Display of modulation accuracy results

The tables show the scalar result values calculated for each measurement. Additionally, the following statistical measures (calculated over multiple measurements) are shown for each result value: mean, peak (worst value), standard deviation and 95th percentile.
Limits can only be set for the current, mean and peak value of EVM, magnitude error, phase error, carrier frequency error, waveform quality factor and I/Q offset.

The tables are modulation-specific.

Table for MSK, PSK, QAM, ASK and APSK
For the following results, the parameter “estimation points per symbol” can be set by the user. It can be set to 1 (only symbol times contribute to the result), 2 (two samples per symbol contribute to the result) or capture oversampling (all samples contribute to the result).

I/Q offset		calculation range automatically selected
I/Q imbalance	not for BPSK, ASK	
Gain imbalance	not for BPSK, ASK	
Quadrature error	not for BPSK, ASK	
Amplitude droop		
Carrier frequency error		
Symbol rate error [34]		
I/Q skew [34]	not for MSK, shaped offset QPSK	

For the following results, the parameter “display points per symbol” can be set by the user. It can be set to 1 (only symbol times contribute to the result), 2 (two samples per symbol contribute to the result) or capture oversampling (all samples contribute to the result). The estimated I/Q offset, I/Q imbalance, amplitude droop, symbol rate error, I/Q skew may be optionally compensated before calculating these values.

Error vector magnitude (EVM)	RMS and peak value of corresponding trace	user-settable calculation range (evaluation range)
Modulation error ratio (MER)	RMS and peak value of corresponding trace	
Magnitude error	RMS and peak value of corresponding trace	
Phase error	RMS and peak value of corresponding trace	
Mean power		
Waveform quality factor ρ (rho)		

Remark: for offset QPSK, the error vector magnitude (EVM) and modulation error ratio (MER) can be influenced by the parameter “Offset EVM”.

Table for FSK
For the following results, the parameter “estimation points per symbol” can be set by the user (1, 2 or capture oversampling).

FSK deviation error		calculation range automatically selected
FSK measurement deviation		
Carrier frequency drift		
Carrier frequency error		

For the following results, the parameter “display points per symbol” can be set by the user (1, 2 or capture oversampling). The estimated FSK deviation error and the estimated carrier frequency drift may be optionally compensated before calculating these values.

Frequency error	RMS and peak value of corresponding trace	user-settable calculation range (evaluation range)
Magnitude error	RMS and peak value of corresponding trace	
Mean power		

[34] Not available for R&S®FSV-K70, but for R&S®VSE-K70 with R&S®FSVA/R&S®FSV connected.

Bit error rate

The bit error rate measurement requires one of the below mentioned prerequisite:

- An XML file containing all valid transmit sequences is loaded. [35]
- The DUT transmits a PRBS bit sequence [36] (only for R&S®FSW-K70P, R&S®FSV3-K70P, R&S®FPL1-K70P or R&S®VSE-K70P).

Bit error rate		current value
		best-case value
		worst-case value
		accumulative value

Detected symbols

Symbol formats		binary
		octal
		decimal
		hexadecimal
Symbol marker	only if a pattern is loaded	correctly detected pattern symbols are marked in green
		decision errors within pattern are highlighted in red [22]
	only if prerequisites for bit error rate measurement are fulfilled (cf. Bit error rate)	decision errors within the result range are highlighted in red [22]

[35] The length of the transmit sequences needs to coincide with the length of the result range. A tool to record all valid transmit sequences is provided with firmware (R&S®VSA sequence recording). Rohde & Schwarz recommends using an external trigger or a synchronization pattern to align the result range for this measurement.

[36] Supported PRBS orders: 9, 11, 15, 16, 20, 21, 23.

Measurement uncertainty (nom.)

Specifications apply under the following conditions: temperature range from +20 °C to +30 °C; signal level ≥ –25 dBm; properly adjusted reference level; external reference frequency applied; offset between R&S®VSE/instrument center frequency and input signal center frequency smaller than 5 % of symbol rate; no additional I/Q impairments; random data sequence. Capture oversampling is set to 4.
For symbol rates < 1 kHz or frequencies > 5 GHz, accuracy may be limited by phase noise.

