

VECTOR SIGNAL ANALYSIS APPLICATION

Specifications

R&S®FPL1/FPS/FSV/FSV3/FSW/FSWP/FSWT-K70/VSE-K70 Vector Signal Analysis Application

R&S®FPL1/FSV3/FSW/FSWP/FSWT/VSE-K70M Multi-Modulation Analysis Application

R&S®FPL1/FSV3/FSW/FSWP/FSWT/VSE-K70P BER PRBS Measurement Application



Data Sheet
Version 11.00

ROHDE & SCHWARZ

Make ideas real



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Definitions

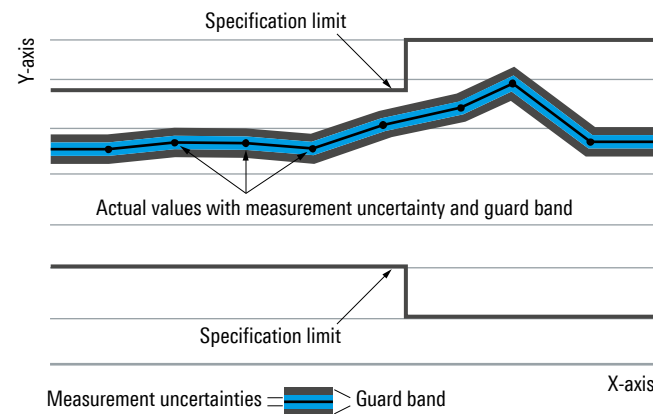
General

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 $<$, \leq , $>$, \geq , \pm , 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".

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 million chips per second (Mcps), whereas bit rates and symbol rates are specified in billion bits per second (Gbps), million bits per second (Mbps), thousand bits per second (kbps), million symbols per second (MSPS) or thousand symbols per second (ksps), and sample rates are specified in million samples per second (Msample/s). Gbps, Mcps, Mbps, MSPS, 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, the R&S®FSWT test receiver 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®FSWT-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, the R&S®FSWT-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, test receiver 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®FSWT | 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 | • FSWT-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 application

Inputs

| | R&S®FSW | R&S®FSWP | R&S®FSWT | 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 | – | • (FSWT-K70) ⁴ | – | • (FSV-K70) ⁵ | – | – | – | – |
| Analog baseband input | • (FSW-K70) ⁶ | – | – | – | – | – | – | – | – |
| File | • | • | • | • | • | • | • | • | • |

Signal acquisition

| | | R&S®FSW | R&S®FSWP | R&S®FSWT | 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 number of symbols ⁷ | 100 000 000 ⁸ (VSE) | 100 000 000 (VSE) | 100 000 000 (VSE) | 100 000 000 (VSE) | 100 000 000 (VSE) | 100 000 000 | 12 000 000 (VSE) | 128 000 | 19 000 000 |
| | | 230 000 000 ⁸ (FSW-K70) | 230 000 000 (FSWP-K70) | 200 000 000 (FSWT-K70) | 50 000 000 ⁹ (FSV3-K70) | 50 000 (FSV-K70) | | 128 000 (FPL1-K70) | | |
| Sample rate ¹⁰ | standard | 100 Hz to 10 GHz | 100 Hz to 10 GHz | 100 Hz to 7.2 GHz | 100 Hz to 128 MHz | 100 Hz to 45 MHz ¹¹ | 100 Hz to 10 GHz | 100 Hz to 16 MHz | 10 kHz to 10 GHz | 100 Hz to 10 GHz |
| | up to ¹² | 20 GHz | 20 GHz | 7.2 GHz | 10 GHz | 640 MHz ¹¹ | 20 GHz | 100 MHz | 10 GHz | 10 GHz |
| Capture oversampling | | 2, 4, 8, 16, 32, 64, 128 ¹³ | | | | | | | | |
| Symbol rate ^{14, 15, 16} | depends on capture oversampling | sample rate/capture oversampling | | | | | | | | |

³ Only with R&S®FSW-B17 option.

⁴ Only with R&S®FSWT-B17 option.

⁵ Only with R&S®FSV-B17 option.

⁶ Only with R&S®FSW-B71 option.

⁷ 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.

⁸ If the R&S®FSW-B2000 or R&S®FSW-B5000 is active, the maximum capture length is limited to 128 000 symbol.

⁹ Firmware version 1.20 or higher required.

¹⁰ Setting range.

¹¹ For R&S®FSV40 model .39, the maximum sample rate is 12.5 MHz.

