FSW
SIGNAL AND SPECTRUM ANALYZER

Continuing innovation in RF performance and usability

Product Brochure
Version 16.01

ROHDE&SCHWARZ
Make ideas real

AT A GLANCE

The high-performance FSW signal and spectrum analyzer helps engineers accomplish the most demanding tasks. Its wide internal analysis bandwidth allows the characterization of wideband components and communications systems. Its unparalleled phase noise facilitates the development of high-performance oscillators such as those 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 like those used in the new 5G New Radio standard or in 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.

Featuring a multitouch display and intuitive menu structure, the FSW offers exceptional ease of operation. Various measurements can be displayed simultaneously in separate windows on the large 12.1" screen, which greatly facilitates result interpretation.

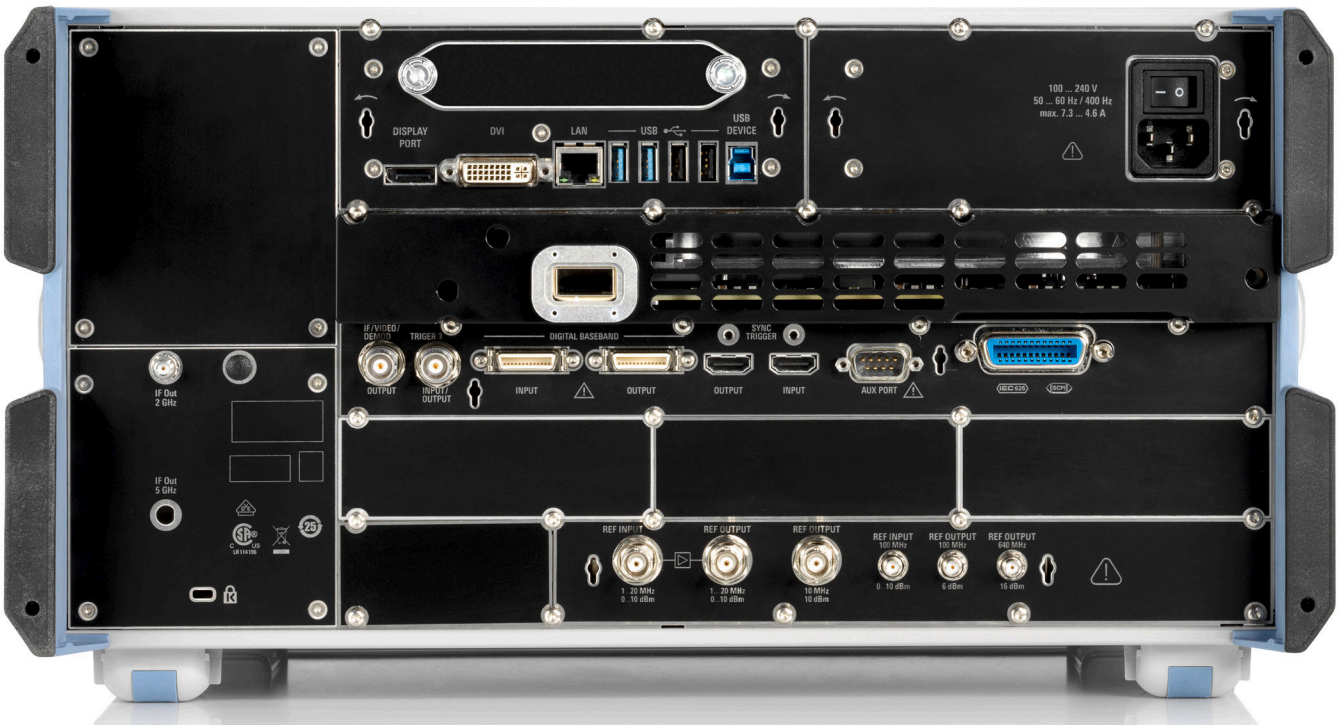
Key facts

- 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 µs POI
- Up to 1 GHz streaming bandwidth over the I/Q 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/Q noise cancellation option (–53 dB for 320 MHz WLAN IEEE802.11be (Wi-Fi 7) signals at 6.905 GHz)

Front view

BENEFITS

Rear view



OUTSTANDING RF PERFORMANCE

The FSW redefines the top of the line for signal and spectrum analyzers, offering superior RF performance in terms of phase noise, displayed average noise level, intermodulation suppression and dynamic range for ACLR and harmonic measurements.

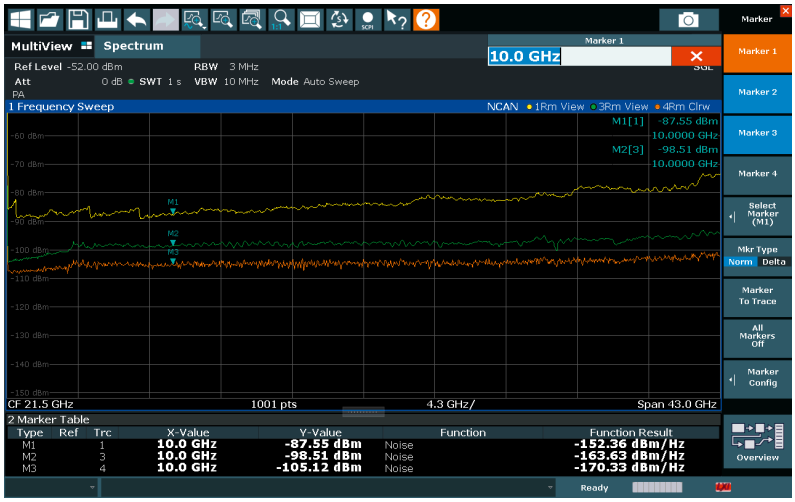
Unmatched phase noise: ideal for measuring oscillators for radar and communications applications

Developers of oscillators, synthesizers and transmit systems benefit from the FSW analyzer's excellent RF performance for phase noise measurements. At 10 kHz offset from the carrier, the FSW achieves a phase noise of typical –140 dBc (1 Hz) for a 1 GHz carrier and typical –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. Depending on the frequency and offset range, the FSW outperforms other high-end analyzers by more than 10 dB.

Excellent dynamic range for spurious measurements thanks to low DANL

Featuring a low displayed average noise level (DANL) of typical –159 dBm (1 Hz) at 2 GHz and –150 dBm (1 Hz) at 25 GHz without using a preamplifier, the FSW measures spurious emissions quickly and reliably over a wide frequency range. A built-in preamplifier reduces the DANL further by over 15 dB and the analyzer's switch-selected noise cancellation improves the DANL by up to 13 dB. As a result, users can identify even the smallest of spurious emissions that were previously hidden in 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 optionally 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 DANL of the FSW at low frequencies up to approximately 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 input of the FSW ensures 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. It provides image-free spectrum analysis at very high frequencies like those used in automotive radar.

High accuracy

The FSW offers high level measurement accuracy. It measures signal levels with < 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 unattained dynamic range, for example for measurements on radio systems for public safety and security.

Ultrawideband filters in sweep mode

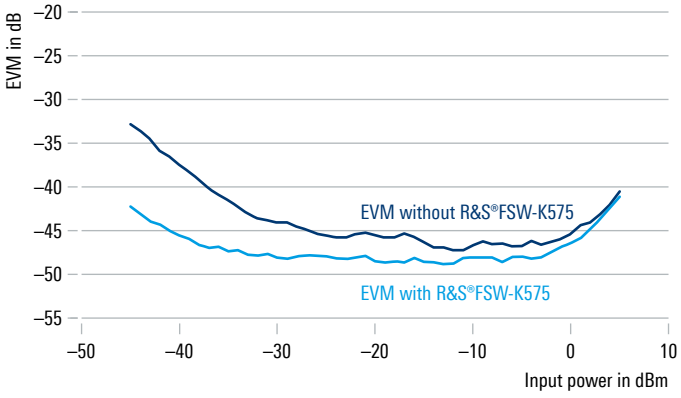
UWB regulations such as EN 302065 call for a 50 MHz resolution filter to measure the peak power, a measurement easily performed with the FSW. With its optional resolution bandwidths of 20 MHz, 40 MHz, 50 MHz and 80 MHz, the FSW offers unique possibilities for wideband signal testing.

