

FSW SIGNAL AND SPECTRUM ANALYZER

Continuing innovation
in RF performance and usability



Product Brochure
Version 17.00

ROHDE & SCHWARZ

Make ideas real



AT A GLANCE

The high-performance FSW signal and spectrum analyzer helps engineers accomplish the most demanding tasks. The wide internal analysis bandwidth helps characterize wideband components and communications systems. Its unparalleled phase noise facilitates the development of high-performance oscillators used in radars. A state-of-the-art multitouch display with gesture support ensures straightforward and intuitive operation. An embedded SCPI recorder enables easy creation of executable scripts.

The FSW offers up to 8.3 GHz analysis bandwidth for measuring wideband-modulated or frequency agile signals such as those used in the new 5G New Radio standard or automotive and pulsed radars.

The 800 MHz real-time analysis bandwidth allows users to monitor wide portions of the spectrum and trigger on short duration signals.

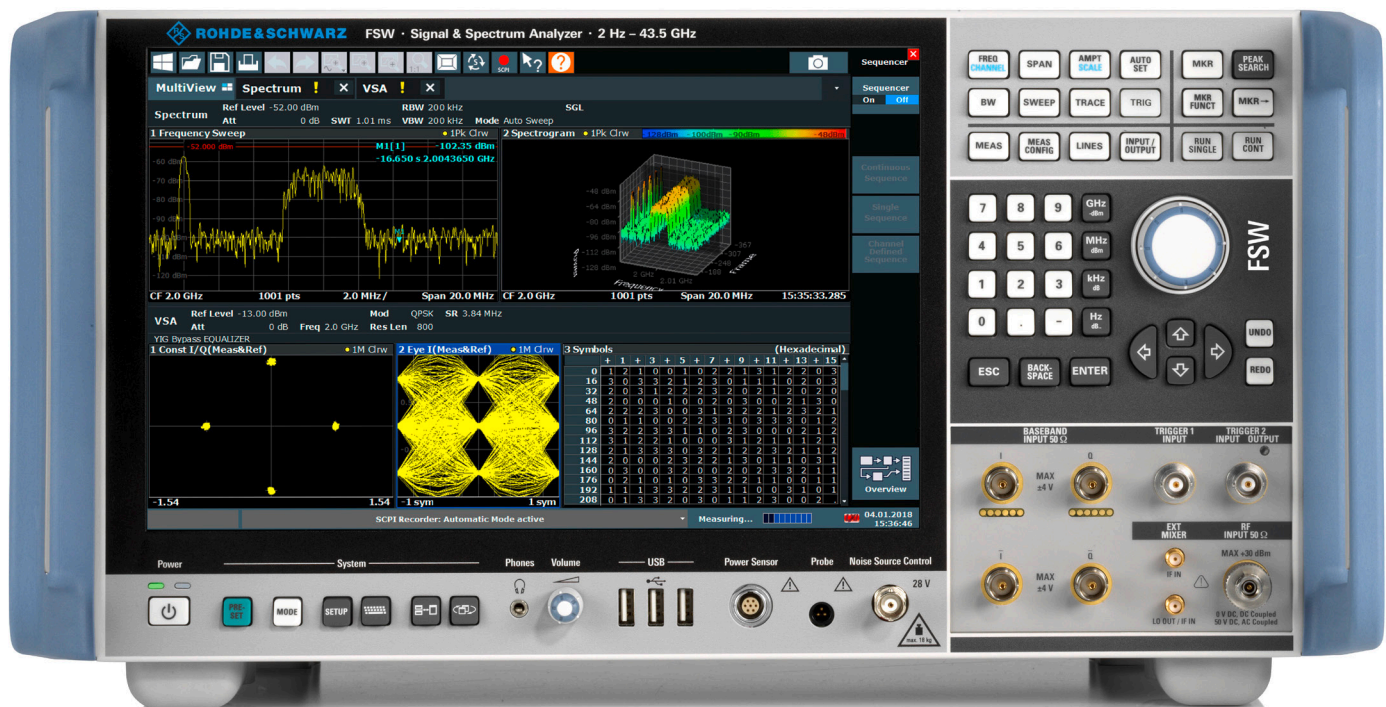
The FSW can measure multiple standards simultaneously. Users can quickly and easily detect and eliminate errors caused by interaction between signals.

The FSW offers exceptional ease of operation with a multitouch display and intuitive menus. Various measurements can be displayed simultaneously in separate windows on the large 12.1" screen to make for easier result interpretation.

Key facts

- ▶ Frequency range from 2 Hz to 90 GHz (up to 325 GHz with external harmonic mixers from Rohde&Schwarz)
- ▶ Low phase noise of -140 dBc (1 Hz) at 10 kHz offset, -143 dBc at 100 kHz offset (1 GHz carrier)
- ▶ 60 dBc spurious-free dynamic range for 2 GHz internal analysis bandwidth
- ▶ Up to 8.3 GHz internal analysis bandwidth
- ▶ 800 MHz real-time analysis bandwidth with 2.4 million FFT/s, 0.46 μ s POI
- ▶ Up to 1 GHz streaming bandwidth over the I/O data streaming interface
- ▶ SCPI recorder simplifies code generation
- ▶ Display with multitouch gesture support
- ▶ Multiple measurement applications can be run and displayed in parallel
- ▶ Outstanding residual EVM (-49 dB for 100 MHz 5G UL signals at 28 GHz) can be further improved with the R&S®FSW-K575 I/O noise cancellation option (-53 dB for 320 MHz WLAN IEEE802.11bn (Wi-Fi 8) signals at 6.905 GHz)

Front view



BENEFITS

Outstanding RF performance

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Advanced user interface

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Stay ahead of 5G and other wireless standards

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Extensive radar analysis functions

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Ideal for satellite RF testing

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Do not miss a thing with the real-time spectrum analysis option

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Powerful vector signal analysis application

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Custom OFDM signal analysis application

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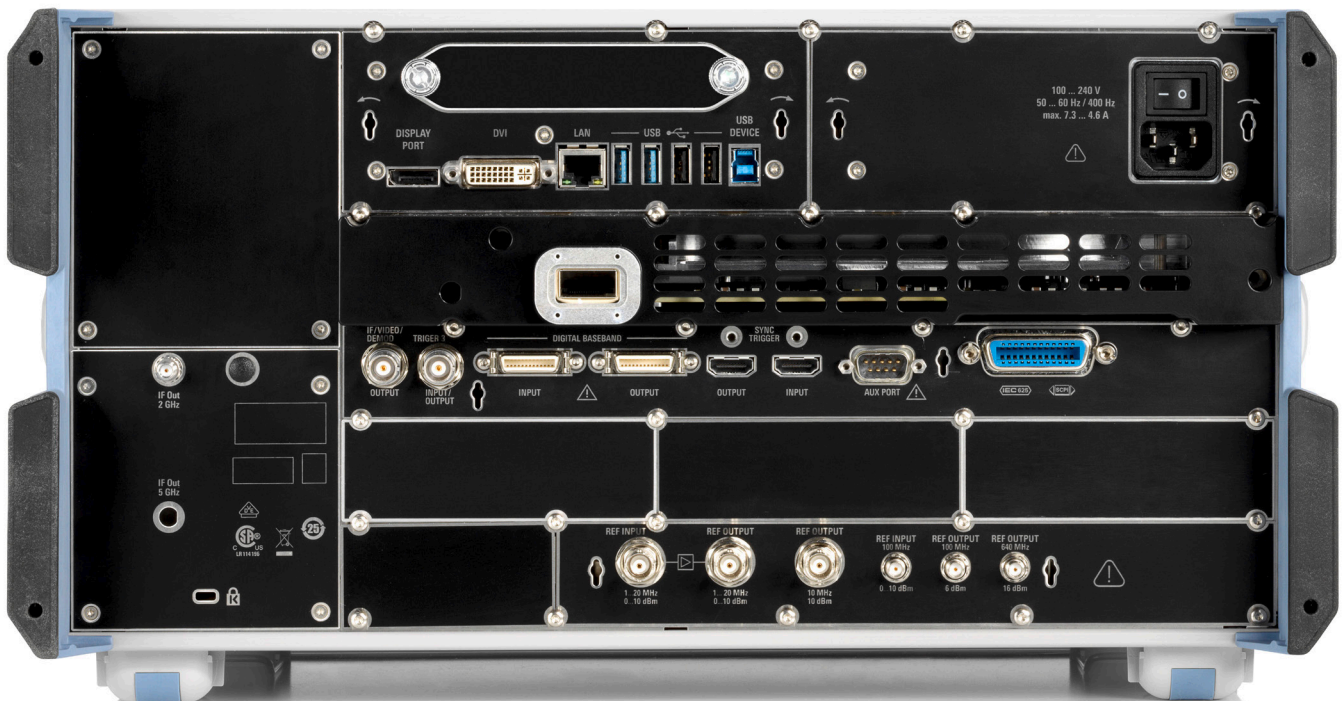
Health and utilization monitoring service (HUMS)

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Wide range of measurement applications

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Rear view



OUTSTANDING RF PERFORMANCE

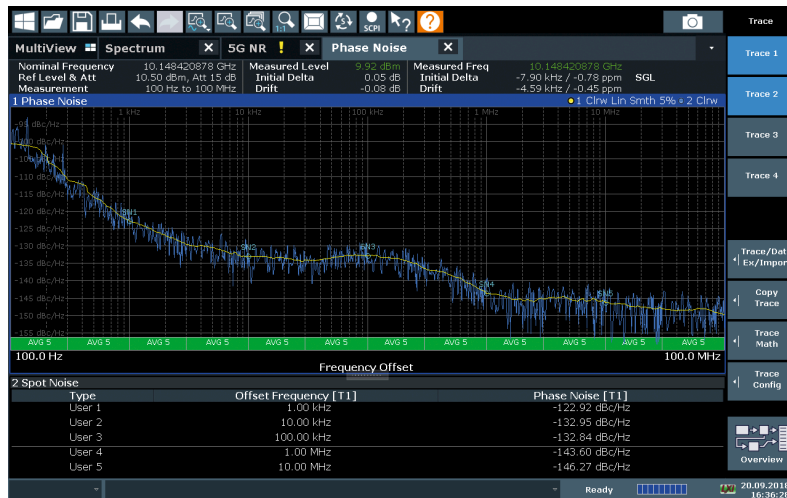
The FSW redefines excellence for signal and spectrum analyzers with superior phase noise, displayed average noise levels, intermodulation suppression and dynamic range for ACLR and harmonic measurements.

Unmatched phase noise: ideal for measuring oscillators for radar and communications applications

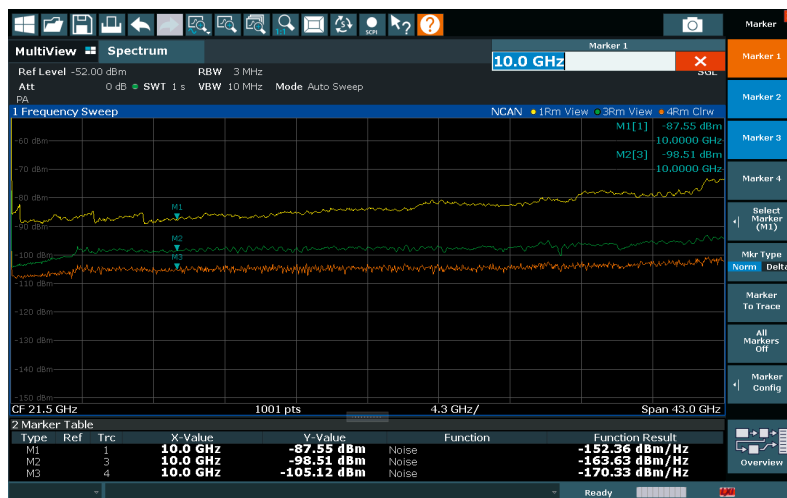
The FSW provides oscillators, synthesizers and transmit system developers excellent RF performance for phase noise measurements. At 10 kHz offset from the carrier, the FSW has typical phase noise of -140 dBc (1 Hz) for a 1 GHz carrier and -131 dBc (1 Hz) for a 10 GHz carrier. It also has an excellent close-in phase noise of typical -114 dBc (1 Hz) at 100 Hz offset. The FSW outperforms other high-end analyzers by more than 10 dB, depending on the frequency and offset range.

Excellent dynamic range for spurious measurements thanks to low DANL

The FSW measures spurious emissions quickly and reliably over a wide frequency range thanks to a low displayed average noise level (DANL) of -159 dBm (1 Hz) at 2 GHz and -150 dBm (1 Hz) at 25 GHz without a preamplifier. A built-in preamplifier further reduces the DANL by over 15 dB and the analyzer switch-selected noise cancellation improves the DANL by up to 13 dB. Users can identify even the smallest of spurious emissions that were previously concealed by the noise floor and effectively optimize transmit systems.



Phase noise at 10 kHz offset from a 10 GHz carrier: typical -133 dBc (1 Hz)



Displayed average noise level (DANL) of an R&S®FSW43 with preamplifier and noise cancellation switched on/off

Harmonic measurements made easy thanks to integrated highpass filters

The FSW can be equipped with switchable highpass filters (R&S®FSW-B13) for carrier frequencies up to 1.5 GHz for harmonic measurements on transmit systems. This preselection clearly improves the dynamic range compared with conventional spectrum analyzers. External filters are no longer needed, which simplifies test system setups.

High sensitivity even at low frequencies

The FSW DANL at low frequencies up to 40 MHz is improved by routing the input signal directly to the A/D converter. Even in the audio and baseband frequency range, it offers a high sensitivity of -120 dBm (1 Hz) at 2 Hz, surpassing comparable analyzers by up to 20 dB.

Image rejection up to 85 GHz

A YIG preselector at the FSW input makes sure that image frequencies are rejected and out-of-band interferers are suppressed. The R&S®FSW85 signal and spectrum analyzer features a YIG preselector for frequencies between 8 GHz and 85 GHz for image-free spectrum analysis at very high frequencies such as those used in automotive radar.

High accuracy

The FSW has excellent level measurement accuracy with signal levels that have < 0.37 dB total measurement uncertainty for frequencies ≤ 8 GHz.

Unparalleled dynamic range up to 1 GHz with separate receive path

The FSW has a separate receive path optimized for frequencies < 1 GHz. This yields a previously impossible dynamic range, for example for measurements on radio systems for public safety and security.