¹² Depends on the hardware configuration. For details, see R&S®FSW/FSWP/FSWT/FSVA3000/FSV3000/FSVA/FSV/FPS/FPL1000 and R&S®RTO data sheets.

¹³ 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.

¹⁴ 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: $[\text{symbol rate} \times (1 + \alpha) + 2 \times \text{FO} < \text{usable I/Q bandwidth}]$.

¹⁵ Digital baseband input with R&S®FSW-B17/ R&S®FSWT-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: $[\text{symbol rate} \times (1 + \alpha) + 2 \times \text{FO} < 0.8 \times \text{digital input sample rate/capture oversampling}]$.

¹⁶ 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: $[0.5 \times \text{symbol rate} \times (1 + \alpha) + \text{FO} < \text{half frequency range}]$.

| | | R&S®FSW | R&S®FSWP | R&S®FSWT | 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 | 500 MHz | 28 MHz ¹⁷ | 28 MHz ¹⁸ | 28 MHz | 12.8 MHz | 28 MHz | 600 MHz | |
| | up to ¹² | 8312 MHz | 320 MHz | 500 MHz | 1000 MHz ¹⁷ | 160 MHz ¹⁸ | 160 MHz | 40 MHz | 28 MHz | 6 GHz | |
| Trigger modes | RF input | free run | • | • | • | • | • | • | • | • | |
| | | external | • | • | • | • | • | • | • | • | |
| | | IF power ¹⁹ | • | • | • | • | • | • | • | • | – |
| | I/Q power | • ²⁰ | • | • | • | – | – | • | – | – | |
| | base- band input | baseband power | • (FSW-K70) | – | – | – | • (FSV-K70) | – | – | – | – |
| | | burst search ²¹ | • | • | • | • | • | • | • | • | • |
| predefined or user- defined patterns ²² | • | • | • | • | • | • | • | • | • | • | |

¹⁷ f > 7.5 GHz, with R&S®FSV3-B11 option and YIG preselector off.

¹⁸ For R&S®FSV40 model .39, the maximum usable I/Q bandwidth is 10 MHz.

¹⁹ Restricted functionality at carrier frequencies < 50 MHz. The IF power trigger can be also limited in bandwidth. For details, see R&S®FSW, R&S®FSWP, R&S®FSWT, R&S®FSVA3000, R&S®FSV3000, R&S®FSVA, R&S®FSV, R&S®FPS, R&S®FPL1000 and R&S®FSL data sheets.

²⁰ Not available for analysis bandwidth > 80 MHz, if R&S®FSW-B512 is installed.

²¹ Checks captured data for power bursts and performs analysis only on detected burst.

²² 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®FSWP-K70, R&S®FSWT-K70, R&S®FSV3-K70, R&S®FPL1-K70 and R&S®VSE-K70.

Rotating PSKs/QAMs, such as $\pi/4$ -16QAM, need to have the same additional phase shift in both modulation ranges. E.g., a $\pi/4$ -16QAM can be combined with a $\pi/4$ -QPSK, but not with a $3\pi/8$ -8PSK.²³

| Type | Order |
|---|--|
| FSK | 2FSK |
| | 4FSK |
| | 8FSK |
| | 16FSK ²⁴ |
| | 32FSK ²⁴ |
| | 64FSK ²⁴ |
| MSK | MSK, including GMSK |
| | DMSK |
| PSK | BPSK, $\pi/2$ -BPSK, $-\pi/2$ -BPSK, $\pi/2$ -DBPSK |
| | QPSK, DQPSK, $\pi/4$ -QPSK, $3\pi/4$ -QPSK, $\pi/4$ -DQPSK |
| | offset QPSK |
| | shaped offset QPSK ²⁴ |
| | 8PSK, $3\pi/8$ -8PSK, D8PSK, $\pi/8$ -D8PSK |
| QAM | 16QAM, $\pi/4$ -16QAM |
| | 32QAM, $-\pi/4$ -32QAM |
| | 64QAM |
| | 128QAM |
| | 256QAM |
| | 512QAM ²⁴ |
| | 1024QAM ²⁴ |
| | 2048QAM ²⁵ |
| | 4096QAM ²⁵ |
| ASK | 2ASK |
| | 4ASK |
| APSK | 16APSK (DVB-S2 configurations for different code rates) |
| | 32APSK (DVB-S2 configurations for different code rates) |
| User modulation (QAM, PSK) ²⁴ (with external MAPWIZ ²⁶ tool) | user-definable constellation 2-ary, 4-ary, 8-ary, 16-ary, 32-ary, 64-ary, 128-ary, 256-ary (static and differential) |

²³ Requires R&S®FSW-K70M, R&S®FSWP-K70M, R&S®FSWT-K70M, R&S®FSV3-K70M, R&S®FPL1-K70M or R&S®VSE-K70M, respectively.