Residual errors for QPSK

The modulation is QPSK, the transmit filter is RRC with rolloff factor 0.22, the measurement filter is RRC with rolloff factor 0.22, and EVM is normalized to mean expected reference power. The parameter “estimation points per symbol” is set to 1, as is the parameter “display points per symbol” for the result summary. The result length is 150 symbol and the number of averages is 10.

EVM	Symbol rate	R&S®FSW/FSWP	R&S®FSVA3000	R&S®FSV3000	R&S®FSVA/FSV/FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO [37] (VSE)
Residual EVM RMS (averaged value)	CF = 1 GHz							
	100 kHz	< 0.3 %	< 0.4 %	< 0.5 %	< 0.5 %	< 0.6 %	< 0.7 %	< 0.5 %
	1 MHz	< 0.4 %	< 0.45 %	< 0.5 %	< 0.5 %	< 1.1 %	< 0.7 %	< 0.5 %
	10 MHz	< 0.6 %	< 0.65 %	< 0.7 %	< 0.7 %	< 0.9 %	< 1.0 %	< 1.0 %
	20 MHz	< 1.0 %	< 1.0 %	< 1.05 %	< 1.2 %	< 1.5 %	< 2.0 %	< 2.0 %

Carrier frequency error	Symbol rate	R&S®FSW/FSWP	R&S®FSVA3000	R&S®FSV3000	R&S®FSVA/FSV/FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO [37] (VSE)
Carrier frequency error uncertainty (2σ value) The R&S®FSW/FSWP/ FSVA3000/FSV3000 FSVA/FSV/FPS/FPL1000/ FSL/RTO frequency uncertainty needs to be added separately. Please refer to the corresponding specifications.	CF = 1 GHz							
	100 kHz	0.5 Hz	0.6 Hz	0.7 Hz	0.7 Hz	1 Hz	4 Hz	10 Hz
	1 MHz	3 Hz	4 Hz	5 Hz	6 Hz	10 Hz	20 Hz	15 Hz
	10 MHz	50 Hz	80 Hz	100 Hz	150 Hz	200 Hz	500 Hz	400 Hz
	20 MHz	150 Hz	250 Hz	280 Hz	300 Hz	350 Hz	1 kHz	600 Hz

Residual errors for FSK

The modulation is 2FSK, the transmit filter is RRC with rolloff factor 0.2, the measurement filter is RRC with rolloff factor 0.2, and the FSK reference deviation is a quarter of the symbol rate. The parameter “estimation points per symbol” is set to 4 (capture oversampling), as is the parameter “display points per symbol” for the result summary. The result length is 150 symbol and the number of averages is 10.

Frequency error	Symbol rate	R&S®FSW/FSWP	R&S®FSVA3000	R&S®FSV3000	R&S®FSVA/FSV/FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO [37] (VSE)
Residual frequency error RMS (averaged value)	CF = 1 GHz							
	100 kHz	< 0.5 %	< 0.5 %	< 0.5 %	< 0.5 %	< 0.5 %	< 0.5 %	< 0.5 %
	1 MHz	< 0.5 %	< 0.5 %	< 0.5 %	< 0.5 %	< 0.8 %	< 0.6 %	< 0.5 %
	10 MHz	< 0.6 %	< 0.65 %	< 0.7 %	< 0.7 %	< 0.9 %	< 1.0 %	< 1.0 %
	20 MHz	< 1.0 %	< 1.1 %	< 1.2 %	< 1.2 %	< 1.5 %	< 10 %	< 2.0 %

[37] Values apply for the speed optimized mode as mentioned in the R&S®VSE data sheet.

Residual errors for predefined standards

Measurements are based on the corresponding predefined standards. The number of averages is 10.

EVM		R&S®FSW/FSWP	R&S®FSVA3000	R&S®FSV3000	R&S®FSVA/FSV/FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO [37] (VSE)
Residual EVM RMS (averaged value)	CF = 1 GHz							
	3GPP WCDMA (CPICH)	< 1.0 %	< 1.0 %	< 1.0 %	< 1.0 %	< 1.0 %	< 1.0 %	< 1.0 %
	GSM EDGE (3π/8-8PSK, normal burst)	< 0.4 %	< 0.45 %	< 0.5 %	< 0.5 %	< 0.6 %	< 0.7 %	< 0.6 %
	GSM (normal burst)	< 0.4 %	< 0.5 %	< 0.6 %	< 0.6 %	< 0.8 %	< 0.9 %	< 0.8 %