Ultrawideband filters in sweep mode

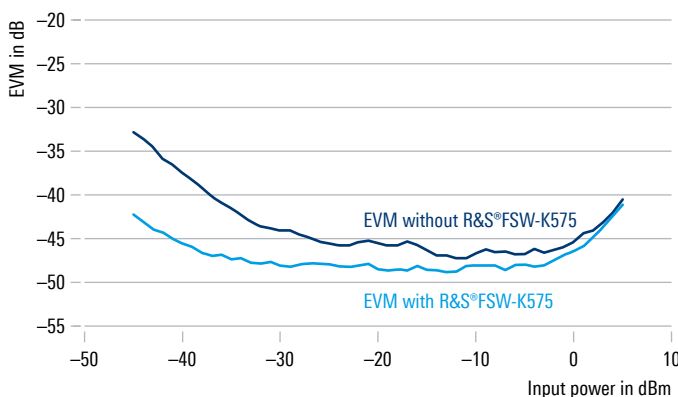
UWB regulations such as EN302065 call for a 50 MHz resolution filter to measure the peak power, a measurement easily performed with the FSW. With its optional resolution bandwidths of 20 MHz, 40 MHz, 50 MHz and 80 MHz, the FSW offers unique possibilities for wideband signal testing.

Outstanding EVM performance up to the millimeterwave range for wideband modulated signals

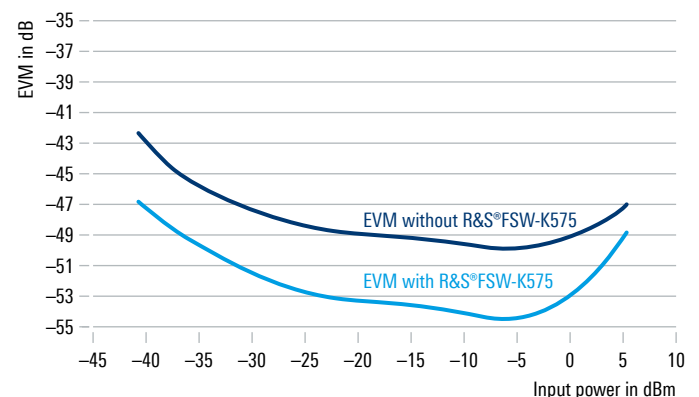
The FSW has very low EVM results across a wide range of input power thanks to its high dynamic range. The FSW has a residual EVM of less than -49 dB for 100 MHz 5G NR signal at 28 GHz.

R&S®FSW-K575 I/Q noise cancellation further reduces the residual instrument EVM with a simple software upgrade and no hardware changes or second measurement path. The FSW can cover measurement scenarios with very stringent EVM requirements with the option. R&S®FSW-K575 reduces the residual EVM for the FSW to less than -53 dB for a 320 MHz wide and 4096QAM WLAN IEEE802.11bn (Wi-Fi 8) signal at 6.905 GHz.

Residual EVM over signal power for a 100 MHz wide 5G NR downlink signal at 28 GHz



Residual EVM over signal power for a 320 MHz WLAN IEEE 802.11be signal at 6.905 GHz (modulation order 4096QAM)



SCALABLE ANALYSIS BANDWIDTH

The demand for analysis bandwidth is constantly increasing. The FSW with up to 8.3 GHz internal analysis bandwidth is ready for the challenge.

Analysis bandwidth extensions for the different FSW models				
Model	Option	Frequency range		
		up to 512 MHz ¹⁾	up to 2 GHz ²⁾	up to 8.3 GHz ³⁾
R&S®FSW8	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512	•		
R&S®FSW13	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512	•		
R&S®FSW26	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512, R&S®FSW-B1200, R&S®FSW-B2001	•	•	
R&S®FSW43	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512, R&S®FSW-B1200, R&S®FSW-B2001, R&S®FSW-B4001, R&S®FSW-B6001, R&S®FSW-B8001	•	•	•
R&S®FSW50	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512, R&S®FSW-B1200, R&S®FSW-B2001, R&S®FSW-B4001, R&S®FSW-B6001, R&S®FSW-B8001	•	•	•
R&S®FSW67 ⁴⁾	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512, R&S®FSW-B1200, R&S®FSW-B2001, R&S®FSW-B4001, R&S®FSW-B6001, R&S®FSW-B8001	•	•	•
R&S®FSW85	R&S®FSW-B80, R&S®FSW-B160, R&S®FSW-B320, R&S®FSW-B512, R&S®FSW-B1200, R&S®FSW-B2001, R&S®FSW-B4001, R&S®FSW-B6001, R&S®FSW-B8001	•	•	•

¹⁾ Available options: 28 MHz standard, 40 MHz, 80 MHz, 160 MHz, 320 MHz, 512 MHz.

²⁾ Available options: 1.2 GHz and 2 GHz.

³⁾ 6.4 GHz and 8.3 GHz analysis bandwidth available for frequencies above 18 GHz and 18.5 GHz.

⁴⁾ 6.4 GHz analysis bandwidth available for frequencies from 18 GHz to 58 GHz. 8.3 GHz analysis bandwidth available for frequencies from 18.5 GHz to 57 GHz.

	Recommended signal analysis bandwidth extensions for the different signal analysis applications			
	28 MHz	40 MHz	80 MHz	160 MHz
	Standard	R&S®FSW-B40	R&S®FSW-B80	R&S®FSW-B160
Standard applications and measurements on single carriers, e.g. WCDMA, CDMA2000, TD-SCDMA, TETRA, NB-IoT	•			
LTE, WLAN IEEE802.11a/b/g/p signals	•			
5G NR				•
WLAN IEEE 802.11n signals		•		
WLAN IEEE 802.11ac/ax/be/bn signals			•	•
HRP UWB IEEE 802.15.4z				
WLAN IEEE 802.11ad signals				
WLAN IEEE 802.11ay signals				
Component characterization and linearization (amplifiers, frequency converters, etc.)		•	•	•
Pulsed radar			•	•
Wideband measurements on CW and frequency hopping radar systems				•
Automotive radar				

ADVANCED USER INTERFACE

The FSW is designed for convenience – with a straightforward result display.

SCPI recorder

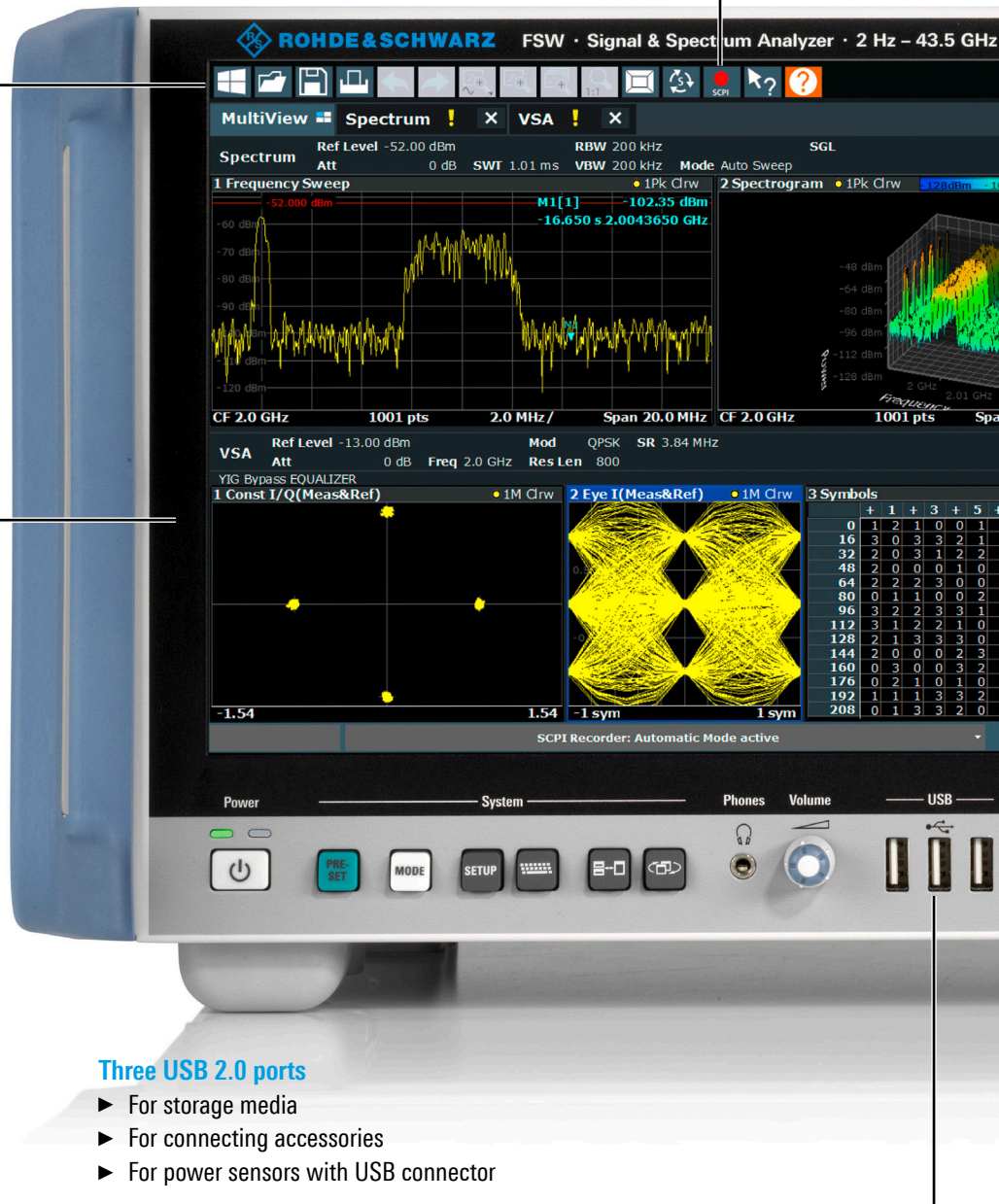
Simplified code generation for automatic, remote controlled measurements

Toolbar

- ▶ Quickly access frequently used functions
- ▶ Load and save configurations
- ▶ Take screenshots
- ▶ Zoom graphs
- ▶ Configure displayed items

12.1" high-resolution, multitouch display

- ▶ 1280 × 800 pixel resolution
- ▶ Multitouch operation



Three USB 2.0 ports

- ▶ For storage media
- ▶ For connecting accessories
- ▶ For power sensors with USB connector

R&S® MultiView and R&S® Sequencer

- ▶ Display all tabs on one screen
- ▶ Measure consecutively
- ▶ Receive continually updated results



Overview settings

Display and adjust all hardware-related settings on one screen

Noise source control

- ▶ 28 V DC power for noise sources with BNC DC input
- ▶ Control with instrument firmware

Smart port

- ▶ For power meters
- ▶ For smart noise sources

STAY AHEAD OF 5G AND OTHER WIRELESS STANDARDS

To meet the increasing demand for wireless connectivity, network infrastructures and user equipment need to accommodate diverse wireless technologies such as LTE, 5G NR, IEEE 802.11 and NB-IoT. The applications range from high speed wireless access to autonomous cars and artificial intelligence.

The FSW capabilities and measurement applications have uncompromising performance for fast and straightforward testing of the numerous specific requirements and characteristics of wireless standards.

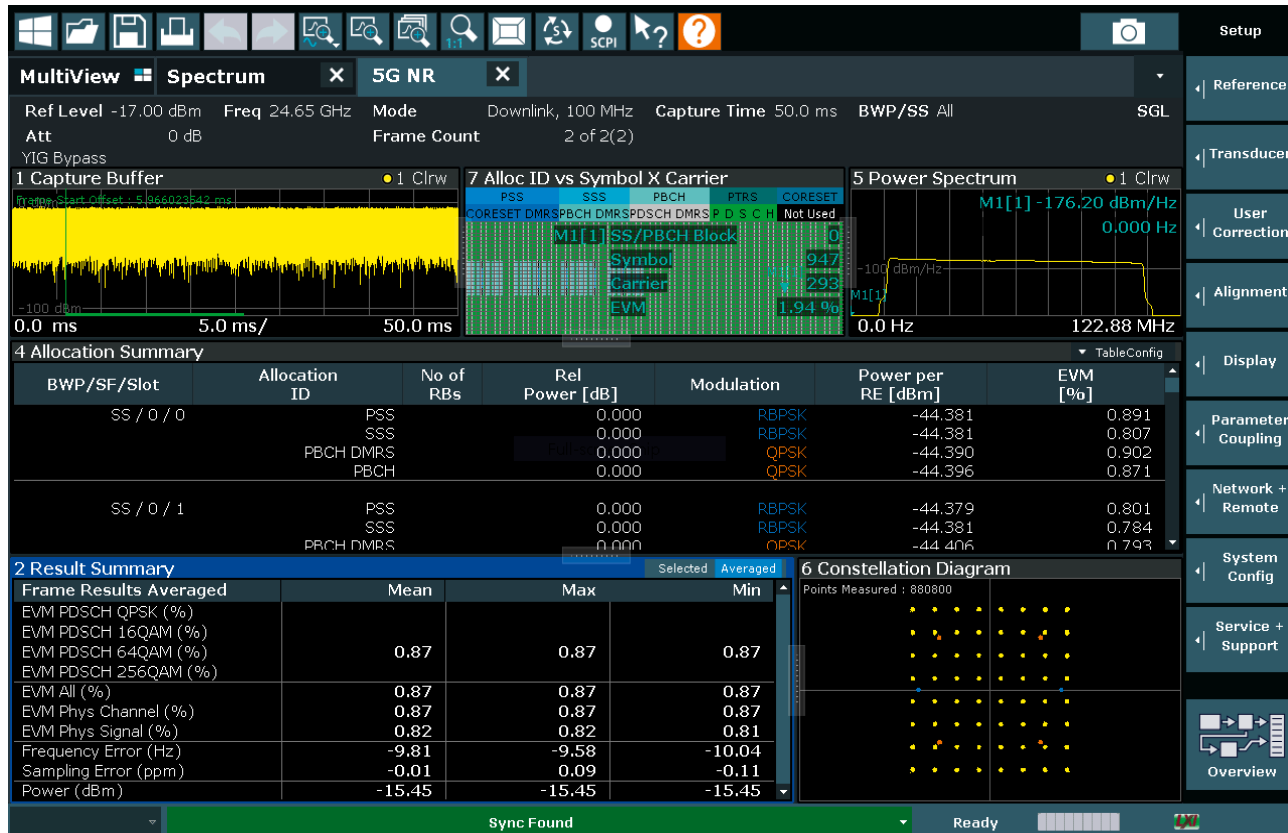
Analysis of 5G signals

FSW 5G measurement applications simplify and speed up in-depth analysis of the physical layer for testing at higher frequencies and wider measurement bandwidths to cover all the physical layer options specified in the standard with the best RF performance on the market.

The R&S®FSW-K144 and R&S®FSW-K145 options cover in-band measurements of 3GPP 5G NR in the downlink and uplink in line with 3GPP 5G NR releases 15 and 16 (R&S®FSW-K148) as well as 17 (R&S®FSW-K171). Each signal subframe is analyzed and a wide range of measurement results are provided, including EVM, frequency and power of different channels and signals.