²⁴ Not available for R&S®FSV-K70, but for R&S®VSE-K70 with R&S®FSVA/R&S®FSV connected.

²⁵ Only available for R&S®FSW/FSWP/FSWT.

²⁶ 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 |
| | 3 π /8-8PSK | normal burst |
| | 3 π /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 |
| | $-\pi$ /4-32QAM | normal burst |
| TETRA | π /4-DQPSK | discontinuous downlink |
| | | continuous downlink |
| APCO25 | QPSK | CQPSK |
| | 4FSK | C4FM |
| | CPM ²⁴ | H-CPM |
| | DQPSK ²⁴ | H-DQPSK |
| Bluetooth® | 2FSK | DH1 |
| | | DH3 |
| | | DH5 |
| | | low energy |
| | | 5.0 low energy |
| | π /4-DQPSK ²⁴ | 2-DH1 |
| | | 2-DH3 |
| | | 2-DH5 |
| D8PSK ²⁴ | 3-DH1 | |
| | 3-DH3 | |
| | 3-DH5 | |
| DOCSIS 3.0 downlink ²⁴ | 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-S2/DVB-S2X ²⁴ | 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 x forward link (without descrambling and desreading) |
| | offset QPSK | 1 x reverse link (without descrambling and desreading) |
| ZigBee (IEEE 802.15.4) | offset QPSK | PHY for 2450 MHz band (without descrambling and desreading) |
| | BPSK | PHY for 915 MHz band (without descrambling and desreading) |
| | | PHY for 868 MHz band (without descrambling and desreading) |
| SOQPSK ²⁴ | 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 ²⁴ | |
| | none | |
| | user-definable filters designed with FILTWIZ ²⁷ | |
| | measurement filter | RRC |
| Gaussian | | |
| EDGE NSR | | |
| EDGE HSR (narrow pulse) | | |
| EDGE HSR (wide pulse) | | |
| rectangular | | |
| low ISI measurement filter ²⁸ | | |
| narrow lowpass | | |
| wide lowpass | | |
| none | | |
| user-definable filters designed with FILTWIZ ²⁷ | | |
| receive filter | appropriate receive filters are automatically selected | |
| User-selectable filter parameters | | |
| Alpha (rolloff factor) | for RC and RRC filters | 0.030 ²⁹ to 1 |
| B × T | for Gaussian and GMSK filters | 0.030 ²⁹ to 1 |

²⁷ FILTWIZ is a free Rohde & Schwarz tool that can be downloaded at www.rohde-schwarz.com. It requires MATLAB[®].

²⁸ Not available for shaped offset QPSK.

²⁹ 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®FSWT | 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 number of symbols ³⁰ | 128 000 | 128 000 | 128 000 | 128 000 | 128 000 (VSE) 20 000 (FSV-K70) ³¹ | 128 000 | 128 000 | 128 000 | 128 000 |

| | | | | | | | | | | | |
|------------------------------------|--|--|--|--|--|--|--|--|--|---|--|
| 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 | | | | | | | | | | | mean reference power |
| | | | | | | | | | | only for PSK, QAM, ASK and APSK | maximum reference power |
| | | | | | | | | | | | mean constellation power |
| | | | | | | | | | | | maximum constellation power |
| Optimization ²⁴ | | | | | | | | | | | minimize RMS error |
| | | | | | | | | | | | minimize EVM |
| Offset EVM | | | | | | | | | | | on/off |
| Equalizer estimation ²⁴ | | | | | | | | | | | normal |
| | | | | | | | | | | only for offset QPSK, shaped offset QPSK | tracking |
| | | | | | | | | | | only for PSK ³² , QAM, ASK, APSK and MSK | averaging |
| | | | | | | | | | | | user-defined |
| Equalizer length ²⁴ | | | | | | | | | | | 1 symbol to 256 symbol |
| Error compensation (optional) | | | | | | | | | | | estimated I/Q offset |
| | | | | | | | | | | PSK, QAM, ASK, APSK and MSK, measured signal | estimated I/Q imbalance |
| | | | | | | | | | | | estimated amplitude droop |
| | | | | | | | | | | | estimated symbol rate error ²⁴ |
| | | | | | | | | | | | estimated I/Q skew ^{24, 32, 33} |
| | | | | | | | | | | | |
| Estimation points per symbol | | | | | | | | | | | estimated carrier frequency drift |
| | | | | | | | | | | FSK, measured signal | estimated FSK deviation error |
| Swap I/Q | | | | | | | | | | | 1, 2 or capture oversampling |
| | | | | | | | | | | FSK, reference signal | on/off |

³⁰ 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.