Frequency error		R&S®FSW/FSWP	R&S®FSVA3000	R&S®FSV3000	R&S®FSVA/FSV/FPS	R&S®FPL1000	R&S®FSL (VSE)	R&S®RTO [37] (VSE)
Residual frequency error RMS (averaged value)	CF = 1 GHz							
	Bluetooth® (DH1)	< 0.8 %	< 0.8 %	< 0.8 %	< 0.8 %	< 1.5 %	< 2.0 %	< 0.8 %

Ordering information

Designation	Type	Order No.
Vector signal analysis		
Vector signal analysis	R&S®FSW-K70	1313.1416.02
Multi-modulation analysis, R&S®FSW-K70 option required	R&S®FSW-K70M	1338.4177.02
BER PRBS measurements, R&S®FSW-K70 option required	R&S®FSW-K70P	1338.3893.02
Vector signal analysis, R&S®FSWP-B1 option required	R&S®FSWP-K70	1325.4280.02
Vector signal analysis	R&S®FSV3-K70	1330.5074.02
Multi-modulation analysis, R&S®FSV3-K70 option required	R&S®FSV3-K70M	1346.3376.02
BER PRBS measurements, R&S®FSV3-K70 option required	R&S®FSV3-K70P	1346.3382.02
Vector signal analysis	R&S®FSV-K70	1310.8455.02
Vector signal analysis	R&S®FPS-K70	1321.4127.02
Vector signal analysis	R&S®FPL1-K70	1323.1748.02
Multi-modulation analysis, R&S®FPL1-K70 option required	R&S®FPL1-K70M	1323.1625.02
BER PRBS measurements, R&S®FPL1-K70 option required	R&S®FPL1-K70P	1323.1631.02
Vector signal analysis measurement software	R&S®VSE-K70	1320.7500.02
Multi-modulation analysis, R&S®VSE-K70 option required	R&S®VSE-K70M	1345.1211.02
BER PRBS measurements, R&S®VSE-K70 option required	R&S®VSE-K70P	1345.1228.02
Vector signal explorer		
Base software	R&S®VSE	1320.7500.06
Signal and spectrum analyzers		
Signal and spectrum analyzer, 2 Hz to 8 GHz	R&S®FSW8	1331.5003.08
Signal and spectrum analyzer, 2 Hz to 13.6 GHz	R&S®FSW13	1331.5003.13
Signal and spectrum analyzer, 2 Hz to 26.5 GHz	R&S®FSW26	1331.5003.26
Signal and spectrum analyzer, 2 Hz to 43.5 GHz	R&S®FSW43	1331.5003.43
Signal and spectrum analyzer, 2 Hz to 50 GHz	R&S®FSW50	1331.5003.50
Signal and spectrum analyzer, 2 Hz to 67 GHz	R&S®FSW67	1331.5003.67
Signal and spectrum analyzer, 2 Hz to 85 GHz	R&S®FSW85	1331.5003.85
Phase noise analyzer, 1 MHz to 8 GHz	R&S®FSWP8	1322.8003.08
Phase noise analyzer, 1 MHz to 26.5 GHz	R&S®FSWP26	1322.8003.26
Phase noise analyzer, 1 MHz to 50 GHz	R&S®FSWP50	1322.8003.50
Signal and spectrum analyzer, 10 Hz to 4 GHz	R&S®FSVA3004	1330.5000.05
Signal and spectrum analyzer, 10 Hz to 7.5 GHz	R&S®FSVA3007	1330.5000.08
Signal and spectrum analyzer, 10 Hz to 13.6 GHz	R&S®FSVA3013	1330.5000.14
Signal and spectrum analyzer, 10 Hz to 30 GHz	R&S®FSVA3030	1330.5000.31
Signal and spectrum analyzer, 10 Hz to 44 GHz	R&S®FSVA3044	1330.5000.44
Signal and spectrum analyzer, 10 Hz to 4 GHz	R&S®FSV3004	1330.5000.04
Signal and spectrum analyzer, 10 Hz to 7.5 GHz	R&S®FSV3007	1330.5000.07
Signal and spectrum analyzer, 10 Hz to 13.6 GHz	R&S®FSV3013	1330.5000.13
Signal and spectrum analyzer, 10 Hz to 30 GHz	R&S®FSV3030	1330.5000.30
Signal and spectrum analyzer, 10 Hz to 44 GHz	R&S®FSV3044	1330.5000.43
Signal and spectrum analyzer	R&S®FSVA4	1321.3008.05
Signal and spectrum analyzer	R&S®FSVA7	1321.3008.08
Signal and spectrum analyzer	R&S®FSVA13	1321.3008.14
Signal and spectrum analyzer	R&S®FSVA30	1321.3008.31
Signal and spectrum analyzer, max. resolution bandwidth 10 MHz	R&S®FSVA40	1321.3008.41