The R&S®FSW-K144 can capture the entire bandwidth of the downlink signal with a wide internal analysis bandwidth of up to 8.3 GHz. You can evaluate a complete system. The high-performance digitizer yields a low inherent error vector magnitude (EVM) for new insight into designs.

The R&S®FSW-K144 5G New Radio downlink measurement application



The bandwidth option is an internal FSW option that reduces the test setup size and the amount of cabling between components while also improving measurement accuracy.

The R&S®FSW-K144 and R&S®FSW-K145 support all specified 5G signal bandwidths from 5 MHz to 2 GHz, with multiple numerologies, multiple bandwidth parts and modulation formats from QPSK to 256QAM.

The R&S®FSW-K145 supports both the OFDMA and the transform precoded modes in the uplink.

The R&S®FSW-K147 option can be used to combine ACLR, SEM and EVM measurements. R&S®FSW-K147C extends the functions to cover multi-component carrier measurements. Parallelized calculations and adaptable trigger settings make the application much faster, which is good for the over-the-air (OTA) characterization of devices that require a large number of measurements.

To simplify signal analysis, several parameters are automatically detected to keep the number of user settings to a minimum.

A wide range of settings and limit lines are provided for adjacent channel leakage ratio and spectrum emission mask measurements in out-of-band measurements.

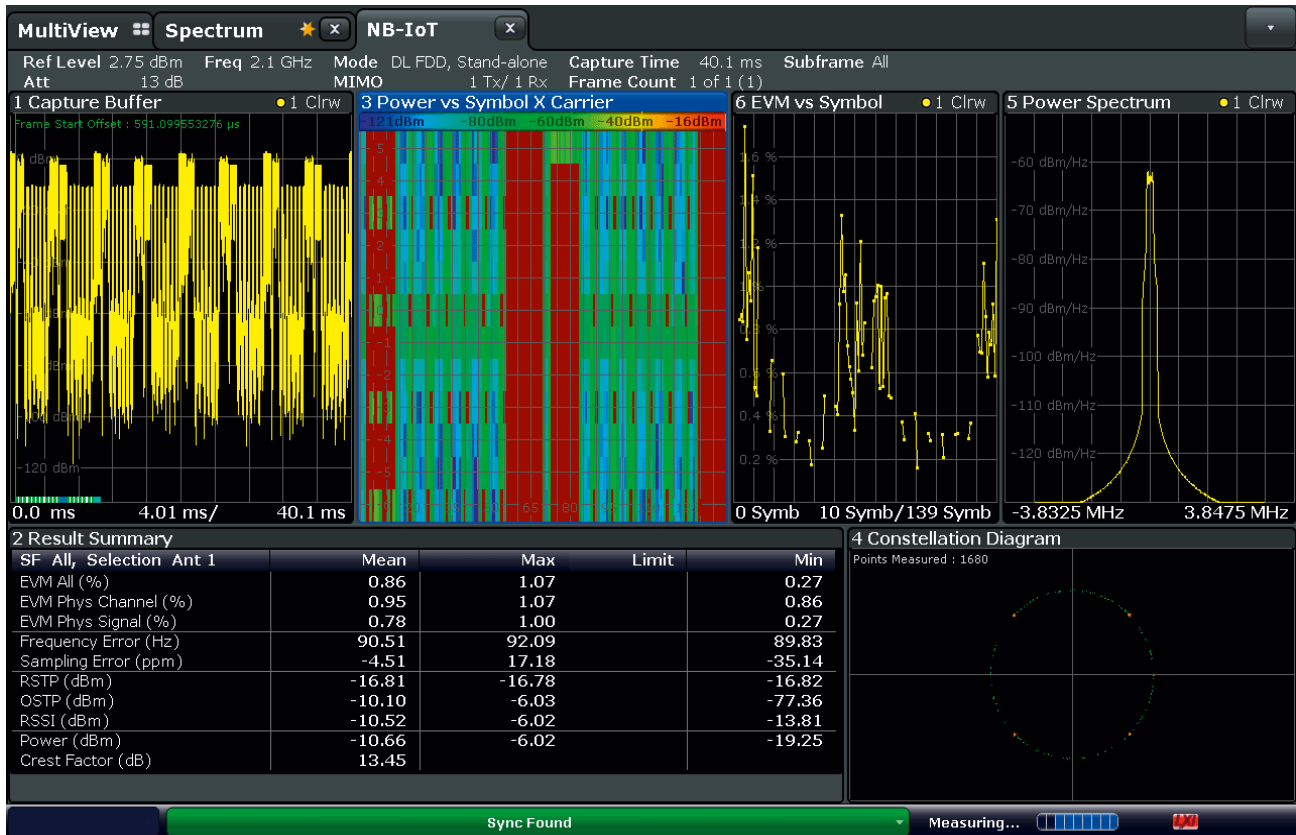
The R&S®FSW-K175 option provides test models in line with the O-RAN conformance specifications for 5G NR and LTE.

The R&S®FSW-K184 Beyond 5G measurement option enables the analysis of signals with non-standard channel bandwidths, custom and QAM constellations up to 16kQAM.

Narrowband IoT (NB-IoT)

The R&S®FSW-K106 covers all three operating modes (in-band, guard band and out-of-band) for base station testing in line with the 3GPP specification. The R&S®FSW-K106 delivers signal modulation results as well as out-of-band spectral measurements (ACLR and SEM). The timing alignment measurement is included to easily measure the timing between transmitters in MIMO operation. To simplify signal analysis, several parameters such as cell ID and modulation formats are automatically detected.

The R&S®FSW-K106 NB-IoT measurement application



STAY AHEAD IN 5G AND OTHER WIRELESS STANDARDS

Wireless connectivity: WLAN IEEE 802.11be/bn

WLAN standards continue to evolve, with IEEE 802.11bn – the successor to Wi-Fi 7 – already in development. Wi-Fi 7 (802.11be) focused on boosting peak data rates with wider channels, higher-order modulation and additional spatial streams. Wi-Fi 8 (802.11bn) takes thing to the next level by addressing throughput while also improving reliability and latency for demanding applications such as AR/VR, industrial automation and real-time communications.

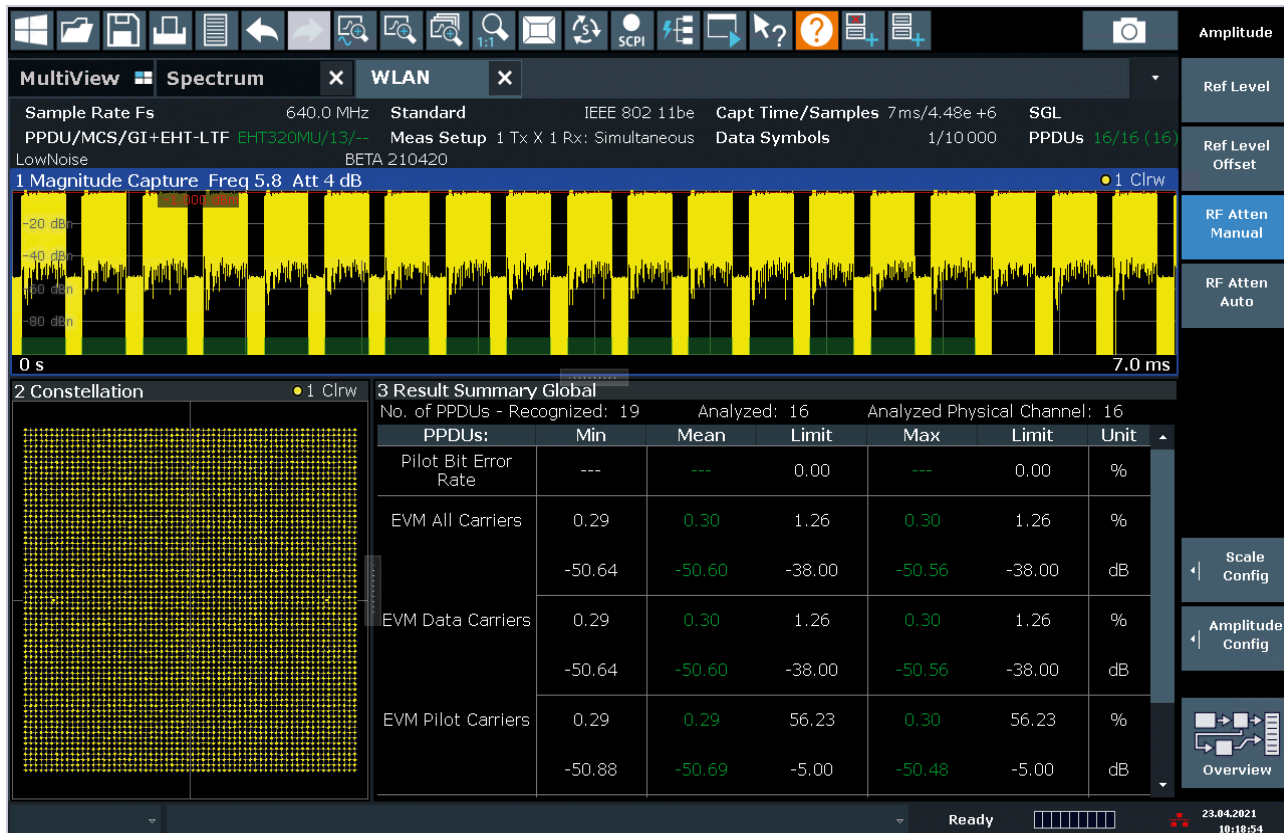
Wi-Fi 8 extends the physical and MAC layer capabilities introduced with Wi-Fi 7 and brings more efficient spectrum use, enhanced multi-link operation (MLO) and smarter resource scheduling. Proven features such as OFDMA, MU-MIMO and 4096QAM remain in place and have been refined to deliver even stronger multi-user performance. IEEE 802.11bn expands the focus beyond raw speed to consistent, dependable connectivity – making Wi-Fi 8 a key enabler for the next generation of wireless technologies.

The outstanding FSW signal and spectrum analyzer with the R&S®FSW-K91BE and R&S®FSW-K91BN options has the precise signal analysis performance necessary for characterizing DUTs. The residual EVM for a 320 MHz bandwidth and 4096QAM modulation is as low as –50 dB in conjunction with the R&S®FSW-B320 option and can be further reduced to –53 dB with the R&S®FSW-K575 I/O noise cancellation option.

Ultrawideband (UWB) IEEE 802.15.4/z

The ultrawideband (UWB) standard was developed a long time ago for simpler near-field communications. The latest IEEE 802.15.4z revision was made in 2020 and the UWB standard has become increasingly popular for applications in the automotive, healthcare and industry market segments. In addition to communications, positioning capabilities are becoming ever more important. This requires highly accurate chip clocks and chip frequency. The R&S®FSW-K149 option, together with the R&S®FSW-B1200 or R&S®FSW-B2001 bandwidth extension option, enables precise analysis of UWB signals and PSD measurements on up to 1.355 GHz wide channels.

Analysis of a 320 MHz wide and 4096QAM modulated WLAN IEEE 802.11be signal using the R&S®FSW-K91BE option.



WiGig WLAN IEEE 802.11ad/ay: very high data rates at 60 GHz

The WLAN IEEE 802.11ad standard provides data throughput speeds of up to 7 Gbps with a channel bandwidth of 2.16 GHz bandwidth in the 60 GHz ISM band. WLAN IEEE 802.11ay bonds up to four of those channels together for transmission rates of 20 Gbit/s to 40 Gbit/s.

The R&S®FSW67 and R&S®FSW85 signal and spectrum analyzers, which are equipped with the R&S®FSW-B2001 and the special R&S®FSW-K95 WLAN IEEE 802.11ad measurement option, are the only one-box solutions on the market that cover WLAN IEEE 802.11ad applications.

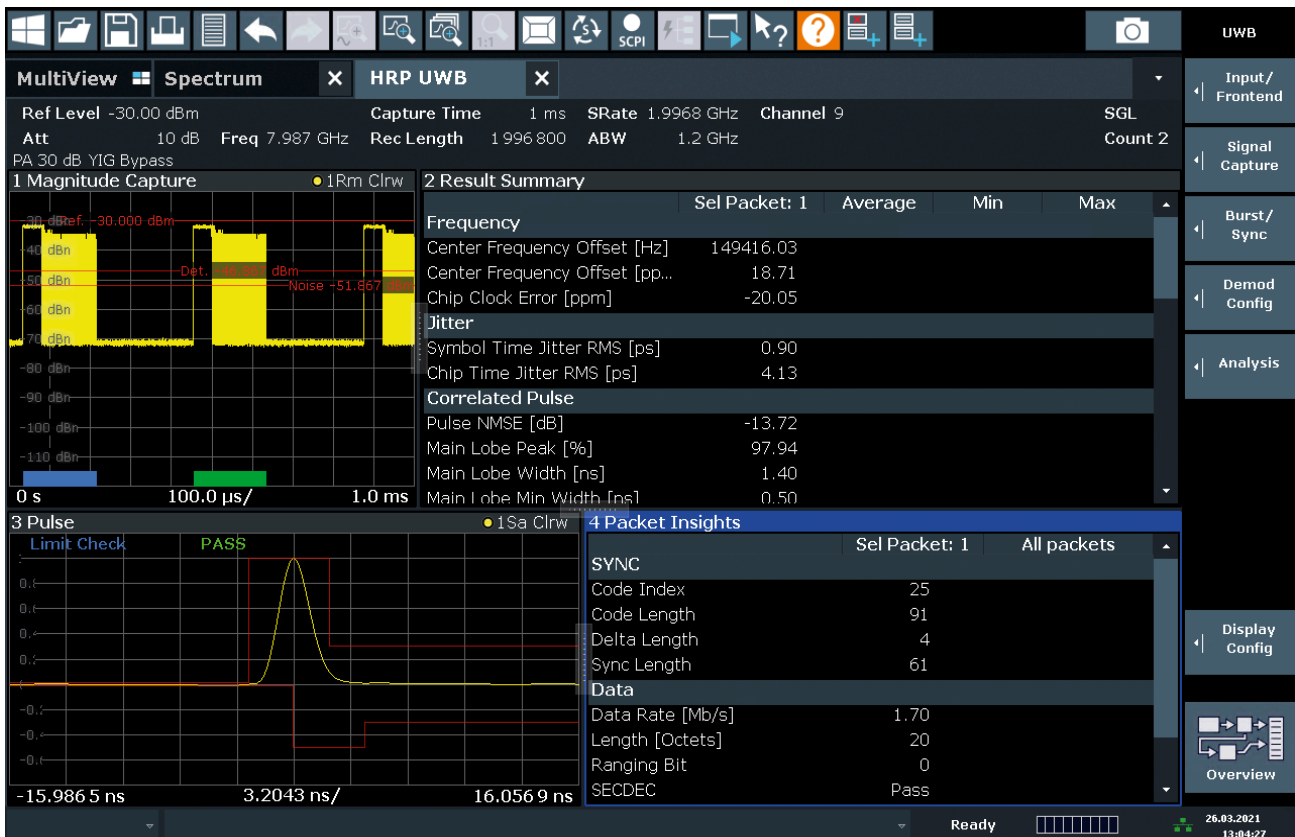
The R&S®FSW85 with optional bandwidth extensions up to 4 GHz, 6.4 GHz or 8.3 GHz (R&S®FSW-B4001/-B6001/-B8001) and a dedicated WLAN IEEE 802.11ay measurement application (R&S®FSW-K97) allows for easy WLAN IEEE 802.11ay analysis. Using the 8.3 GHz analysis option, up to four bonded channels can be evaluated at the push of a button.