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

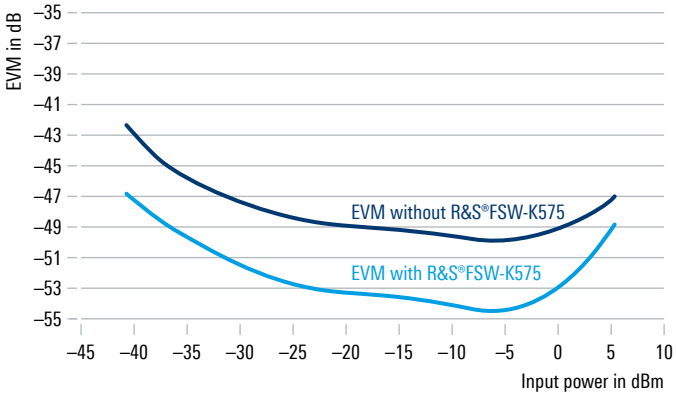
Thanks to its high dynamic range, the FSW achieves very low EVM results across a wide range of input power. For a 100 MHz wide 5G NR signal at 28 GHz, it achieves a residual EVM below –49 dB.

R&S®FSW-K575 I/Q noise cancellation further reduces the residual instrument EVM with a simple software upgrade and without any hardware changes or second measurement path. The option lets the FSW cover measurement scenarios with very stringent EVM requirements. R&S®FSW-K575 reduces the residual EVM for the FSW to less than –53 dB for a 320 MHz wide and 4096QAM WLAN IEEE 802.11be (Wi-Fi 7) 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 to take on this challenge.

Analysis bandwidth extensions for the different FSW models

Model	Option	Frequency range	
		up to 512 MHz [1]	up to 2 GHz [2]
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 IEEE 802.11a/b/g/p signals	•			
5G NR				•
WLAN IEEE 802.11n signals		•		
WLAN IEEE 802.11ac, IEEE 802.11ax and IEEE 802.11be signals			•	•
HRP UWB WLAN 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				

4.4 GHz	6.4 GHz 3)	8.3 GHz 3)

	320 MHz	512 MHz	1.2 GHz	2 GHz	4.4 GHz	6.4 GHz	8.3 GHz
	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
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ADVANCED USER INTERFACE

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

SCPI recorder

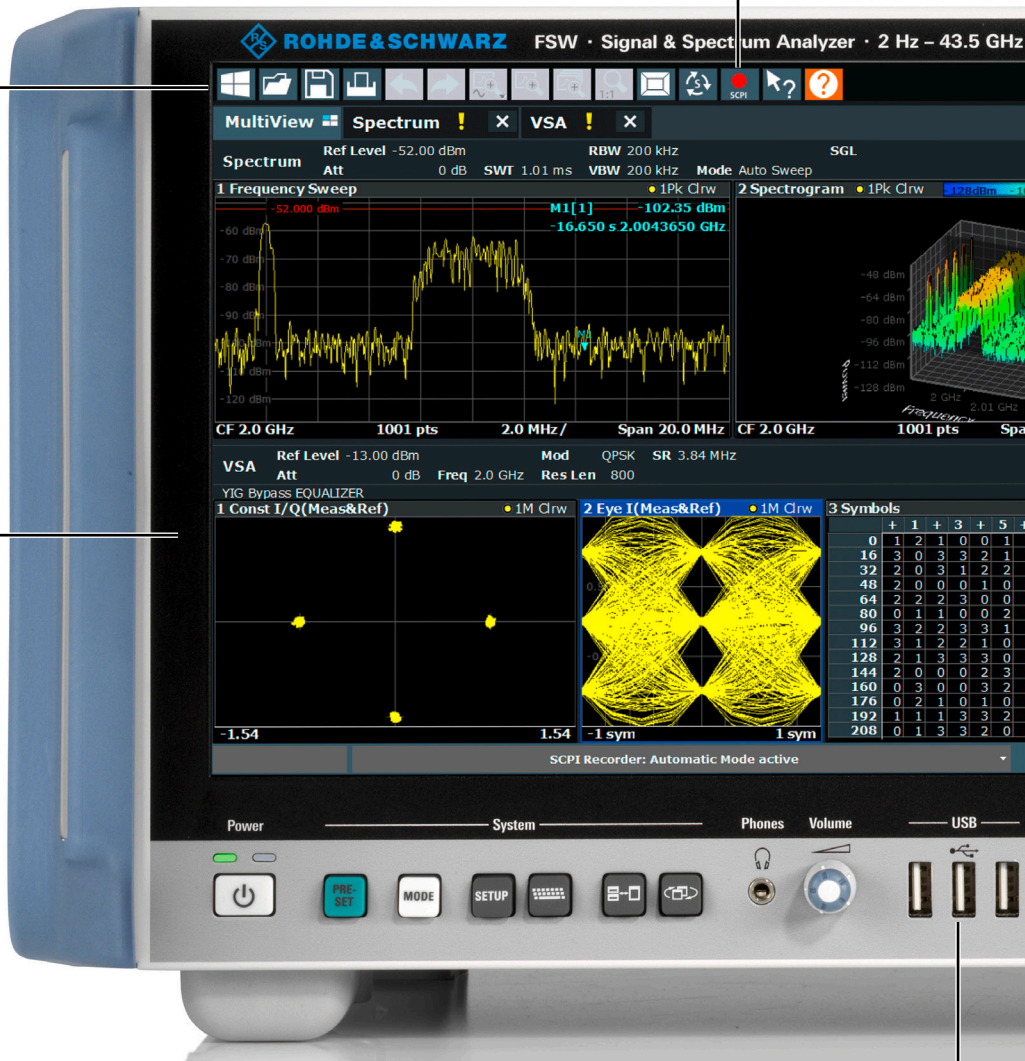
Simplified code generation for automatic, remote controlled measurements

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

BE AHEAD IN 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 provides the right capabilities and measurement applications with uncompromised performance for fast and straightforward testing of numerous wireless standards with their specific requirements and characteristics.

Analysis of 5G signals

The FSW 5G measurement applications simplify and speed up in-depth analysis of the physical layer, allowing you to test at higher frequencies and wider measurement bandwidths and 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.

With its wide internal analysis bandwidth of optionally up to 8.3 GHz, the R&S®FSW-K144 can capture the entire bandwidth of the downlink signal and allows you to evaluate the complete system. Its high-performance digitizer yields a low inherent error vector magnitude (EVM), providing new insight into designs. Another advantage is that the bandwidth option is an internal FSW option. This reduces both the size of the test setup and the amount of cabling between components and also increases 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.