Signal and spectrum analyzer	R&S®FSV4	1321.3008.04
Signal and spectrum analyzer	R&S®FSV7	1321.3008.07
Signal and spectrum analyzer	R&S®FSV13	1321.3008.13
Signal and spectrum analyzer	R&S®FSV30	1321.3008.30
Signal and spectrum analyzer, max. resolution bandwidth 10 MHz	R&S®FSV40	1321.3008.39
Signal and spectrum analyzer	R&S®FSV40	1321.3008.40
Signal and spectrum analyzer, 9 kHz to 4 GHz	R&S®FPS4	1319.2008.04
Signal and spectrum analyzer, 9 kHz to 7 GHz	R&S®FPS7	1319.2008.07
Signal and spectrum analyzer, 9 kHz to 13.6 GHz	R&S®FPS13	1319.2008.13
Signal and spectrum analyzer, 9 kHz to 30 GHz	R&S®FPS30	1319.2008.30
Signal and spectrum analyzer, 9 kHz to 40 GHz	R&S®FPS40	1319.2008.40
Signal and spectrum analyzer, 5 kHz to 3 GHz	R&S®FPL1003	1304.0004.03
Signal and spectrum analyzer, 5 kHz to 7.5 GHz	R&S®FPL1007	1304.0004.07
Spectrum analyzer, 9 kHz to 3 GHz	R&S®FSL3	1300.2502.03
Spectrum analyzer, 9 kHz to 3 GHz, with tracking generator	R&S®FSL3	1300.2502.13
Spectrum analyzer, 9 kHz to 6 GHz	R&S®FSL6	1300.2502.06
Spectrum analyzer, 9 kHz to 6 GHz, with tracking generator	R&S®FSL6	1300.2502.16
Spectrum analyzer, 9 kHz to 18 GHz	R&S®FSL18	1300.2502.18
Spectrum analyzer, 9 kHz to 18 GHz, with tracking generator	R&S®FSL18	1300.2502.28
Oscilloscopes		
Oscilloscope, 600 MHz	R&S®RTO1002	1316.1000.02
Oscilloscope, 600 MHz	R&S®RTO1004	1316.1000.04
Oscilloscope, 1 GHz	R&S®RTO1012	1316.1000.12
Oscilloscope, 1 GHz	R&S®RTO1014	1316.1000.14
Oscilloscope, 2 GHz	R&S®RTO1022	1316.1000.22
Oscilloscope, 2 GHz	R&S®RTO1024	1316.1000.24
Oscilloscope, 4 GHz	R&S®RTO1044	1316.1000.44
Oscilloscope, 600 MHz, 2 channels	R&S®RTO2002	1329.7002.02
Oscilloscope, 600 MHz, 4 channels	R&S®RTO2004	1329.7002.04
Oscilloscope, 1 GHz, 2 channels	R&S®RTO2012	1329.7002.12
Oscilloscope, 1 GHz, 4 channels	R&S®RTO2014	1329.7002.14
Oscilloscope, 2 GHz, 2 channels	R&S®RTO2022	1329.7002.22
Oscilloscope, 2 GHz, 4 channels	R&S®RTO2024	1329.7002.24
Oscilloscope, 3 GHz, 2 channels	R&S®RTO2032	1329.7002.32
Oscilloscope, 3 GHz, 4 channels	R&S®RTO2034	1329.7002.34
Oscilloscope, 4 GHz, 4 channels	R&S®RTO2044	1329.7002.44
Oscilloscope, 6 GHz, 4 channels	R&S®RTO2064	1329.7002.64
Service option		
R&S®VSE software maintenance	R&S®VSE-SWM	1320.7622.81