Bluetooth® BR/EDR/LE/Channel Sounding

Modern communications devices and smartphones use various radio standards such as LTE, 5G NR, Wi-Fi, UWB and Bluetooth®. The FSW signal and spectrum analyzer is a single instrument for analyzing these modern devices in line with their dedicated standards. The R&S®FSW-K8 Bluetooth® measurement application supports modulation characteristic measurements in I/Q mode and ACP/ in-band emission measurements in swept spectrum mode. It covers Bluetooth® basic rate (BR), Bluetooth® enhanced data rate (EDR) and Bluetooth® Low Energy (LE) signals to ensure compliance with mandatory output power, carrier frequency stability, modulation accuracy and adjacent channel power (ACP).

The new R&S®FSW-K8E Bluetooth® Channel Sounding measurement application is designed for measuring physical layer signals in line with the Bluetooth 6.0 specification. This application supports all mandatory TX measurements required for Bluetooth® Channel Sounding, enabling high-accuracy distance measurements using a specially designed physical layer. The FSW can precisely measure the characteristics of the channel sounding signal, giving users a competitive advantage.

HRP UWB signal analysis with the R&S®FSW-K149 high rate pulse repetition frequency ultrawideband measurement application.



EXTENSIVE RADAR ANALYSIS FUNCTIONS

Extensive analysis functions and fast identification of spurious emissions are essential when testing modern radar systems with their wideband signals, intrapulse modulation techniques and frequency hopping capabilities.

Fast and comprehensive radar signal analysis

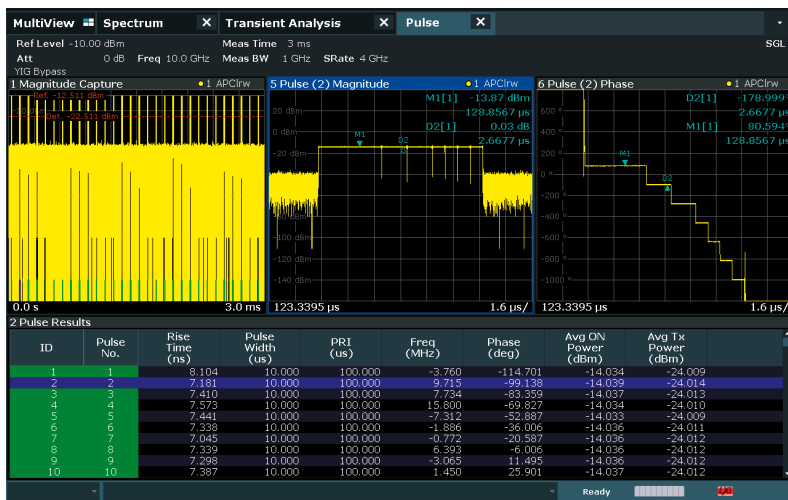
At the touch of a button, the R&S®FSW-K6 pulse measurement application covers all relevant pulse parameters such as pulse duration, pulse period, pulse rise and fall times, power drop across a pulse and intrapulse phase modulation. The application produces a trend analysis over many pulses. The user selects results for simultaneous display on the screen. The FSW delivers a full picture of a radar system within seconds. The segmented I/Q capture function ensures that I/Q data is timestamped and stored only when a pulse is detected. This feature increases the analysis period by a factor of nearly 1000 for pulse lengths less than 1 μ s and a 1 kHz pulse repetition interval (PRI). The FSW is ready to support the design of ultrawideband radar with up to 8.3 GHz internal analysis bandwidth.

Detailed pulse compression radar measurements

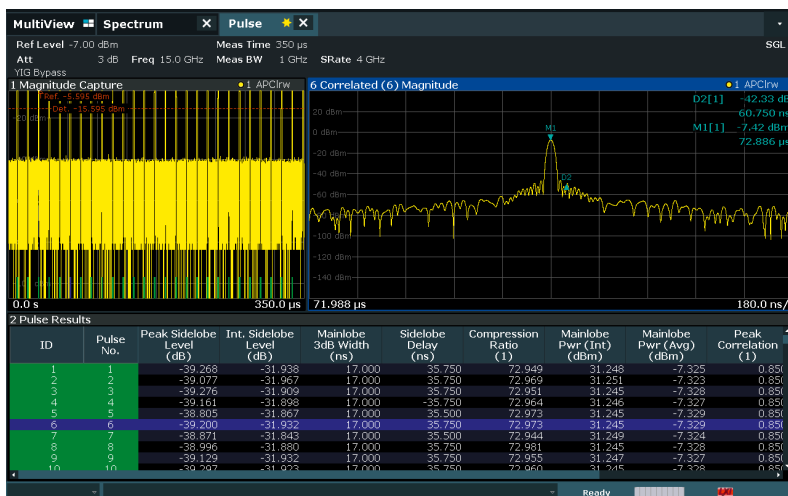
The R&S®FSW-K6S time sidelobe measurement option measures pulse compression parameters and helps evaluate the degradation of radar performance caused by modulators and excitors. You can import any I/Q based reference waveform in I/Q data file format even confidential, proprietary waveforms. The R&S®FSW-K6S also supports reference waveforms captured with the FSW and stored in I/Q data file format as well as built-in waveforms such as Barker and polynomial FM.

Characterization of transient chirp and hop signals

The R&S®FSW-K60/K60C transient analysis option/chirp measurement option characterizes FMCW signals such as those used in car radar sensors. The FSW automatically



Equipped with the R&S®FSW-K6 pulse measurements option, the FSW delivers pulse parameters at the touch of a button.



Pulse compression parameters and correlated magnitude display of a chirped pulse are shown with the R&S®FSW-K6S option.

calculates the chirp rate and the deviation from the ideal FMCW chirp to enable efficient radar sensor optimization.

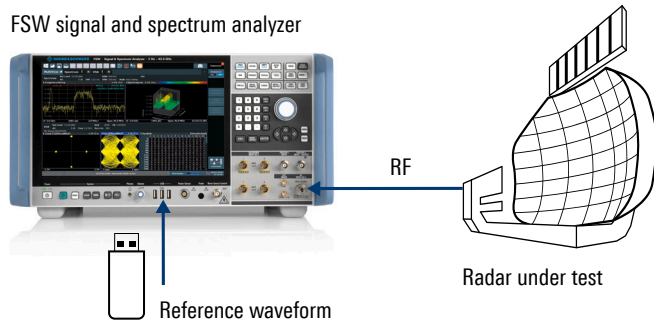
The R&S®FSW-K60 with the R&S®FSW-K60H transient hop measurement option is a convenient tool for analyzing signals with fast channel-switching characteristics such as those in frequency hopping radios. Results include dwell time/hop, switching time, frequency and deviation.

The R&S®FSW-K60P transient phase noise extension adds phase noise measurements to individual chirps or hops in the measurement results.

The analyzer shows trends and performs statistical analyses for all pulse, chirp and hop parameters. Trend analysis allows you to quickly identify the effects of supply voltages (or their frequencies, such as 50 Hz or 400 Hz) and to rapidly verify frequency hopping patterns and changes in the pulse repetition interval.

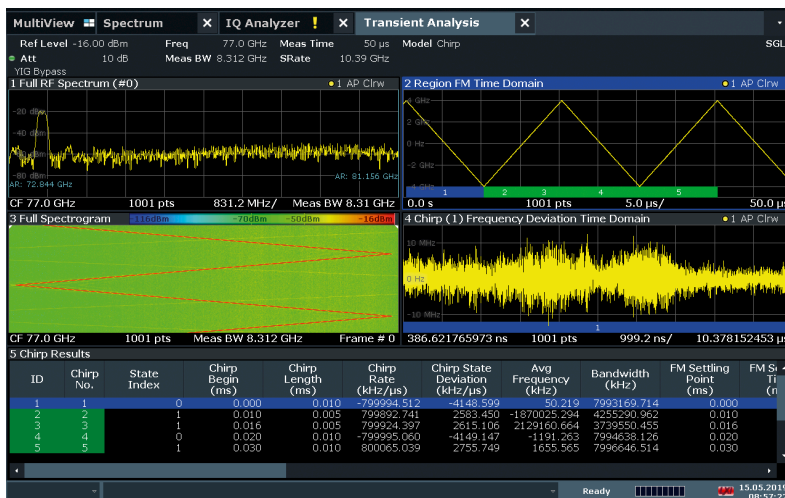
Pulse compression measurement setup with the R&S®FSW-K6/-K6S measurement option

FSW signal and spectrum analyzer

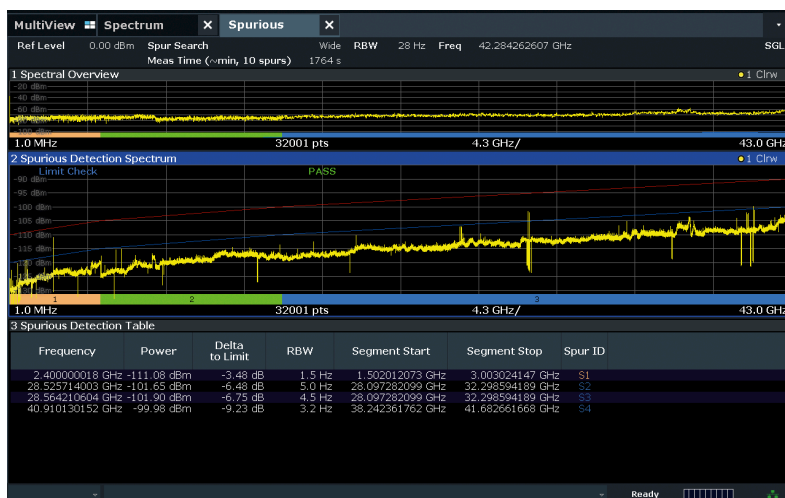


Fast and reliable detection of spurious emissions

To measure the low levels of spurious emissions, resolution bandwidth often needs to be reduced, increasing the measurement time. The R&S®FSW-K50 spurious measurement option automates spurious searches to perform them faster than the standard spurious search measurements available in spectrum analyzers. You only need to enter the frequency range and the desired spur detection level. The application calculates the optimum resolution bandwidth (RBW) for each frequency. The R&S®FSW-K50 spurious search option is much faster than conventional spurious search methods for measurements at -120 dBm or less.



Analysis of an FMCW signal with the R&S®FSW-K60K option and 8.3 GHz analysis bandwidth



Spurious measurement result screen

IDEAL FOR SATELLITE RF TESTING

Satellite communications must cover a diverse set of broadcasting, wireless communications and remote sensing user requirements for commercial and government systems. Rohde & Schwarz has fast and reliable high-performance measurement solutions for designing, developing and testing satellite payloads, payload subsystems and components.

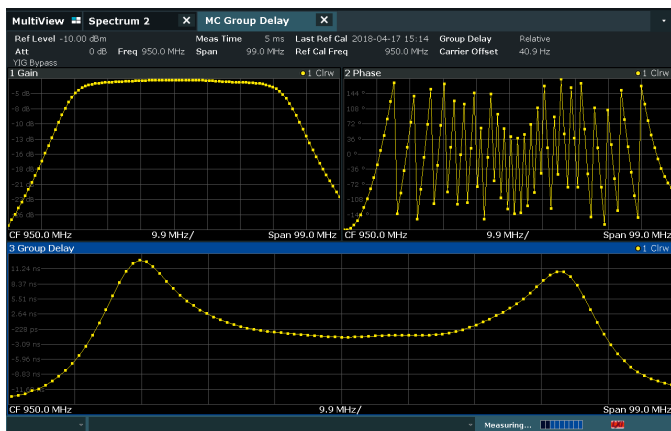
Multicarrier group delay measurements

The FSW spectrum analyzer and the R&S®SMW200A signal generator along with the R&S®FSW-K17 option can help measure absolute and relative group delay (GD) within milliseconds on satellite transponders, frequency converters and other components. The R&S®FSW-K17 offers 1 ns measurement accuracy for relative GD measurements on frequency converters and 300 ps measurement accuracy for non-frequency-converting measurements.

It can handle signal degradations that occur during in-orbit testing and has an extremely low noise floor thanks to multicarrier reference signals. No reference mixer or golden device is required for frequency converting measurements.

The R&S®FSW-K17S option is an extension of the R&S®FSW-K17. It supports broadband signal analysis to improve the overall signal-to-noise ratio (SNR) and speed of the measurement by analyzing subspans of the overall signal.

Relative group delay measurement on a bandpass filter

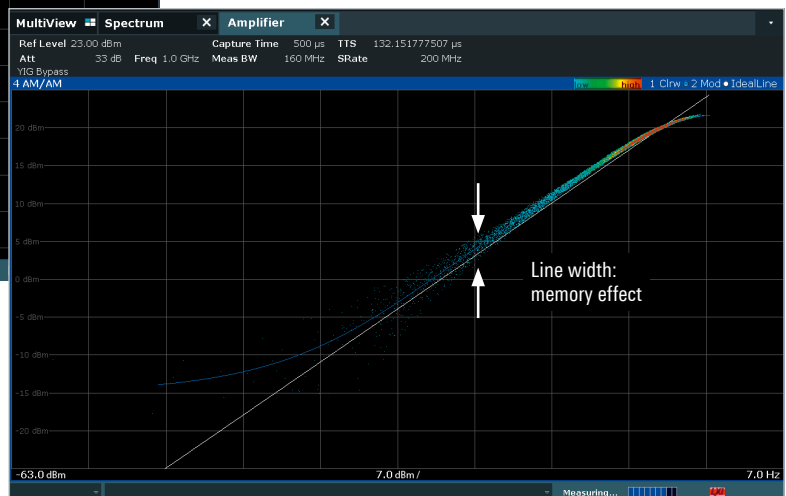


Small parts of the overall signal can be output sequentially on the R&S®SMW200A and analyzed by the FSW with this option.