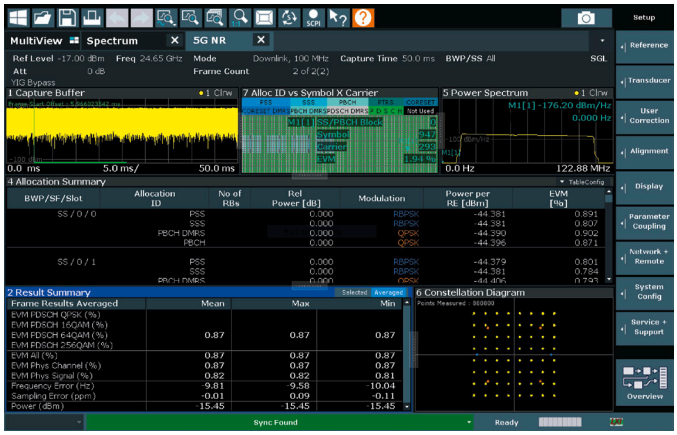
The R&S®FSW-K147 option enables combined measurement of ACLR, SEM and EVM. R&S®FSW-K147C extends the functionalities for multi-component carrier measurements. Thanks to parallelized calculations and adaptable trigger settings, the application offers significant speed advantages. This is of particular interest 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, which reduces the number of user settings to a minimum.

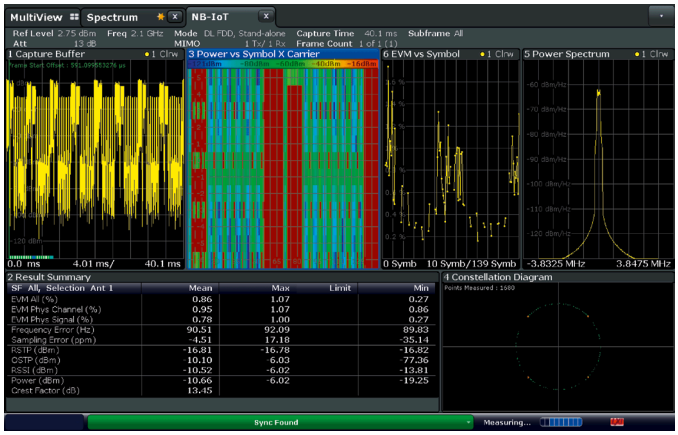
For out-of-band measurements, a wide range of settings and limit lines are provided for adjacent channel leakage ratio and spectrum emission mask measurements.

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-K144 5G New Radio downlink measurement application



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



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. It delivers signal modulation results as well as out-of-band spectral measurements (ACLR and SEM). The timing alignment measurement is included to be able 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.

Wireless connectivity: WLAN IEEE 802.11ax/be

The latest WLAN standards such as WLAN IEEE 802.11be aim to significantly increase data rates. To achieve a higher throughput, WLAN IEEE 802.11be has several new features, including a channel bandwidth of up to 320 MHz. The WLAN IEEE 802.11be standard is an extension of the WLAN IEEE 802.11ax standard. Its aim is to improve system capacity especially in scenarios that are interference limited due to the high density of WLAN devices. The outstanding performance of the FSW signal and spectrum analyzer permits the precise signal analysis necessary when characterizing DUTs with the R&S®FSW-K91AX and R&S®FSW-K91BE options. For a 320 MHz bandwidth and 4096QAM modulation, the residual EVM is as low as –50 dB in conjunction with the R&S®FSW-B320 option and can be further improved and reduced to less than –53 dB with the R&S®FSW-K575 I/Q noise cancellation option.

Ultrawideband (UWB) WLAN IEEE 802.15.4/4z

The ultrawideband (UWB) standard was developed a long time ago for simpler near-field communications. The latest WLAN 8 802.15.4z 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.

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.

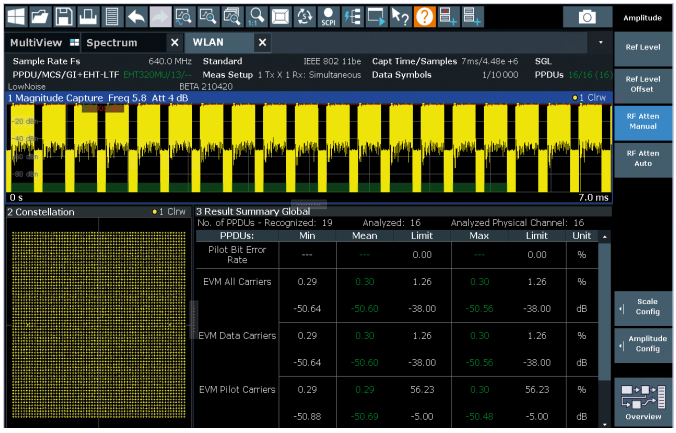
The R&S®FSW67 and R&S®FSW85 signal and spectrum analyzers, which are equipped with the R&S®FSW-B2001 and the special R&S®FSW-K95 WLAN IEEE 802.11ad measurement option, are the only one-box solutions on the market that cover WLAN IEEE 802.11ad applications.

In addition, 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 an 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.

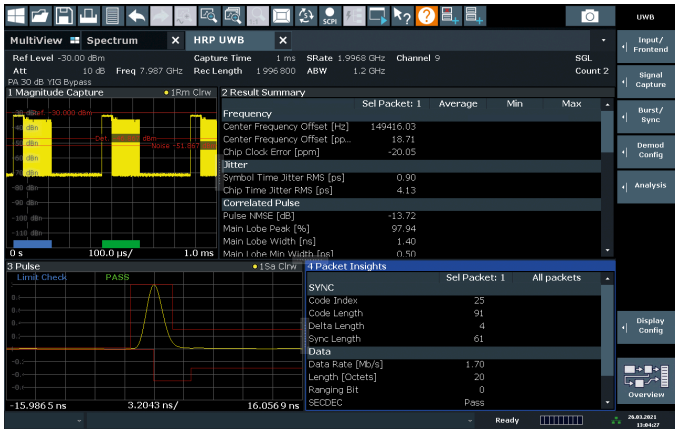
Bluetooth® BR/EDR/Low Energy

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 various modern devices in line with dedicated standards. The R&S®FSW-K8 Bluetooth® measurement application supports modulation characteristic measurements in I/Q mode and ACP/in-band trace emission measurements in swept spectrum mode. It also supports basic rate (BR), enhanced data rate (EDR) and Bluetooth® Low Energy signal measurements to cover mandatory output power, carrier frequency stability, modulation accuracy and adjacent channel power (ACP).

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



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 prerequisites when testing modern radar systems with their wideband signals, intrapulse modulation techniques and frequency hopping capabilities.

Fast and comprehensive radar signal analysis

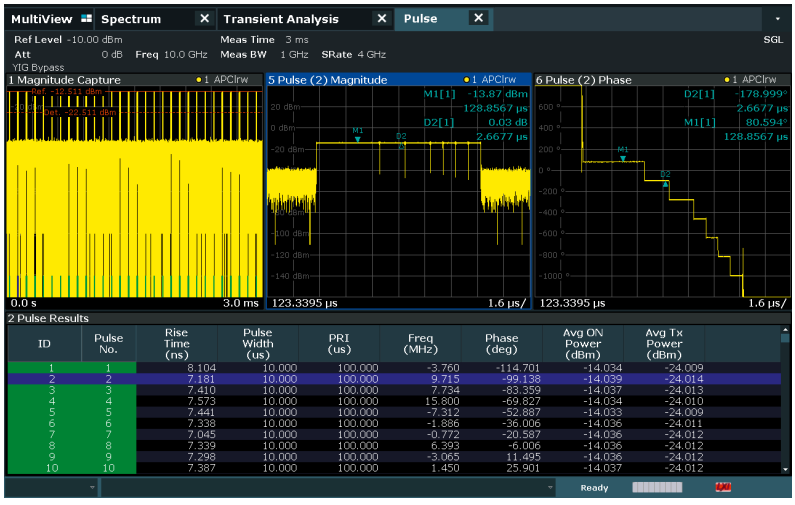
The R&S®FSW-K6 pulse measurement application measures all relevant pulse parameters such as pulse duration, pulse period, pulse rise and fall times, power drop across a pulse and intrapulse phase modulation at the touch of a button. It produces a trend analysis over many pulses. The user selects which results to display simultaneously 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 in memory only when a pulse is detected. This feature significantly increases the analysis period – by a factor of nearly 1000 for pulse lengths less than 1 µs and a 1 kHz pulse repetition interval (PRI). With up to 8.3 GHz internal analysis bandwidth, the FSW is ready to support the design of ultrawideband radar.