³¹ For the R&S®FSV with FMR7 CPU board, the maximum result length is 10 000 symbol.

³² Not available for shaped offset QPSK.

³³ 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 ³⁴ | | 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 ³⁵ | 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 |
| Error vector signal | vector difference between measured signal and reference signal | absolute/relative frequency versus time |
| | | EVM versus time (EVM normalization selectable) |
| Error signal ^{34, 35} | difference between the measured signal's magnitude/phase/frequency and the reference signal's magnitude/phase/ frequency | I/Q versus time |
| | | 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.

³⁴ 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.

³⁵ 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 ³⁶ | | |
| I/Q skew ³⁶ | 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 | | |

³⁶ 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 ³⁷
- The DUT transmits a PRBS bit sequence ³⁸ (only for R&S®FSW-K70P, R&S®FSWP-K70P, R&S®FSWT-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 ²⁴ |
| | only if prerequisites for bit error rate measurement are fulfilled (cf. Bit error rate) | decision errors within the result range are highlighted in red ²⁴ |

³⁷ 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.

³⁸ Supported PRBS orders: 7, 9, 11, 15, 16, 20, 21, 23, 31.

Measurement uncertainty (nominal)

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/FSWT | R&S®FSVA3000 | R&S®FSV3000 | R&S®FSVA/FSV/FPS | R&S®FPL1000 | R&S®FSL (VSE) | R&S®RTO ³⁹ (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/FSWT | R&S®FSVA3000 | R&S®FSV3000 | R&S®FSVA/FSV/FPS | R&S®FPL1000 | R&S®FSL (VSE) | R&S®RTO ³⁹ (VSE) |
|--|-------------|-------------------|--------------|-------------|------------------|-------------|---------------|-----------------------------|
| Carrier frequency error uncertainty (2 σ value) | 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 |
| The R&S®FSW/FSWP/FSWT/FSVA3000/FSV3000/FSVA/FSV/FPS/FPL1000/FSL/RTO frequency uncertainty needs to be added separately. Please refer to the corresponding data sheets. | | | | | | | | |

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/FSWT | R&S®FSVA3000 | R&S®FSV3000 | R&S®FSVA/FSV/FPS | R&S®FPL1000 | R&S®FSL (VSE) | R&S®RTO ³⁹ (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 % |

³⁹ 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/FSWT | R&S®FSVA3000 | R&S®FSV3000 | R&S®FSVA/FSV/FPS | R&S®FPL1000 | R&S®FSL (VSE) | R&S®RTO³⁹ (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 | | | | | | | | |
| Frequency error | | R&S®FSW/FSWP/FSWT | R&S®FSVA3000 | R&S®FSV3000 | R&S®FSVA/FSV/FPS | R&S®FPL1000 | R&S®FSL (VSE) | R&S®RTO³⁹ (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 |
| Multi-modulation analysis, R&S®FSWP-K70 option required | R&S®FSWP-K70M | 1350.6860.02 |
| BER PRBS measurements, R&S®FSWP-K70 option required | R&S®FSWP-K70P | 1350.6876.02 |
| Vector signal analysis | R&S®FSWT-K70 | 1338.7560.02 |
| Multi-modulation analysis, R&S®FSWT-K70 option required | R&S®FSWT-K70M | 1350.5970.02 |
| BER PRBS measurements, R&S®FSWT-K70 option required | R&S®FSWT-K70P | 1350.5986.02 |
| 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 |

| Designation | Type | Order No. |
|---|-------------|------------------|
| 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, maximum 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, maximum 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 |
| Test receiver | | |
| Test receiver, 10 Hz to 26.5 GHz | R&S®FSWT26 | 1313.7008.26 |
| 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 |

| Designation | Type | Order No. |
|------------------------------|-------------|------------------|
| Service option | | |
| R&S®VSE software maintenance | R&S®VSE-SWM | 1320.7622.81 |

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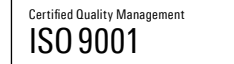
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- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

Rohde & Schwarz

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