In satellite applications, measurement repeatability and accuracy is extremely important. Good dynamic range is critical in such applications, which is especially important when testing the system level of a satellite in an environment with high gain (approximately 120 dB), high noise levels and high intermodulation. One way to improve dynamic range is to use narrower stimulus signals.



Gain transfer curve measurement (AM/AM) of an amplifier. For the curve above, a CW signal with a linear power ramp has been used as the stimulus. As expected, the AM/AM curve is a line. The curve on the right was measured using a digitally modulated signal generated by the R&S®SMW200A. The AM/AM is a cloud-like curve; the line width is due to amplifier memory effects.



Amplifier measurements

A combination of the R&S®SMW200A, R&S®SMM100A or R&S®SMBV100B vector signal generator and the FSW signal and spectrum analyzer equipped with the R&S®FSW-K18 option is suitable for characterizing two-port devices such as satellite transponders, power amplifiers and converters. The R&S®FSW-K18 uses either a CW power sweep or a digitally modulated stimulus signal to determine how the DUT will perform when tested under real-world conditions using a signal with the same modulation, bandwidth and crest factor as in the intended application. Typical measurements include gain compression, AM/AM, AM/PM, distortion and ACLR. The R&S®FSW-K18D option provides direct digital predistortion that linearizes the DUT based on an iterative approach. It minimizes EVM and ACLR without being limited to a certain DPD algorithm, making it ideal for comparing PAs under linearization conditions. The R&S®FSW-K18M option also uses an algorithm which can be applied to any reference signal. The R&S®FSW-K18F option measures the frequency response of the DUT and displays magnitude, phase and group delay versus frequency.

Noise power ratio (NPR)

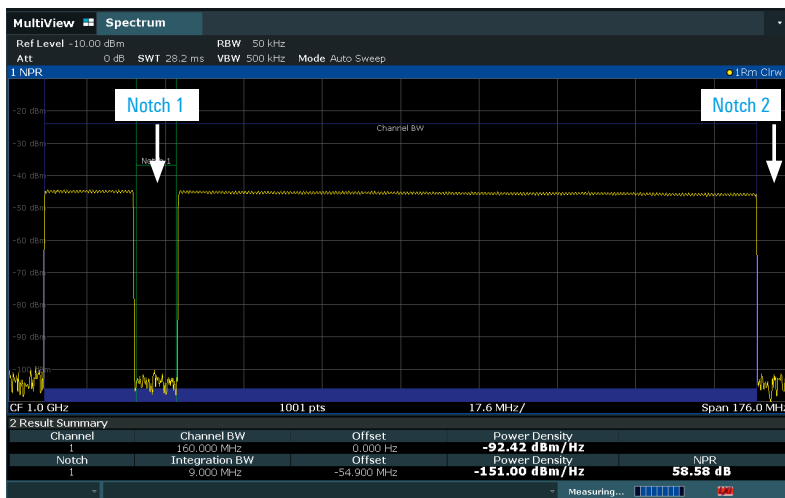
The R&S®FSW-K19 option makes the FSW a convenient and straightforward means for measuring the NPR over a maximum of 25 notches.

DVB-S2X modulation analysis

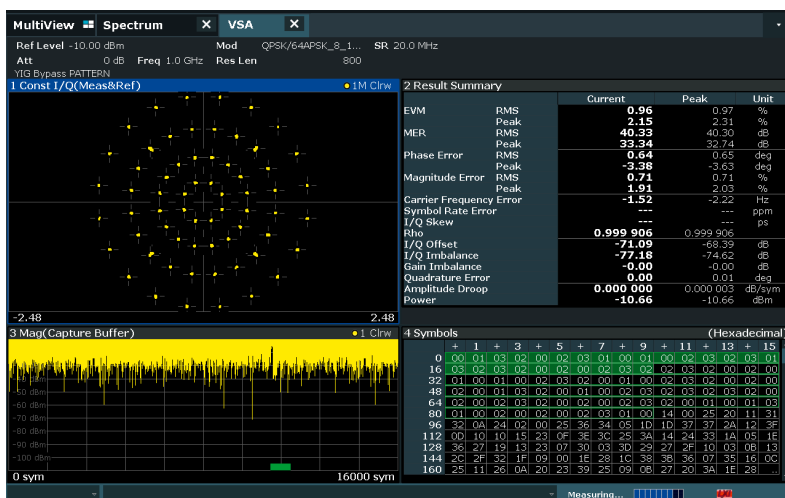
The R&S®FSW-K70M multicarrier modulation analysis application (R&S®FSW-K70 option required) allows DVB-S2X signal analysis. The R&S®FSW-K70M detects the start of a frame, demodulates both the header and payload parts of the signal and displays the constellation diagram and relevant modulation analysis parameters.

Uncoded bit error rate (BER)

The R&S®FSW-K70P is an extension of the R&S®FSW-K70 vector signal analysis option for measuring the raw bit error rate on PRBS data up to PRBS23. The R&S®FSW-K70 can also measure BER based on user-defined bit sequences.



Noise power ratio measurement with the R&S®FSW-K19 option



DVB-S2X signals use different modulation schemes for the payload and the header sections of the frame. The different types of modulation can be analyzed using the R&S®FSW-K70M and R&S®FSW-K70 options. The screenshot above shows a DVB-S2X signal using 64APSK for the payload and QPSK for the pilot channels.

DO NOT MISS A THING WITH THE REAL-TIME SPECTRUM ANALYSIS OPTION

The high-performance R&S®FSW-K161R, R&S®FSW-B512R and R&S®FSW-B800R real-time options let the FSW seamlessly display RF spectra in real time. Level-controlled detection of signals takes less than 0.5 μ s (R&S®FSW-B800R).

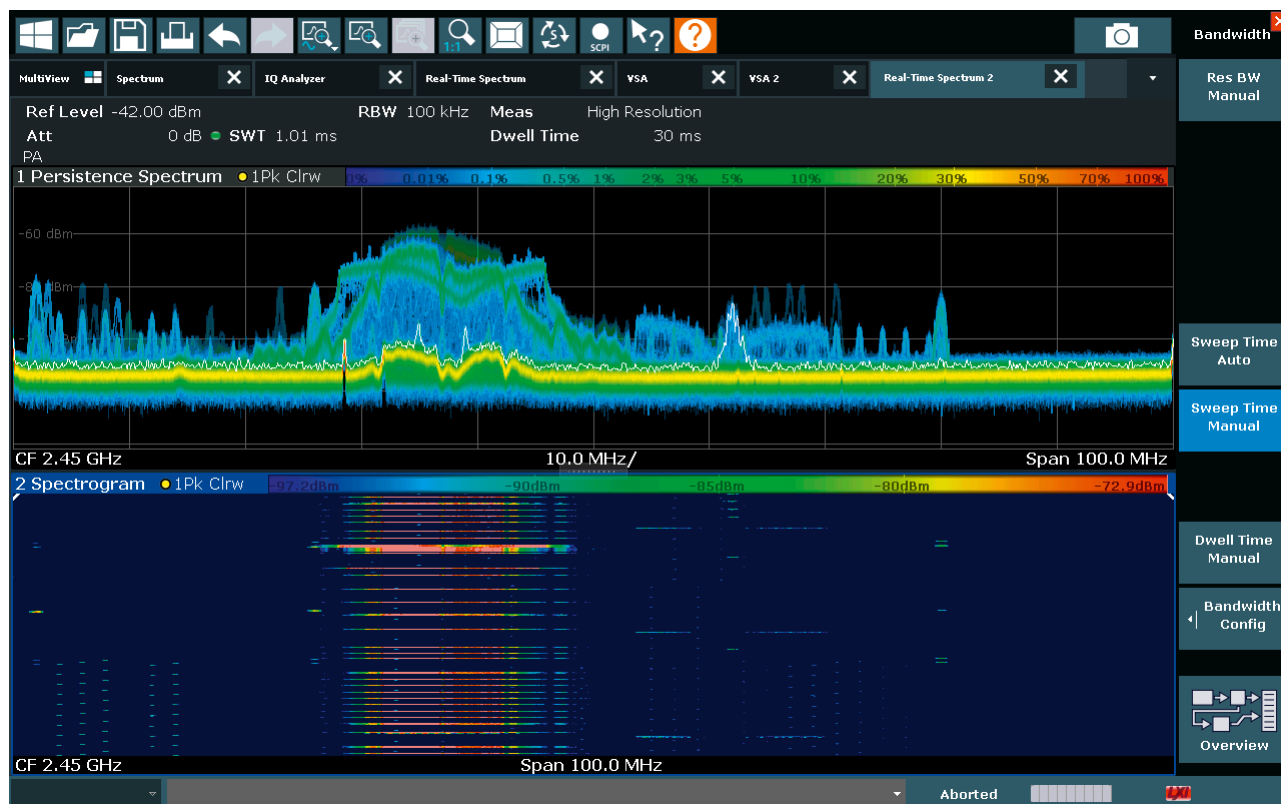
Full-featured signal and spectrum analyzer

The R&S®FSW-K161R, R&S®FSW-B512R and R&S®FSW-B800R options make the FSW a full-featured signal and spectrum analyzer with built-in real-time analyzer. If level-controlled detection of signals with a length $> 15 \mu$ s is sufficient, the R&S®FSW-K512RE and R&S®FSW-K800RE firmware options can be activated with a keycode (if the necessary bandwidth option is installed).

The FSW can then perform measuring tasks for a wide range of applications. Aerospace and defense (A&D) engineers will primarily focus on seamlessly analyzing frequency agile radar signals and detecting unwanted spurious emissions or validating tactical, frequency agile communications systems.

Regulatory authorities also need to seamlessly monitor frequency bands and reliably detect unwanted or unlicensed signals.

Real-time spectrum of the ISM band at 2.4 GHz



Detection of extremely short or frequency agile signals

The FSW real-time options allow users to reliably detect extremely short sporadic interference in the nanosecond range even in close proximity to powerful carriers – in a bandwidth up to 800 MHz.

Detection is supported by the instantaneous spectrum, a real-time spectrogram and, in persistence mode, a real-time spectrum with the signal amplitudes shown in different colors according to their frequency of occurrence (persistence spectrum).

This seamless spectrum display enables users to analyze existing frequency hopping algorithms or create alternative ones to prevent collisions between signals of different standards operating in the same frequency band (e.g. WLAN and Bluetooth®).

Saving spectra for subsequent, more detailed analysis

Using frequency-dependent masks, the FSW can also trigger on extremely short transient events that typical spectrum analyzers cannot detect. The spectrum or the I/Q data in the time domain can be saved for more detailed analysis at a later date.

Users can determine the cause of interference or the hindrance to base station data throughput. Interference originating from digital circuits or synthesizer frequency switching can also be easily detected.

The FSW performs measurements with up to 67% spectral overlap in the time domain (R&S®FSW-K161R) at an analysis bandwidth of 160 MHz for level measurements, signal loss mitigation at the edges of the FFT window or higher time resolution. The maximum FFT rate of almost 2.4 million spectra/s allows 16% overlap at an analysis bandwidth of 800 MHz.

Key parameters in real-time analysis					
	R&S®FSW-K161R ¹⁾	R&S®FSW-B512R	R&S®FSW-K512RE ²⁾	R&S®FSW-B800R	R&S®FSW-K800RE ³⁾
FFT length	1024 to 16000	1024 to 32000	1024 to 32000	512 to 32000	512 to 32000
Maximum real-time bandwidth	160 MHz	512 MHz	512 MHz	800 MHz	800 MHz
Maximum streaming bandwidth	160 MHz	512 MHz	512 MHz	1000 MHz	1000 MHz
Demodulation bandwidth	320 MHz	512 MHz	512 MHz	2 GHz	2 GHz
Maximum FFT rate (FFT/s)	585938	1 171 875	71 022	2 343 750	71 022
POI	1.87 µs	0.91 µs	> 15 µs	0.46 µs	> 15 µs
User-configurable resolution bandwidth (RBW) for span/RBW ratio	6.35 to 3200	6.25 to 6400	51.2 to 6400	6.25 to 6400	80 to 6400

¹⁾ Only with R&S®FSW-B160/-B320 bandwidth upgrade.

²⁾ Only with R&S®FSW-B512 bandwidth upgrade.

³⁾ Only with R&S®FSW-B1200/-B2001 bandwidth upgrade.

POWERFUL VECTOR SIGNAL ANALYSIS APPLICATION

The R&S®FSW-K70 vector signal analysis option allows users to flexibly analyze digitally modulated single carriers down to the bit level. The clearly structured operating concept simplifies measurements, despite the wide range of analysis tools.