Detailed pulse compression radar measurements

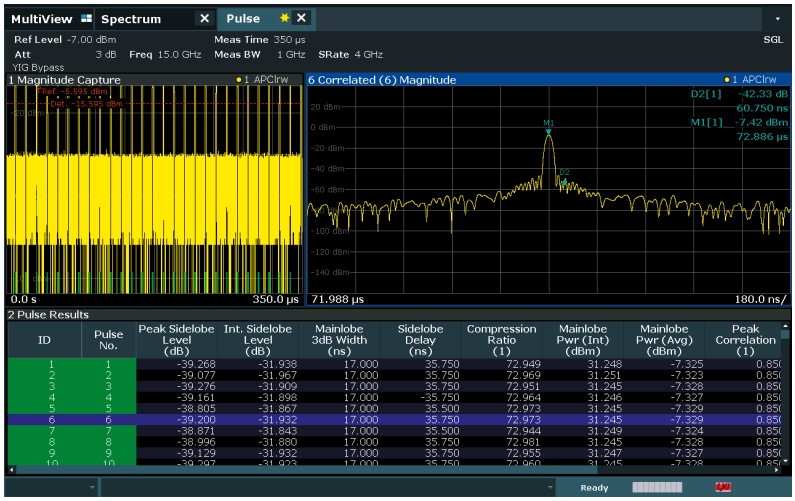
The R&S®FSW-K6S time sidelobe measurement option measures the pulse compression parameters and helps evaluate the degradation of radar performance caused, for example, by modulators and exciters. You can import any I/Q based reference waveform in I/Q data file format, allowing the use of confidential, 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.



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

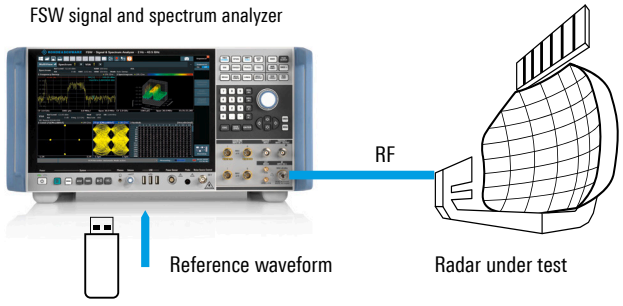


Pulse compression parameters and correlated magnitude display of a chirped pulse are shown with the R&S®FSW-K6S option.

The FSW automatically 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 that occur in frequency hopping radios. Results include dwell time/hop, switching time, frequency and deviation.

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

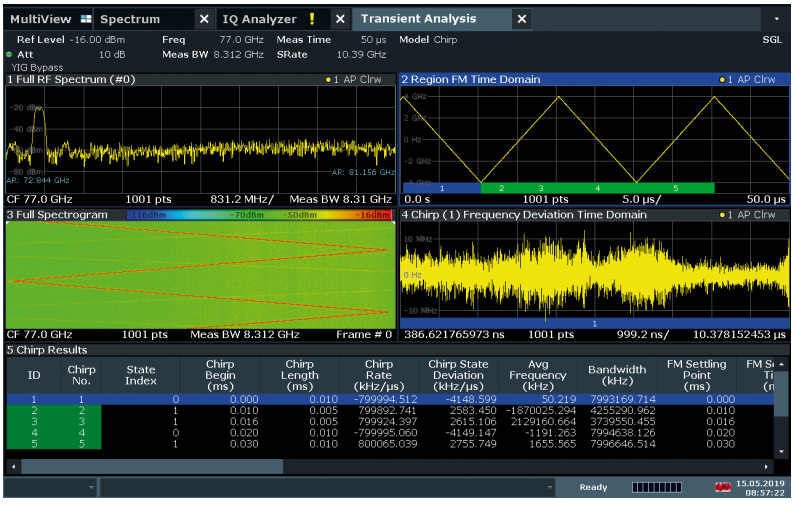


The R&S®FSW-K60P transient phase noise extension adds phase noise measurements to individual chirps or hops in the measurement results.

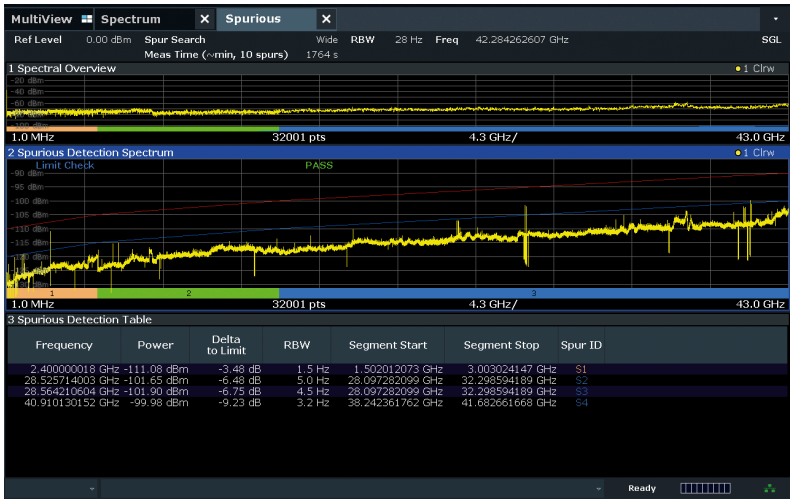
The analyzer shows trends and performs statistical analyses on all pulse, chirp and hop parameters. Trend analysis allows you to quickly identify the effects of supply voltages (or their frequencies, such as 50 Hz or 400 Hz) and to rapidly verify frequency hopping patterns and changes in the pulse repetition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

Fast and reliable detection of spurious emissions

In order to measure the low levels of spurious emissions, it is often necessary to reduce the resolution bandwidth, which increases the measurement time. The R&S®FSW-K50 spurious measurement option automates spurious searches, which are performed 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 measuring at each frequency. The R&S®FSW-K50 spurious search option is significantly faster than conventional spurious search methods for measurements at –120 dBm or below.



Analysis of an FMCW signal with the R&S®FSW-K60C option and 8.3 GHz analysis bandwidth



Spurious measurement result screen

IDEAL FOR SATELLITE RF TESTING

Satellite communications must cover a diverse set of user requirements in broadcasting, wireless communications and remote sensing for both commercial and government systems. Rohde&Schwarz offers 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 be used to 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 in non-frequency-converting measurements.

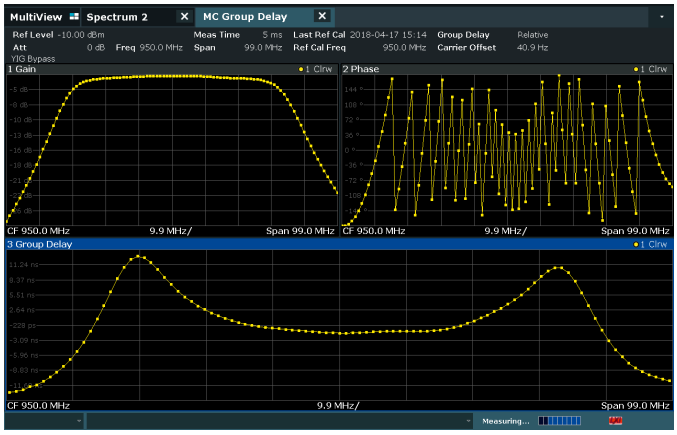
It is designed to handle signal degradations that occur during in-orbit testing and achieves an extremely low noise floor due to multicarrier reference signals. No reference mixer or golden device is required for frequency converting measurements.

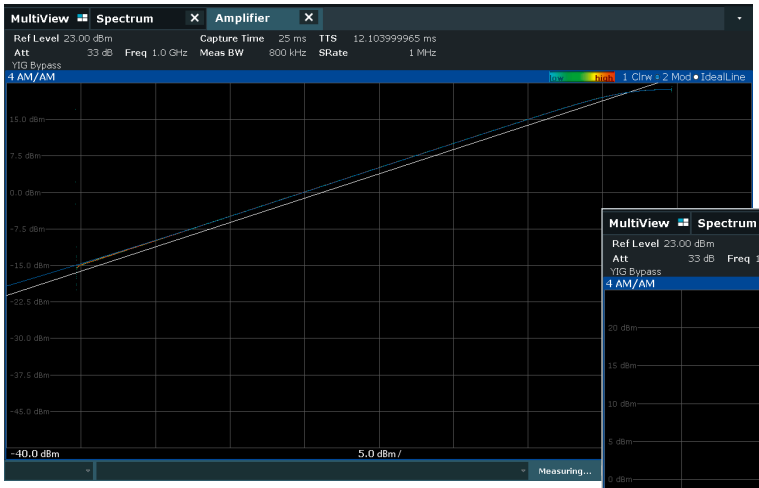
The R&S®FSW-K17S option is an extension of the R&S®FSW-K17. It supports broadband signal analysis to improve the overall signal-to-noise (S/N) ratio and speed of the measurement by analyzing subspans of the overall signal.

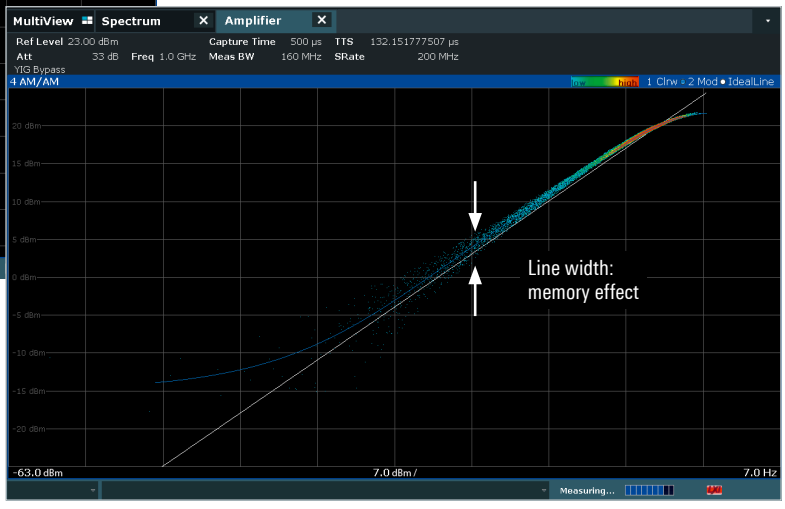
With this option, small parts of the overall signal can be output sequentially on the R&S®SMW200A and analyzed by the FSW.

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

Relative group delay measurement on a bandpass filter







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. It is therefore the ideal tool for comparing PAs under linearization conditions. In addition, the R&S®FSW-K18M option utilizes 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)

Equipped with the R&S®FSW-K19 option, the FSW offers a convenient and straightforward way to measure the NPR over a maximum of 25 notches.

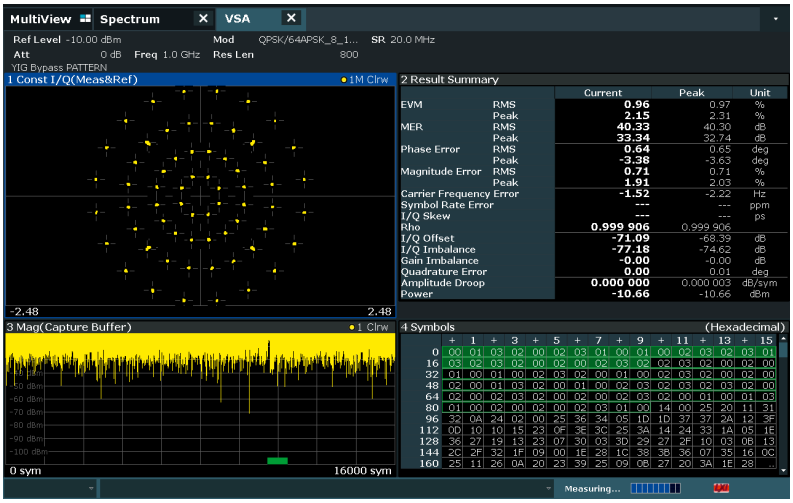
DVB-S2X modulation analysis

The R&S®FSW-K70M multicarrier modulation analysis application (R&S®FSW-K70 option required) allows DVB-S2X signals to be analyzed. The R&S®FSW-K70M detects the start of 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 that allows the measurement of raw bit error rate on PRBS data up to PRBS23. In addition, the R&S®FSW-K70 offers the ability to 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

Equipped with the high-performance R&S®FSW-K161R, R&S®FSW-B512R and R&S®FSW-B800R real-time options, the FSW displays RF spectra seamlessly and in real time. Level-controlled detection of signals takes less than 0.5 µs (R&S®FSW-B800R).

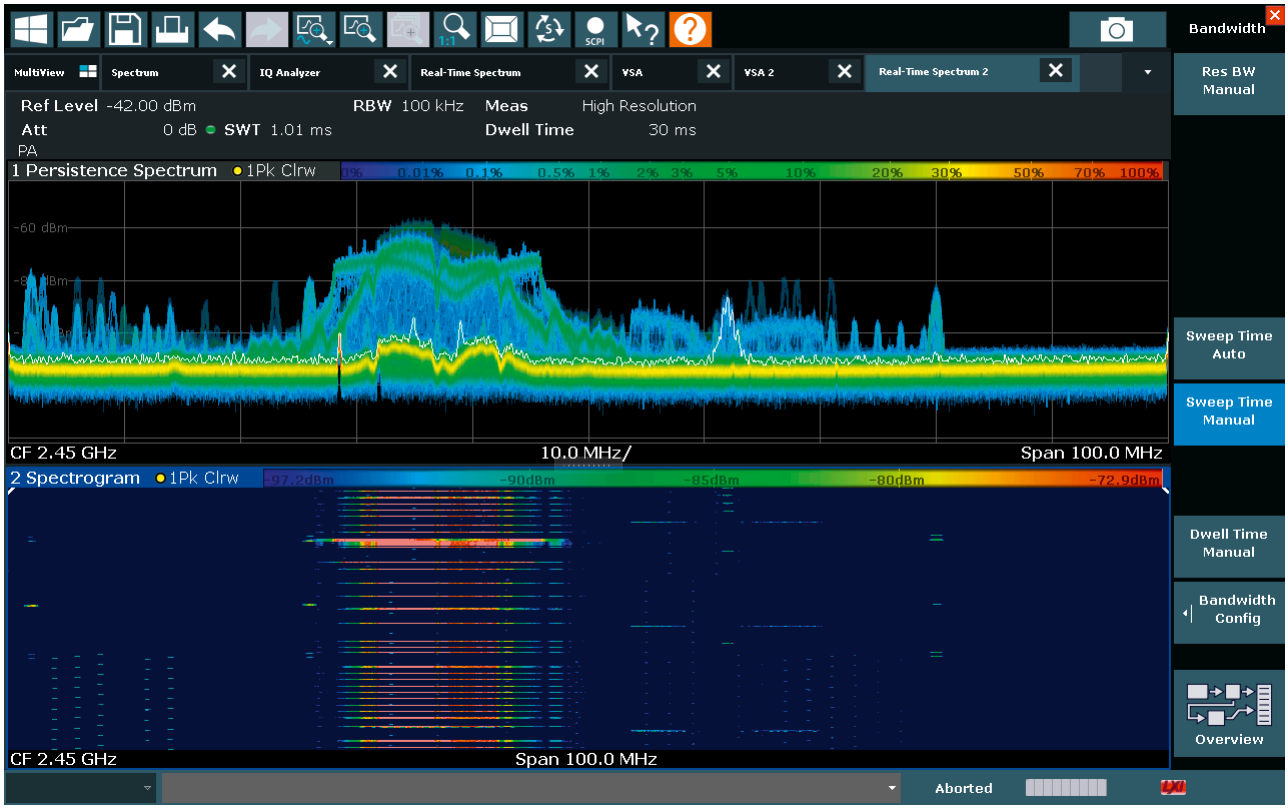
Full-featured signal and spectrum analyzer

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 µs 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).