Flexible modulation analysis from MSK to 4096QAM

- ▶ Modulation formats
 - 2FSK, 4FSK to 64FSK
 - MSK, GMSK, DMSK
 - BPSK, $\pi/2$ -BPSK, $\pi/2$ -DBPSK, QPSK, offset QPSK, DQPSK, $\pi/4$ -DQPSK, $3\pi/4$ -QPSK, 8PSK, D8PSK, $3\pi/8$ -8PSK, $\pi/8$ -D8PSK
 - 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM, 2048QAM, 4096QAM
 - 16APSK (DVB-S2), 32APSK (DVB-S2), 2ASK, 4ASK
 - $\pi/4$ -16QAM (EDGE), $-\pi/4$ -32QAM (EDGE), SOQPSK
- ▶ Analysis length up to 128000 symbols
- ▶ 28 MHz signal analysis bandwidth (optionally 40/80/160/320/512 MHz and 1.2/2/4/6.4/8.3 GHz)

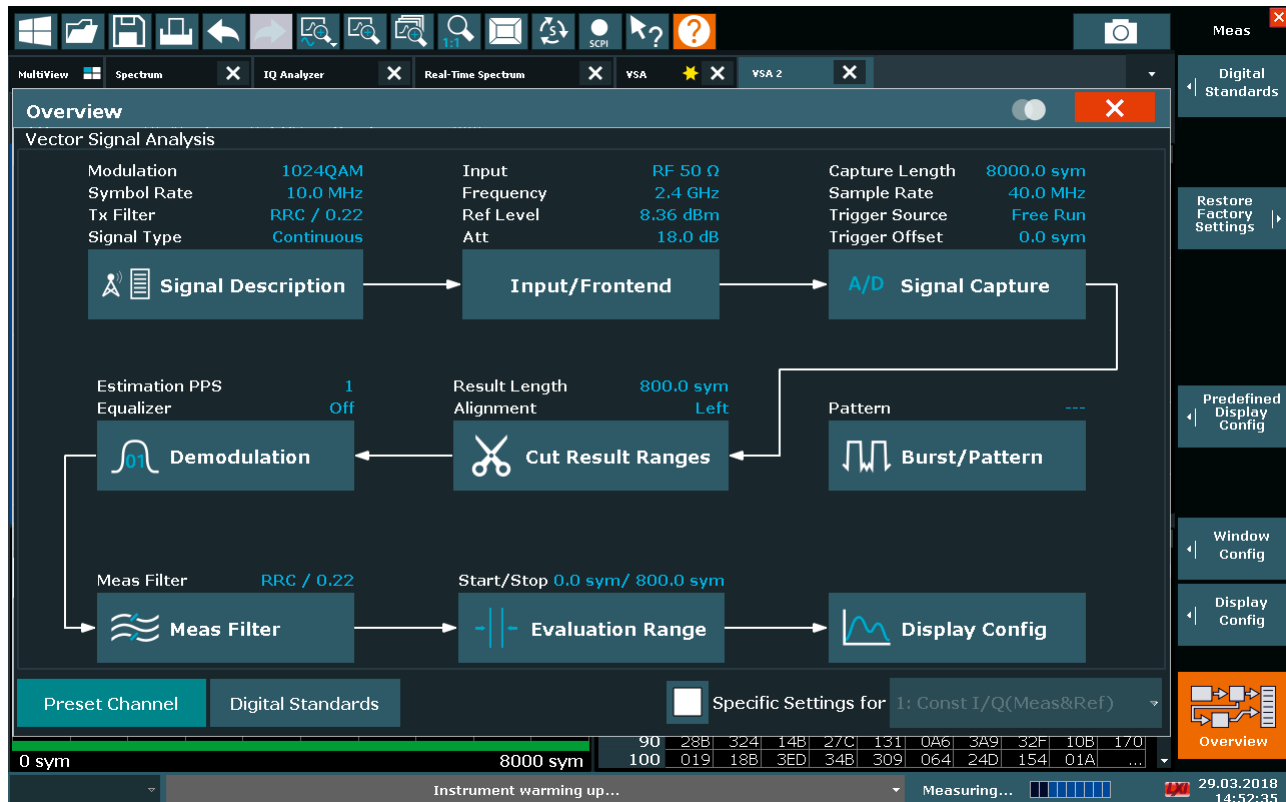
Numerous standard-specific default settings

- ▶ User-definable constellations and mappings
- ▶ GSM, GSM/EDGE
- ▶ 3GPP WCDMA, EUTRA/LTE, CDMA2000
- ▶ TETRA, APCO25
- ▶ Bluetooth®, ZigBee
- ▶ DECT, DVB-S2(X), DOCSIS 3.0

Easy operation with graphical support

The visualization of the demodulation stages and the associated settings is so clear that even inexperienced and infrequent users can find the correct settings. The combination of touchscreen and block diagram simplifies operation and readability. The R&S®FSW-K70 option helps users automatically find useful settings based on the description of the signal to be analyzed (e.g. modulation format, continuous or with bursts, symbol rate, transmit filtering).

Clearly structured block diagram display

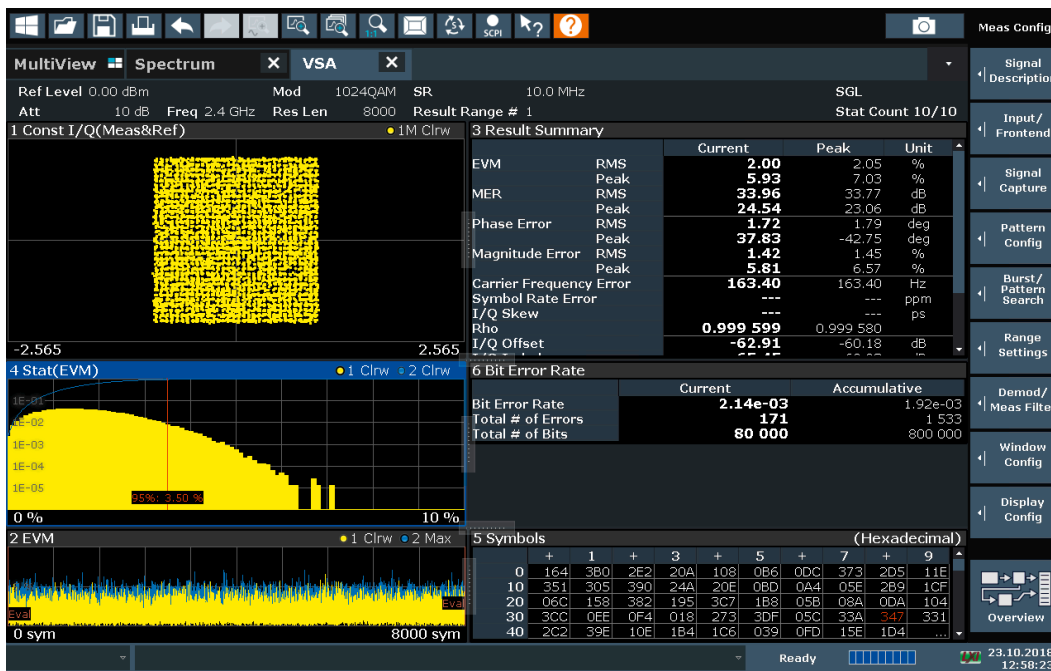


Flexible analysis tools for detailed signal analysis make troubleshooting really easy

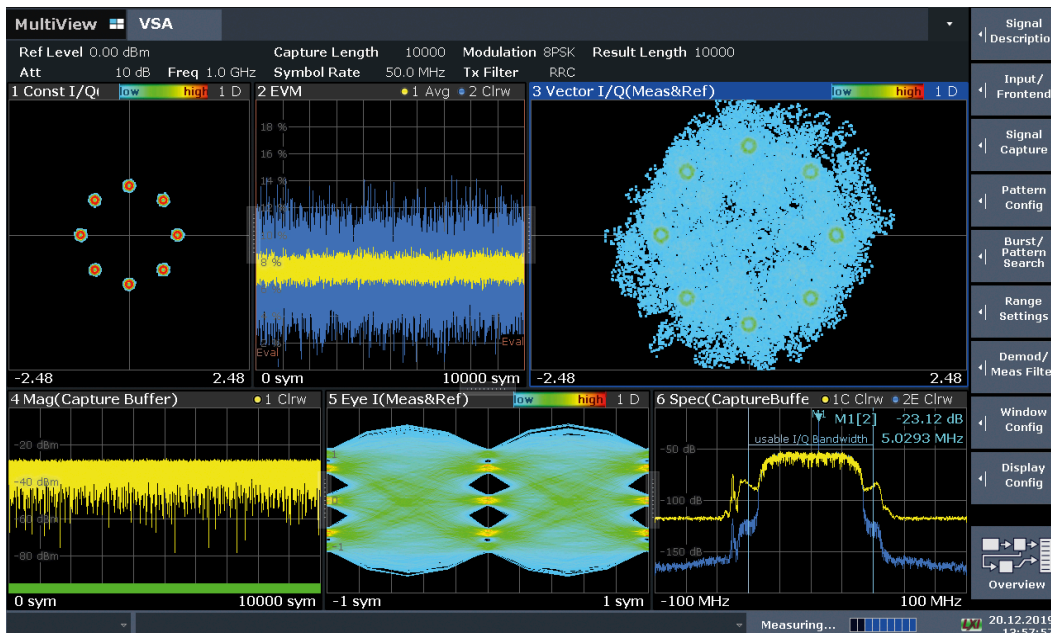
- ▶ Display options for amplitude, frequency and phase
 - I/Q, eye diagram; amplitude, phase and frequency errors
 - Constellation or vector diagram
- ▶ Analysis of RF signals or analog and digital baseband signals
- ▶ Statistical analysis
 - Histogram
 - Standard deviation and 95th percentile in the result summary

- ▶ Spectrum analysis of the measurement and error signal considerably helps users find signal errors such as incorrect filtering and interferers
- ▶ Flexible burst search for analyzing complex signal combinations, short bursts and signal mixes – capabilities that go beyond the scope of many signal analyzers
- ▶ Equalizer helps users find the optimum filter design

Analysis of a 1024QAM modulated signal: constellation diagram, result table, symbol table and EVM distribution



Identifying EG interferer with density mode



CUSTOM OFDM SIGNAL ANALYSIS APPLICATION

Easily analyze custom OFDM signals with the R&S®FSW-K96 OFDM signal analysis option.

The R&S®FSW-K96 option can demodulate and analyze custom OFDM and DFT-s-OFDM (SC-FDMA) signals with a known FFT size and cyclic prefix (CP). Synchronization can be performed using either the CP or a preamble sequence.

Configuration file wizard and import

The integrated configuration file wizard makes it possible to create a configuration file describing the pilot, data resources and modulations within minutes. The wizard visualizes the signal structure and enables a simple selection of both symbol/carrier positions within the signal and a constellation-point-based selection for assigning pilot and data modulation types.

The R&S®FSW-K96 option can also fully analyze signals created with the R&S®SMW-K114 OFDM signal generation option using the configuration file produced automatically on the generator.

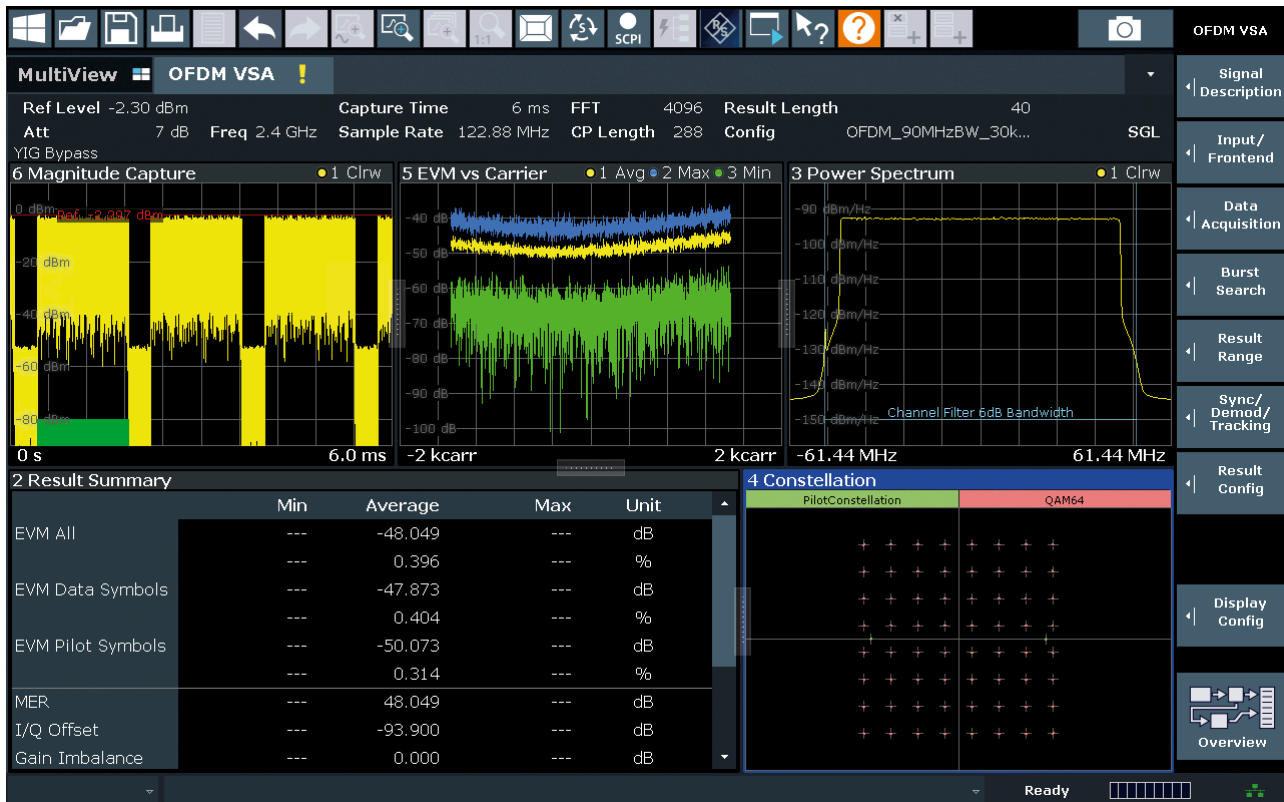
Flexible and standard-independent

Complex OFDM-based communications standards can be analyzed with the R&S®FSW-K96 option its real advantage is the high degree of freedom it offers when configuring and measuring parameters.

User-definable OFDM parameters include:

- ▶ Sampling rate, FFT size, capture time, result length
- ▶ Cyclic prefix length: two different cyclic prefix lengths are supported per signal configuration
- ▶ Preamble structure
- ▶ Pilot and data carriers
- ▶ Fixed constellation points per pilot sample
- ▶ Different modulation formats for data carriers
- ▶ Symbol ID and bitstream result
- ▶ Burst recognition
- ▶ Channel estimation and equalization using phase, timing and level tracking
- ▶ Cyclic delay shift
- ▶ FFT shift
- ▶ Transform precoding

Analyzing a custom OFDM signal with 100 MHz bandwidth



HEALTH AND UTILIZATION MONITORING SERVICE (HUMS)

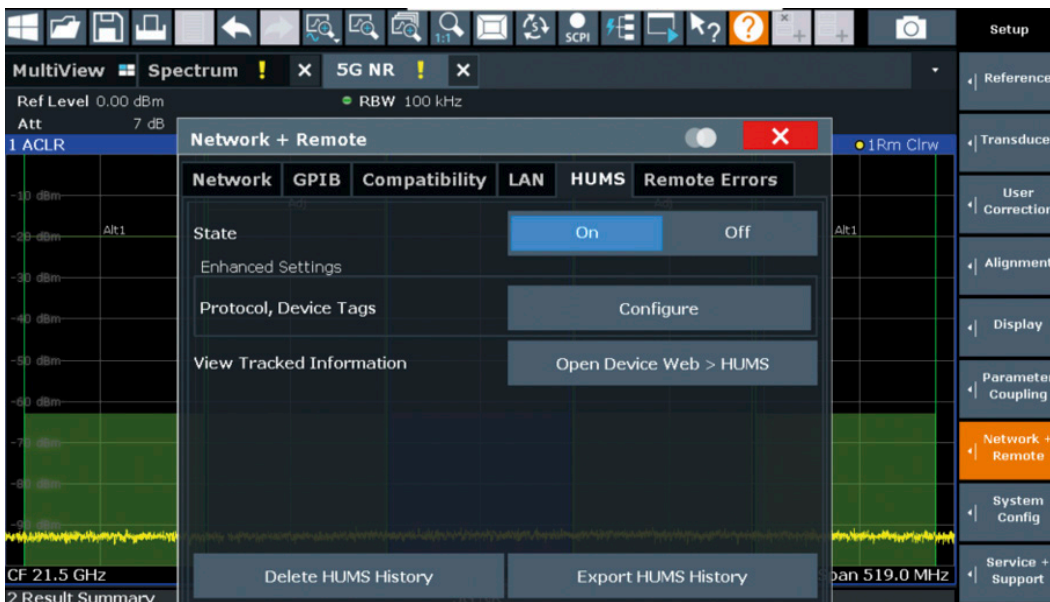
Increase utilization, avoid downtime and reduce costs.