This enables the FSW to 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, for example, 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, for example, determine the cause of interference or what is hindering a base station's data throughput. Interference originating from digital circuits or produced during synthesizer frequency switching can also be easily detected using this method.

For correct level measurements and to mitigate signal loss at the edges of the FFT window or to achieve higher time resolution, 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. 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	1171875	71022	2343750	71022
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, π/2-BPSK, π/2-DBPSK, QPSK, offset QPSK, DQPSK, π/4-DQPSK, 3π/4-QPSK, 8PSK, D8PSK, 3π/8-8PSK, π/8-D8PSK
  - 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM, 2048QAM, 4096QAM
  - 16APSK (DVB-S2), 32APSK (DVB-S2), 2ASK, 4ASK
  - π/4-16QAM (EDGE), –π/4-32QAM (EDGE), SOQPSK
- Analysis length up to 128 000 symbols
- 28 MHz signal analysis bandwidth (optionally 40/80/160/320/512 MHz and 1.2/2/4/6.4/8.3 GHz)

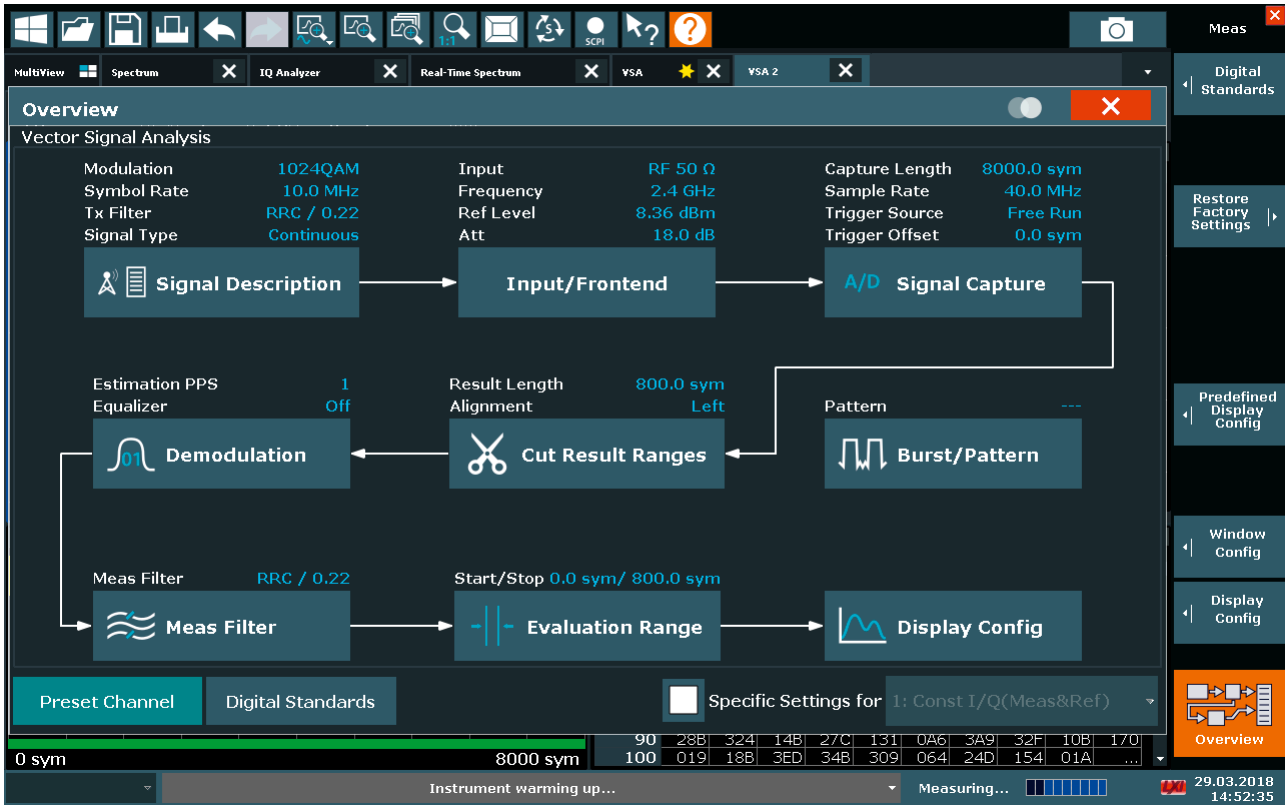
Numerous standard-specific default settings

- 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).

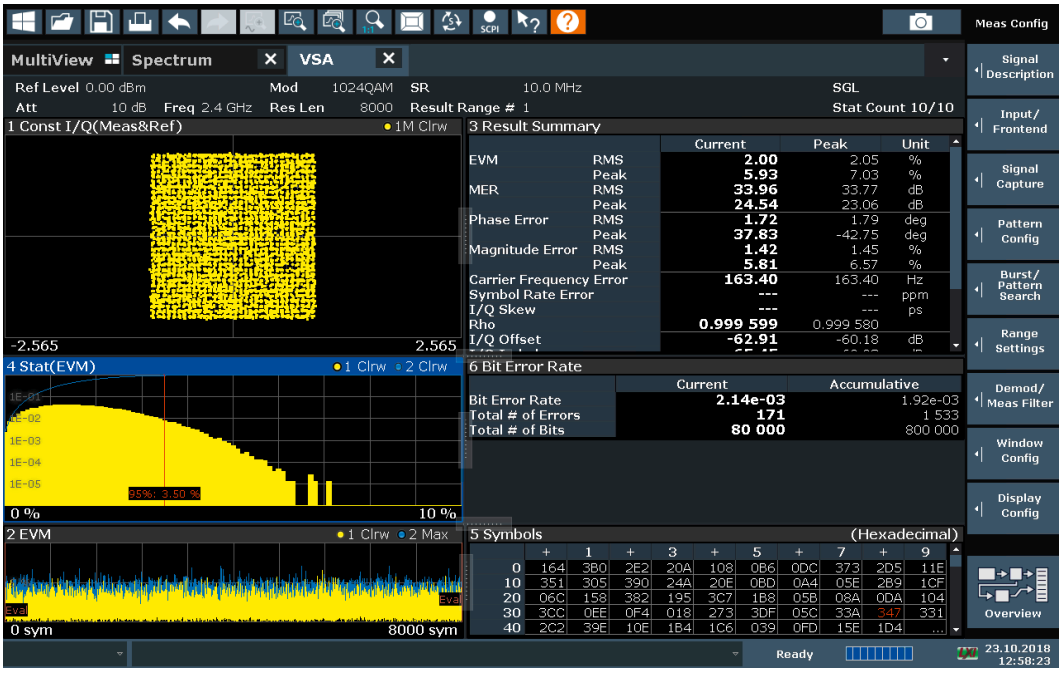
Clearly structured block diagram display



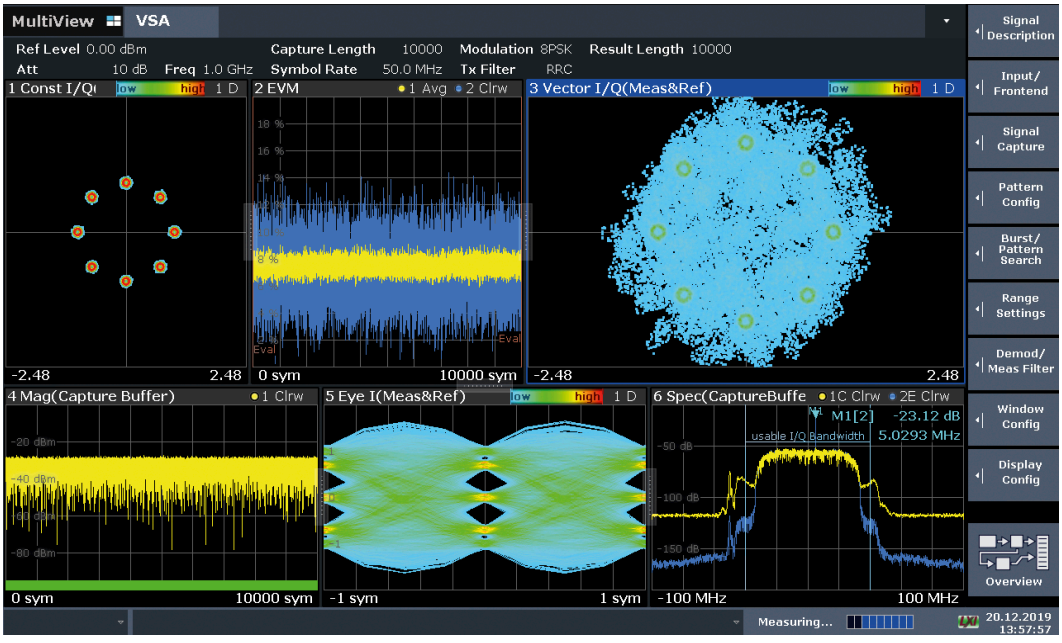
Flexible analysis tools for detailed signal analysis make troubleshooting really easy

- 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 the assignment of pilot and data modulation types.

Additionally, the R&S®FSW-K96 option can 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

While even complex OFDM based communications standards can be analyzed using the R&S®FSW-K96 option, the application's real performance lies in the high degree of freedom it offers with regard to configuration and measurement 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)

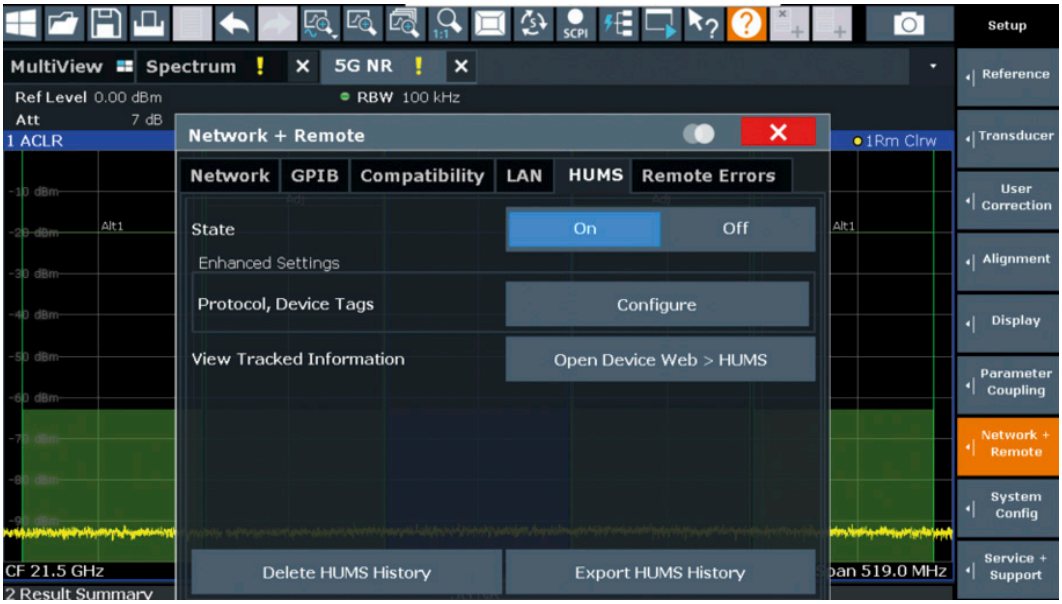
Increase utilization, avoid downtime and reduce costs.

Nowadays, more and more test and measurement equipment is connected to the local network. Monitoring this equipment is necessary to increase the overall instrument utilization, avoid downtimes and optimize costs.

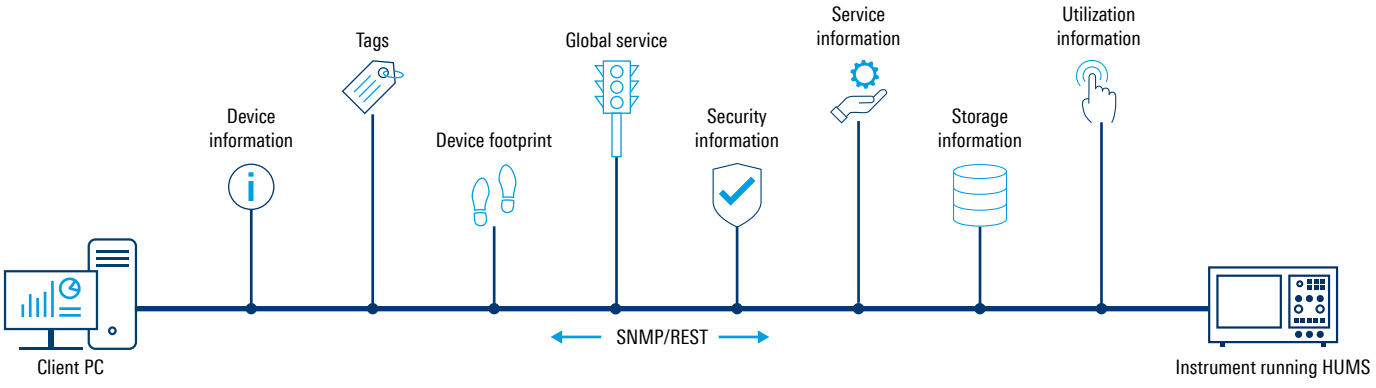
The FSW offers the optional R&S®FSW-K980 HUMS software option for easy monitoring of the instrument use, status and health.