More and more test and measurement equipment is now connected to a local network. The equipment needs to be monitored to increase overall instrument utilization, avoid downtimes and optimize costs.

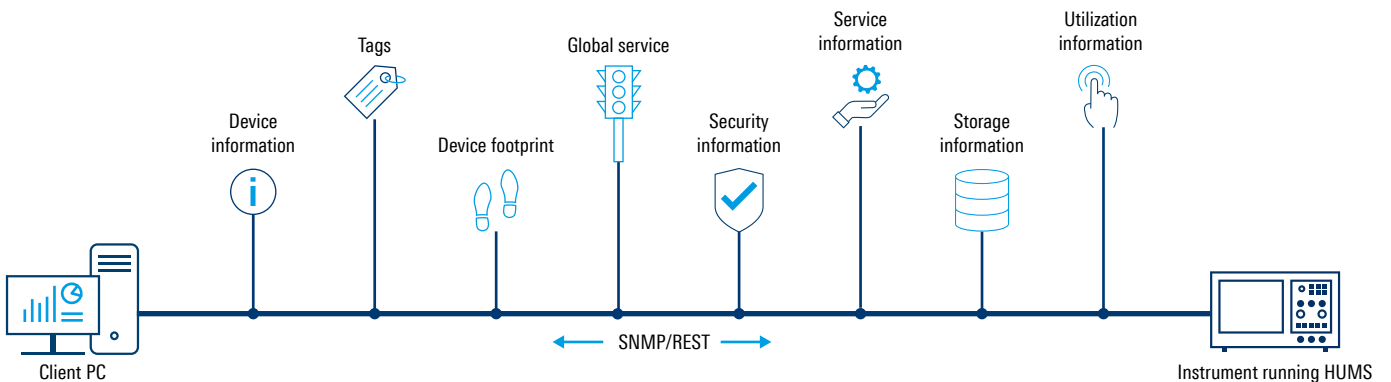
The FSW has the R&S®FSW-K980 HUMS software option for easy monitoring of the instrument usage, status and health.

The software runs as a service in the background on the device operating system and communicates with the operating system (OS) and the device firmware. HUMS can be accessed via an SNMP or REST interface and provides all necessary information about the health status and utilization over time.

The R&S®FSW-K980 HUMS option configuration



The R&S®FSW-K980 HUMS option provides utilization and health data via SNMP or REST interfaces.



WIDE RANGE OF MEASUREMENT APPLICATIONS

GENERAL-PURPOSE MEASUREMENT APPLICATIONS

Measurement application	Measurement parameters	Measurement functions
R&S®FSW-K6 Pulse measurements	Pulse parameters: <ul style="list-style-type: none"> ▶ Timing: pulse width, pulse repetition interval, duty cycle, rise/fall time, settling time, timestamp, off time ▶ Frequency: carrier frequency, pulse-to-pulse frequency difference, chirp rate, frequency deviation, frequency error ▶ Power: peak power, average power, peak-to-average power, pulse-to-pulse power ▶ Phase: carrier phase, pulse-to-pulse phase difference, phase deviation, phase error ▶ Amplitude: droop, ripple, overshoot width, top/base power, average on power, average transmitted power, minimum/peak power, peak-to-average/peak-to-min power ratio, pulse-to-pulse power ratio 	<ul style="list-style-type: none"> ▶ Point-in-pulse measurements: frequency, amplitude, phase versus pulse, trends and histograms for all parameters ▶ Pulse statistics: standard deviation, average, maximum, minimum ▶ Pulse tables ▶ User-defined measurement parameters ▶ Segmented data capturing ▶ Time sidelobe analysis (R&S®FSW-K6S option required)
R&S®FSW-K6S Time sidelobe	Time sidelobe: peak-to-sidelobe level, integrated sidelobe level, mainlobe 3 dB width, sidelobe delay, compression ratio, mainlobe power/phase/frequency, peak correlation	
R&S®FSW-K7 Modulation analysis for AM/FM/PM modulated single carriers	<ul style="list-style-type: none"> ▶ Modulation depth (AM) ▶ Frequency deviation (FM) ▶ Phase deviation (ϕM) ▶ Modulation frequency ▶ THD and SINAD ▶ Carrier power 	<ul style="list-style-type: none"> ▶ AF spectrum ▶ RF spectrum ▶ AF scope display ▶ AF filters (lowpass and highpass) ▶ Weighting filters (CCITT) ▶ Squelch
R&S®FSW-K15 VOR/ILS measurements	VOR: <ul style="list-style-type: none"> ▶ Bearing (VOR phase) ▶ 30 Hz/9960 Hz AM modulation depth ▶ 30 Hz FM deviation (subcarrier) ▶ 30 Hz/9960 Hz AM/30 Hz FM: frequency, K2, K3, THD ▶ Identifier: modulation depth, frequency, code ILS: <ul style="list-style-type: none"> ▶ DDM, SDM ▶ 90 Hz/150 Hz AM modulation depth ▶ 90 Hz/150 Hz AM: frequency, K2, K3, THD, phase ▶ Identifier: modulation depth, frequency, code 	<ul style="list-style-type: none"> ▶ Reference measurements for calibrating navigation receivers ▶ Production test measurements on ILS/VOR ground stations ▶ Measurement and calibration of ramp testers
R&S®FSW-K17 Multicarrier group delay measurements R&S®FSW-K17S Subspan measurement for group delay	<ul style="list-style-type: none"> ▶ Group delay (absolute and relative) ▶ Magnitude ▶ Phase 	<ul style="list-style-type: none"> ▶ Calibration (load and save calibration data) for measurement of components and frequency converters ▶ Configurable multicarrier scenarios
R&S®FSW-K18 Amplifier measurements R&S®FSW-K18D Direct DPD measurements R&S®FSW-K18F Frequency response measurements R&S®FSW-K18M Memory polynomial DPD	<ul style="list-style-type: none"> ▶ AM/AM, AM/PM, EVM ▶ Width of AM/PM and AM/AM curves ▶ Synchronous measurement of RF signal and amplifier current and voltage ▶ Power-added efficiency (PAE) on amplifiers with envelope tracking ▶ Magnitude, phase, and group delay versus frequency ▶ Polynomial coefficients (R&S®FSW-K18) ▶ Memory polynomial coefficients (R&S®FSW-K18M) 	<ul style="list-style-type: none"> ▶ General amplifier measurements ▶ Polynomial based digital predistortion (R&S®FSW-K18) ▶ Direct digital predistortion (R&S®FSW-K18D) ▶ Memory polynomial predistortion (R&S®FSW-K18M) ▶ Control and synchronization of the R&S®SMW200A vector signal generator ▶ Characterization of dynamic behavior of two-port devices

Measurement application	Measurement parameters	Measurement functions
R&S®FSW-K19 Noise power ratio measurements	Noise power ratio	Noise power ratio measures the intermodulation and noise floor of RF transponders and components in satellite systems
R&S®FSW-K30 Noise figure and gain measurements based on Y-factor method	<ul style="list-style-type: none"> ▶ Noise figure ▶ Noise temperature ▶ Gain ▶ Y factor 	<ul style="list-style-type: none"> ▶ Analyzer noise correction (second stage correction) ▶ Measurements on frequency-converting DUTs ▶ Control of a generator as an LO in frequency-converting measurements ▶ SSB and DSB
R&S®FSW-K40 Phase noise measurements	<ul style="list-style-type: none"> ▶ SSB phase noise ▶ Residual FM and residual ϕM ▶ Jitter 	<ul style="list-style-type: none"> ▶ 1 Hz to 10 GHz offset range ▶ Selection of resolution bandwidth and number of averages for each offset range ▶ Definable evaluation ranges for residual FM/ϕM ▶ Signal tracking ▶ Optional suppression of spurious emissions
R&S®FSW-K50 Spurious measurements	<ul style="list-style-type: none"> ▶ List with true spurious emissions that violate a predefined threshold ▶ A second threshold can be defined as a hard limit; spurious emissions that violate this threshold are shown in red 	<ul style="list-style-type: none"> ▶ Detection of spurious emissions with optimized resolution bandwidth in line with a predefined S/N ratio ▶ At least three times faster than standard measurement due to optimal configuration of test parameters ▶ Spot search for further optimization of S/N ratio ▶ Targeted search for spurious emissions ▶ Suppression of internal spurious emissions
R&S®FSW-K54 EMC diagnosis and precompliance measurements in line with commercial and military standards	<ul style="list-style-type: none"> ▶ Disturbance voltage ▶ Disturbance power ▶ Disturbance radiation 	<ul style="list-style-type: none"> ▶ Detectors and resolution bandwidths, in line with CISPR 16-1-1 and MIL-STD/DO160 ▶ Up to 16 independent measurement markers; linkable to various EMI detectors and measurement times ▶ Limit lines and correction factors for typical measurement tasks ▶ Choice of linear or logarithmic scale on frequency axis ▶ Marker demodulation (AM/FM) for signal identification
R&S®FSW-K544 Frequency response correction	SnP file in Touchstone file format	Corrects frequency response (amplitude and phase) of the measurement setup
R&S®FSW-K60 Transient measurement application R&S®FSW-K60C Transient chirp measurement R&S®FSW-K60H Transient hop measurement R&S®FSW-K60P Transient phase noise measurements	<ul style="list-style-type: none"> ▶ Frequency hopping signals: dwell time, settling time, switching time, frequency deviation, power, phase deviation, power ripple ▶ Chirp signals: frequency deviation, chirp begin, chirp length, chirp rate, chirp state deviation, phase deviation, power, power ripple 	<ul style="list-style-type: none"> ▶ Spectrogram and section of spectrogram, tabular display, frequency, frequency error, phase and amplitude versus time, FFT spectrum ▶ Pan and zoom functions to select analysis region using touch gestures; supported in spectrogram, spectrum and time domain trace displays ▶ Phase noise ▶ Frequency and phase deviation spectrograms ▶ Trends and histograms for all parameters ▶ Hop/chirp statistics: standard deviation, average, maximum, minimum ▶ User-defined measurement parameters

WIDE RANGE OF MEASUREMENT APPLICATIONS

Measurement application	Measurement parameters	Measurement functions
R&S®FSW-K70 Vector signal analysis R&S®FSW-K70M Multimodulation analysis R&S®FSW-K70P BER PRBS measurements	Analysis of digitally modulated single carriers down to bit level: <ul style="list-style-type: none"> ▶ EVM ▶ MER ▶ Phase error ▶ Magnitude error ▶ Carrier frequency error ▶ Symbol rate error ▶ I/Q skew ▶ Rho ▶ I/Q offset, I/Q imbalance, quadrature error ▶ Amplitude droop ▶ Power ▶ Bit error rate of known data streams ▶ Bit error rate of bit streams generated with PRBS shift registers (R&S®FSW-K70P) ▶ Analysis of vector modulated signals with multiple modulations, e.g. DVB-S2(X) (R&S®FSW-K70M) 	<ul style="list-style-type: none"> ▶ Eye diagram ▶ Constellation diagram ▶ Vector diagram ▶ Histogram ▶ Equalizer ▶ Multiple modulation formats, e.g. <ul style="list-style-type: none"> ▪ 2FSK to 64FSK ▪ MSK, GMSK, DMSK ▪ Multiple PSKs (e.g. BPSK, QPSK, 8PSK, 3π/8-8PSK and more) ▪ 16QAM to 1024QAM ▪ 16APSK (DVB-S2), 32APSK (DVB-S2), 2ASK, 4ASK ▪ User-definable constellations
R&S®FSW-K96 OFDM signal analysis	Analysis of custom OFDM signals: <ul style="list-style-type: none"> ▶ EVM (pilots, data, pilots and data) ▶ EVM versus carrier versus symbol ▶ Frequency error ▶ Sampling clock error ▶ I/Q offset ▶ Gain imbalance ▶ Quadrature error ▶ Power versus time ▶ Power spectrum ▶ Power versus carrier versus symbol ▶ Channel flatness ▶ Group delay ▶ Impulse response ▶ Bitstream 	<ul style="list-style-type: none"> ▶ Constellation diagram ▶ CCDF ▶ Channel estimation and compensation using phase, timing and level tracking ▶ Configuration file wizard ▶ Free configuration of pilot and data carriers and modulation schemes
R&S®FSW-K575 I/Q noise cancellation	Number of averages	Removes wideband receiver noise and corrects signals so that only external noise contributions are included (those not caused by the instrument)

MEASUREMENT APPLICATIONS FOR WIRELESS COMMUNICATIONS SYSTEMS

Measurement application/technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K8 Bluetooth® BR/EDR/LE measurements R&S®FSW-K8E Bluetooth® 6.0 Channel Sounding measurements	Output power	<ul style="list-style-type: none"> ▶ Packet length ▶ Constellation ▶ Demod waveform ▶ Delta frequency ▶ Frequency drift ▶ ICFT 	RF spectrum	RF envelope	<ul style="list-style-type: none"> ▶ Automatic detection of packet type ▶ Symbols ▶ Bluetooth® Channel Sounding supports modes 0, 1, 2 and 3
R&S®FSW-K10 GSM/EDGE/EDGE Evolution	Power measurement in time domain, including carrier power	<ul style="list-style-type: none"> ▶ EVM ▶ Phase/frequency error ▶ Origin offset suppression ▶ Constellation diagram 	<ul style="list-style-type: none"> ▶ Modulation spectrum ▶ Transient spectrum 	–	<ul style="list-style-type: none"> ▶ Single burst and multiburst ▶ Automatic detection of modulation
R&S®FSW-K72/-K73 3GPP FDD (WCDMA)	<ul style="list-style-type: none"> ▶ Code domain power ▶ Code domain power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ Peak code domain error ▶ Constellation diagram ▶ I/Q offset ▶ Residual code domain error ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error (chip rate error) 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement 	<ul style="list-style-type: none"> ▶ Channel table with channels used on base station ▶ Timing offset ▶ Power versus time 	<ul style="list-style-type: none"> ▶ Automatic detection of <ul style="list-style-type: none"> ▪ Active channels and decoding of useful information ▪ Encryption code ▪ HSDPA modulation format ▶ Support of <ul style="list-style-type: none"> ▪ Compressed mode signals ▪ HSPA and HSPA+ (HSDPA+ and HSUPA+)
R&S®FSW-K76/-K77 TD-SCDMA	<ul style="list-style-type: none"> ▶ Code domain power ▶ Code domain power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ Peak code domain error ▶ Constellation diagram ▶ I/Q offset ▶ Residual code domain error ▶ Gain imbalance ▶ Center frequency error (chip rate error) 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement 	<ul style="list-style-type: none"> ▶ Channel table with channels used on base station ▶ Timing offset ▶ Power versus time 	<ul style="list-style-type: none"> ▶ Automatic detection of <ul style="list-style-type: none"> ▪ Active channels and decoding of useful information ▪ HSDPA modulation format ▶ Support of HSPA+ (HSDPA+ and HSUPA+)
R&S®FSW-K82/-K83 CDMA2000	<ul style="list-style-type: none"> ▶ Carrier power ▶ Code domain power ▶ Code domain power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ RHO ▶ EVM ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Center frequency error 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement 	<ul style="list-style-type: none"> ▶ Channel table with channels used on base station ▶ Timing offset 	<ul style="list-style-type: none"> ▶ Automatic detection of active channels and decoding of useful information ▶ Robust demodulation algorithms for reliable measurement of multicarrier signals

WIDE RANGE OF MEASUREMENT APPLICATIONS

Measurement application/technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K84/-K85 1xEV-DO	<ul style="list-style-type: none"> ▶ Carrier power ▶ Code domain power ▶ Code domain power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ RHO_{Pilot} (R&S®FSW-K84) ▶ RHO_{Data} (R&S®FSW-K84) ▶ RHO_{MAC} (R&S®FSW-K84) ▶ RHO_{Overall} ▶ EVM ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Center frequency error 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement 	<ul style="list-style-type: none"> ▶ Channel table with channels used on base station ▶ Timing offset 	<ul style="list-style-type: none"> ▶ Automatic detection of active channels and decoding of useful information ▶ Robust demodulation algorithms for reliable measurement of multicarrier signals
R&S®FSW-K91 WLAN IEEE 802.11a/b/g					<ul style="list-style-type: none"> ▶ Automatic detection of <ul style="list-style-type: none"> ▪ Burst type ▪ MCS index ▪ Bandwidth ▪ Guard interval ▶ Estimation of payload length from burst ▶ WLAN IEEE 802.11be PPDU, EHT trigger based PPDU ▶ WLAN IEEE 802.11bn PPDU formats: UHR MU, UHR non-OFDMA SU, UHR TB RRU and DRU, UHR ELR PPDU
R&S®FSW-K91P WLAN IEEE 802.11p		<ul style="list-style-type: none"> ▶ EVM (pilot, data) ▶ EVM versus carrier ▶ EVM versus symbol ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error ▶ Symbol clock error ▶ Group delay 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement ▶ Spectrum flatness 	<ul style="list-style-type: none"> ▶ Bitstream ▶ Signal field ▶ Constellation versus carrier 	
R&S®FSW-K91N WLAN IEEE 802.11n	<ul style="list-style-type: none"> ▶ Power versus time 				
R&S®FSW-K91AC WLAN IEEE 802.11ac	<ul style="list-style-type: none"> ▶ Burst power ▶ Crest factor 				
R&S®FSW-K91AX WLAN IEEE 802.11ax					
R&S®FSW-K91BE WLAN IEEE 802.11be					
R&S®FSW-K91BN WLAN IEEE 802.11bn					
R&S®FSW-K95 WLAN IEEE 802.11ad	<ul style="list-style-type: none"> ▶ Power versus time ▶ PPDU power ▶ Crest factor 	<ul style="list-style-type: none"> ▶ EVM (pilot, data) ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Symbol clock error ▶ Center frequency error ▶ Time skew ▶ Phase error versus symbol ▶ Phase tracking versus symbol 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ Power spectrum ▶ Channel frequency response 	<ul style="list-style-type: none"> ▶ Header information ▶ Bitstream (encoded and decoded) 	<ul style="list-style-type: none"> ▶ Automatic detection of: <ul style="list-style-type: none"> ▶ PPDU type ▶ MCS index
R&S®FSW-K97 WLAN IEEE 802.11ay SC (additional results and features to R&S®FSW-K95)	SNR	EVM versus symbol		<ul style="list-style-type: none"> ▶ Bit error rate header ▶ Bit error rate payload 	<ul style="list-style-type: none"> ▶ Channel bonding 1-4, restricted by analysis bandwidth ▶ Automatic detection of <ul style="list-style-type: none"> ▪ Guard interval ▪ PPDU length ▶ Channel aggregation
R&S®FSW-K100/-K101/-K104/-K105 EUTRA/LTE TDD and FDD UL and DL	<ul style="list-style-type: none"> ▶ Power measurement in time and frequency domains ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ Constellation diagram ▶ I/Q offset ▶ Gain imbalance ▶ Quadrature error ▶ Center frequency error (symbol clock error) 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement ▶ Spectrum flatness 	<ul style="list-style-type: none"> ▶ Bitstream ▶ Allocation summary list ▶ Averaging over multiple measurements 	<ul style="list-style-type: none"> ▶ Automatic detection of modulation, cyclic prefix length and cell ID

Measurement application/technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K102 EUTRA/LTE-Advanced and MIMO DL		See R&S®FSW-K100/-K104 modulation quality measurements for each individual MIMO path	Multicarrier ACLR/SEM	CSI reference signal Time alignment error	MIMO time alignment for R&S®FSW-K100/-K104 Interband carrier aggregation time alignment MBSFN settings Exclude in-band NB-IoT
R&S®FSW-K103 EUTRA/ LTE-Advanced UL			<ul style="list-style-type: none"> ▶ Multicarrier ACLR for FDD and TDD ▶ SEM for contiguously aggregated component carriers 		
R&S®FSW-K106 NB-IoT DL measurements	Power measurement in time and frequency domains	<ul style="list-style-type: none"> ▶ EVM ▶ Constellation diagram ▶ Frequency error ▶ Sampling error 	Spectrum flatness, ACLR, SEM	Allocation summary list	<ul style="list-style-type: none"> ▶ Standalone, guard band and in-band operation ▶ Automatic detection of cell ID
R&S®FSW-K118 Verizon 5GTF downlink	<ul style="list-style-type: none"> ▶ Power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ EVM xPDSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error 		<ul style="list-style-type: none"> ▶ Allocation summary ▶ Multicarrier filter 	Automatic detection of cell ID
R&S®FSW-K119 Verizon 5GTF uplink	<ul style="list-style-type: none"> ▶ Power versus time ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ EVM xPUSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error 		<ul style="list-style-type: none"> ▶ Allocation summary ▶ Multicarrier filter 	

WIDE RANGE OF MEASUREMENT APPLICATIONS

Measurement application/technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K144 5G NR Rel. 15 downlink R&S®FSW-K145 5G NR Rel. 15 uplink R&S®FSW-K147 5G NR combined ACLR/SEM/EVM R&S®FSW-K147C 5G NR multi-CC combined ACLR/SEM/EVM measurements R&S®FSW-K148 5G NR Rel. 16 extension for uplink/downlink R&S®FSW-K171 5G NR Rel. 17 extension for uplink/downlink R&S®FSW-K175 extension for O-RAN measurements R&S®FSW-K184 Beyond 5G measurements extension for uplink/downlink	<ul style="list-style-type: none"> ▶ Power versus time ▶ Transmit on/off power 	<ul style="list-style-type: none"> ▶ EVM ▶ EVM xPDSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error ▶ Up to 16kQAM ▶ Custom constellations 	<ul style="list-style-type: none"> ▶ ACLR ▶ SEM ▶ Multicarrier SEM and ACLR 	<ul style="list-style-type: none"> ▶ Allocation summary ▶ Channel table with channels used on base station ▶ Time alignment error ▶ Beamforming summary ▶ Bitstream 	<ul style="list-style-type: none"> ▶ Automatic detection of cell ID ▶ Support of multiple bandwidth parts
R&S®FSW-K149 High rate pulse repetition frequency ultrawideband measurements	<ul style="list-style-type: none"> ▶ PPDU power ▶ SHR power ▶ Power versus time 	<ul style="list-style-type: none"> ▶ Center frequency offset ▶ Chip clock error ▶ Chip and symbol time jitter ▶ Normalized cross-correlation ▶ Pulse (mask, monotonically rising) ▶ NRMSE (SHR, PHR, PSDU, STS) ▶ Pulse level (PHR, PSDU, STS) ▶ Marker (ranging) 	<ul style="list-style-type: none"> ▶ Packet spectrum ▶ PSD mask 	<ul style="list-style-type: none"> ▶ Chip time and phase jitter histograms ▶ Symbol time and phase jitter histograms ▶ Packet insights (code index, delta length, data rate, data length, ranging bit, SECDEC, AOA1, payload (via SCPI)) 	<ul style="list-style-type: none"> ▶ Automatic detection of preamble information ▶ Support of all UWB channels and bandwidths
R&S®FSW-K201 OneWeb reverse link measurement application	<ul style="list-style-type: none"> ▶ Power measurement in time and frequency domains ▶ CCDF 	<ul style="list-style-type: none"> ▶ EVM ▶ Constellation diagram ▶ I/Q offset ▶ Gain imbalance ▶ Quadrature error ▶ Center frequency error (symbol clock error) 	<ul style="list-style-type: none"> ▶ Spectrum mask ▶ ACLR ▶ Power measurement ▶ Spectrum flatness 		<ul style="list-style-type: none"> ▶ Automatic detection of modulation and cyclic prefix length

MEASUREMENT APPLICATIONS FOR WIRE-CONNECTED COMMUNICATIONS SYSTEMS

Measurement application/ technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K192 DOCSIS 3.1 downstream	<ul style="list-style-type: none"> ▶ Power ▶ Power versus time ▶ Power versus symbol x carrier 	<ul style="list-style-type: none"> ▶ MER versus carrier ▶ MER versus symbol ▶ MER versus symbol x carrier ▶ MER (pilot, data) ▶ Constellation diagram ▶ Center frequency error ▶ Symbol clock error ▶ Group delay 	<ul style="list-style-type: none"> ▶ Power measurement ▶ Spectrum flatness 	Decoding: <ul style="list-style-type: none"> ▶ LDPC BER ▶ LDPC CWER ▶ Trigger to frame 	Automatic detection of: <ul style="list-style-type: none"> ▶ Cyclic prefix ▶ Roll-off ▶ PLC start index ▶ Continuous pilots ▶ NCP ▶ Profile A ▶ N_{FFT}
R&S®FSW-K193 DOCSIS 3.1 upstream	<ul style="list-style-type: none"> ▶ Power ▶ Power versus time ▶ Power versus symbol x carrier 	<ul style="list-style-type: none"> ▶ MER versus carrier ▶ MER versus symbol ▶ MER versus symbol x carrier ▶ MER (pilot, data) ▶ Constellation diagram ▶ Center frequency error ▶ Symbol clock error ▶ Group delay 	<ul style="list-style-type: none"> ▶ Power spectrum ▶ Power versus carrier (synchronous ACP) ▶ Spectrum flatness 	<ul style="list-style-type: none"> ▶ Individual results for frame objects ▶ Trigger to frame 	Automatic detection of: <ul style="list-style-type: none"> ▶ Cyclic prefix ▶ Roll-off

SPECIFICATIONS IN BRIEF

Specifications in brief		
Frequency		
Frequency range	R&S®FSW8	2 Hz to 8 GHz
	R&S®FSW13	2 Hz to 13.6 GHz
	R&S®FSW26	2 Hz to 26.5 GHz
	R&S®FSW43	2 Hz to 43.5 GHz
	R&S®FSW50	2 Hz to 50 GHz
	R&S®FSW67	2 Hz to 67 GHz
	R&S®FSW85	2 Hz to 85 GHz, up to 90 GHz with R&S®FSW-B90G option, YIG preselector = off
Aging of frequency reference		1 × 10 ⁻⁷ /year
	with R&S®FSW-B4 option	3 × 10 ⁻⁸ /year
Bandwidths		
Resolution bandwidths	standard filter	1 Hz to 10 MHz, additional 20 MHz and 40 MHz with R&S®FSW-B8E option (no export license required); additional 20 MHz, 40 MHz, 50 MHz and 80 MHz with R&S®FSW-B8 option (export license required for models R&S®FSW43/50/67/85)
	RRC filter	18 kHz (NADC), 24.3 kHz (TETRA), 3.84 MHz (3GPP)
	channel filter	100 Hz to 5 MHz
	video filter	1 Hz to 10 MHz
I/Q demodulation bandwidth		28 MHz
	with R&S®FSW-B40 option	40 MHz
	with R&S®FSW-B80 option	80 MHz
	with R&S®FSW-B160 option	160 MHz
	with R&S®FSW-B320 option	320 MHz
	with R&S®FSW-B512 option	512 MHz
	with R&S®FSW-B1200 option	1.2 GHz ¹⁾
	with R&S®FSW-B2001 option	2 GHz ¹⁾
	with R&S®FSW-B2000 option	2 GHz ²⁾
	with R&S®FSW-B4001 option	4.4 GHz ³⁾
	with R&S®FSW-B5000 option	5 GHz ⁴⁾
	with R&S®FSW-B6001 option	6.4 GHz ⁵⁾
	with R&S®FSW-B8001 option	8.3 GHz ⁵⁾
Phase noise	10 kHz offset from carrier	
	500 MHz carrier	-141 dBc (1 Hz) (typ.)
	1 GHz carrier	-140 dBc (1 Hz) (typ.)
	10 GHz carrier	-133 dBc (1 Hz) (typ.)
Displayed average noise level (DANL)	2 GHz	-156 dBm (1 Hz) (typ.)
	with R&S®FSW-B13 option	-159 dBm (1 Hz) (typ.)
DANL with preamplifier (R&S®FSW-B24 option)	2 GHz	-169 dBm (1 Hz) (typ.)
Intermodulation		
Third order intercept (TOI)	f < 1 GHz	+30 dBm (typ.)
	f < 3 GHz	+25 dBm (typ.)
	19 GHz to 26.5 GHz	+23 dBm (typ.)
Total measurement uncertainty	8 GHz	< 0.37 dB

¹⁾ Not available for the R&S®FSW8 and R&S®FSW13.

²⁾ 2 GHz demodulation bandwidth for frequencies > 5.5 GHz. R&S®RTO2044 oscilloscope required. Not available for the R&S®FSW8 and R&S®FSW13.

³⁾ Available for the R&S®FSW43, R&S®FSW50, R&S®FSW67 and R&S®FSW85.

⁴⁾ Available for the R&S®FSW43 and R&S®FSW85. 5 GHz demodulation bandwidth for frequencies > 9.5 GHz. R&S®RTO2064 oscilloscope required.

⁵⁾ Available for the R&S®FSW43, R&S®FSW50, R&S®FSW67 and R&S®FSW85.

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