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: ► 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	► 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	► Modulation depth (AM) ► Frequency deviation (FM) ► Phase deviation (φM) ► Modulation frequency ► THD and SINAD ► Carrier power	► AF spectrum ► RF spectrum ► AF scope display ► AF filters (lowpass and highpass) ► Weighting filters (CCITT) ► Squelch
R&S®FSW-K15 VOR/ILS measurements	VOR: ► 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: ► DDM, SDM ► 90 Hz/150 Hz AM modulation depth ► 90 Hz/150 Hz AM: frequency, K2, K3, THD, phase ► Identifier: modulation depth, frequency, code	► 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	► Group delay (absolute and relative) ► Magnitude ► Phase	► 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	► 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)	► 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	▶ Noise figure ▶ Noise temperature ▶ Gain ▶ Y factor	▶ 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	▶ SSB phase noise ▶ Residual FM and residual φM ▶ Jitter	▶ 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/ ▶ Signal tracking ▶ Optional suppression of spurious emissions
R&S®FSW-K50 Spurious measurements	▶ 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	▶ 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	▶ Disturbance voltage ▶ Disturbance power ▶ Disturbance radiation	▶ 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	▶ 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	▶ 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: ► 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)	► Eye diagram ► Constellation diagram ► Vector diagram ► Histogram ► Equalizer ► Multiple modulation formats, e.g. ► 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: ► 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	► 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/ Low Energy measurements	Output power	▶ Packet length ▶ Constellation ▶ Demod waveform ▶ Delta frequency ▶ Frequency drift ▶ ICFT	RF spectrum	RF envelope	▶ Automatic detection of packet type ▶ Symbols
R&S®FSW-K10 GSM/EDGE/ EDGE Evolution	Power measurement in time domain, including carrier power	▶ EVM ▶ Phase/frequency error ▶ Origin offset suppression ▶ Constellation diagram	▶ Modulation spectrum ▶ Transient spectrum	–	▶ Single burst and multiburst ▶ Automatic detection of modulation
R&S®FSW-K72/-K73 3GPP FDD (WCDMA)	▶ Code domain power ▶ Code domain power versus time ▶ CCDF	▶ 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)	▶ Spectrum mask ▶ ACLR ▶ Power measurement	▶ Channel table with channels used on base station ▶ Timing offset ▶ Power versus time	▶ Automatic detection of – Active channels and decoding of useful information – Encryption code – HSDPA modulation format ▶ Support of – Compressed mode signals – HSPA and HSPA+ (HSDPA+ and HSUPA+)
R&S®FSW-K76/-K77 TD-SCDMA	▶ Code domain power ▶ Code domain power versus time ▶ CCDF	▶ EVM ▶ Peak code domain error ▶ Constellation diagram ▶ I/Q offset ▶ Residual code domain error ▶ Gain imbalance ▶ Center frequency error (chip rate error)	▶ Spectrum mask ▶ ACLR ▶ Power measurement	▶ Channel table with channels used on base station ▶ Timing offset ▶ Power versus time	▶ Automatic detection of – Active channels and decoding of useful information – HSDPA modulation format ▶ Support of HSPA+ (HSDPA+ and HSUPA+)
R&S®FSW-K82/-K83 CDMA2000	▶ Carrier power ▶ Code domain power ▶ Code domain power versus time ▶ CCDF	▶ RHO ▶ EVM ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Center frequency error	▶ Spectrum mask ▶ ACLR ▶ Power measurement	▶ Channel table with channels used on base station ▶ Timing offset	▶ Automatic detection of active channels and decoding of useful information ▶ Robust demodulation algorithms for reliable measurement of multicarrier signals
R&S®FSW-K84/-K85 1xEV-DO	▶ Carrier power ▶ Code domain power ▶ Code domain power versus time ▶ CCDF	▶ 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	▶ Spectrum mask ▶ ACLR ▶ Power measurement	▶ Channel table with channels used on base station ▶ Timing offset	▶ 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-K91 WLAN IEEE 802.11a/b/g **R&S®FSW-K91P** WLAN IEEE 802.11p **R&S®FSW-K91N** WLAN IEEE 802.11n **R&S®FSW-K91AC** WLAN IEEE 802.11ac **R&S®FSW-K91AX** WLAN IEEE 802.11ax **R&S®FSW-K91BE** WLAN IEEE 802.11be	► Power versus time ► Burst power ► Crest factor	► 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	► Spectrum mask ► ACLR ► Power measurement ► Spectrum flatness	► Bitstream ► Signal field ► Constellation versus carrier	► Automatic detection of – Burst type – MCS index – Bandwidth – Guard interval ► Estimation of payload length from burst ► WLAN IEEE 802.11be PPDU formats: EHT MU PPDU, EHT trigger based PPDU
R&S®FSW-K95 WLAN IEEE 802.11ad	► Power versus time ► PPDU power ► Crest factor	► 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	► Spectrum mask ► Power spectrum ► Channel frequency response	► Header information ► Bitstream (encoded and decoded)	Automatic detection of: ► 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		► Bit error rate header ► Bit error rate payload	► Channel bonding 1-4, restricted by analysis bandwidth ► Automatic detection of – Guard interval – PPDU length ► Channel aggregation
R&S®FSW-K100/ -K101/-K104/-K105 EUTRA/LTE TDD and FDD UL and DL	► Power measurement in time and frequency domains ► CCDF	► EVM ► Constellation diagram ► I/Q offset ► Gain imbalance ► Quadrature error ► Center frequency error (symbol clock error)	► Spectrum mask ► ACLR ► Power measurement ► Spectrum flatness	► Bitstream ► Allocation summary list ► Averaging over multiple measurements	Automatic detection of modulation, cyclic prefix length and cell ID
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

Measurement application/ technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K103 EUTRA/ LTE-Advanced UL			▶ 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	▶ EVM ▶ Constellation diagram ▶ Frequency error ▶ Sampling error	Spectrum flatness, ACLR, SEM	Allocation summary list	▶ Standalone, guard band and in-Band operation ▶ Automatic detection of cell ID
R&S®FSW-K118 Verizon 5GTF downlink	▶ Power versus time ▶ CCDF	▶ EVM ▶ EVM xPDSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error		▶ Allocation summary ▶ Multicarrier filter	Automatic detection of cell ID
R&S®FSW-K119 Verizon 5GTF uplink	▶ Power versus time ▶ CCDF	▶ EVM ▶ EVM xPUSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error		▶ Allocation summary ▶ Multicarrier filter	
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	Power versus time	▶ EVM ▶ EVM xPDSCH ▶ Constellation diagram ▶ I/Q offset ▶ I/Q imbalance ▶ Gain imbalance ▶ Center frequency error	▶ ACLR ▶ SEMI	▶ Allocation summary ▶ Channel table with channels used on base station	▶ Automatic detection of cell ID ▶ Support of multiple bandwidth parts

WIDE RANGE OF MEASUREMENT APPLICATIONS

Measurement application/ technology	Power	Modulation quality	Spectrum measurements	Miscellaneous	Special features
R&S®FSW-K149 High rate pulse repetition frequency ultrawideband measurements	► PPDU power ► SHR power ► Power versus time	► 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)	► Packet spectrum ► PSD mask	► 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, A0A1, payload (via SCPI))	► Automatic detection of preamble information ► Support of all UWB channels and bandwidths
R&S®FSW-K201 OneWeb reverse link measurement application	► Power measurement in time and frequency domains ► CCDF	► EVM ► Constellation diagram ► I/Q offset ► Gain imbalance ► Quadrature error ► Center frequency error (symbol clock error)	► Spectrum mask ► ACLR ► Power measurement ► Spectrum flatness		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	► Power ► Power versus time ► Power versus symbol × carrier	► MER versus carrier ► MER versus symbol ► MER versus symbol × carrier ► MER (pilot, data) ► Constellation diagram ► Center frequency error ► Symbol clock error ► Group delay	► Power measurement ► Spectrum flatness	Decoding: ► LDPC BER ► LDPC CWER ► Trigger to frame	Automatic detection of: ► Cyclic prefix ► Rolloff ► PLC start index ► Continuous pilots ► NCP ► Profile A ► N_{FFT}
R&S®FSW-K193 DOCSIS 3.1 upstream	► Power ► Power versus time ► Power versus symbol × carrier	► MER versus carrier ► MER versus symbol ► MER versus symbol × carrier ► MER (pilot, data) ► Constellation diagram ► Center frequency error ► Symbol clock error ► Group delay	► Power spectrum ► Power versus carrier (synchronous ACP) ► Spectrum flatness	► Individual results for frame objects ► Trigger to frame	Automatic detection of: ► Cyclic prefix ► Rolloff

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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