Тестовый приемник
FSWT26

AT A GLANCE

Thanks to its digitally implemented measurement bandwidth of up to 500 MHz and its very high sensitivity, the R&S®FSWT fulfills the requirements for a TEMPEST measuring receiver. The intuitive, straightforward operating concept enables users to accomplish measurement tasks quickly and easily.

The R&S®FSWT is the right T&M instrument for applications that require checking the information content of even the smallest signals. With two equivalent, switchable RF inputs, up to 500 MHz measurement and analysis bandwidth and two independently settable analog outputs for video voltage and demodulators, it fits perfectly into typical test setups and easily replaces older instruments. The R&S®FSWT can optionally be equipped with preselection and a preamplifier in the base unit (5 HU). Twenty-one switchable filters with very low insertion loss suppress even strong out-of-band signals. With the preamplifier, the noise figure at 100 MHz is only 1.5 dB. The test receiver measures and demodulates even weak signals reliably.

Thanks to its selection of measurement bandwidth and detectors, the R&S®FSWT is also used for EMI measurements in line with commercial and military standards.

All measurement bandwidths from 1 Hz to 500 MHz are digitally implemented with extremely high accuracy. Video voltage, IF, AM, FM and other signals are exactly reconstructed and fed to two analog outputs. The user observes the signals in parallel on an oscilloscope. Alternatively, the test receiver saves the acquired signal as I/Q data for offline analysis or streams the data to a recorder or a custom FGPA for further processing.
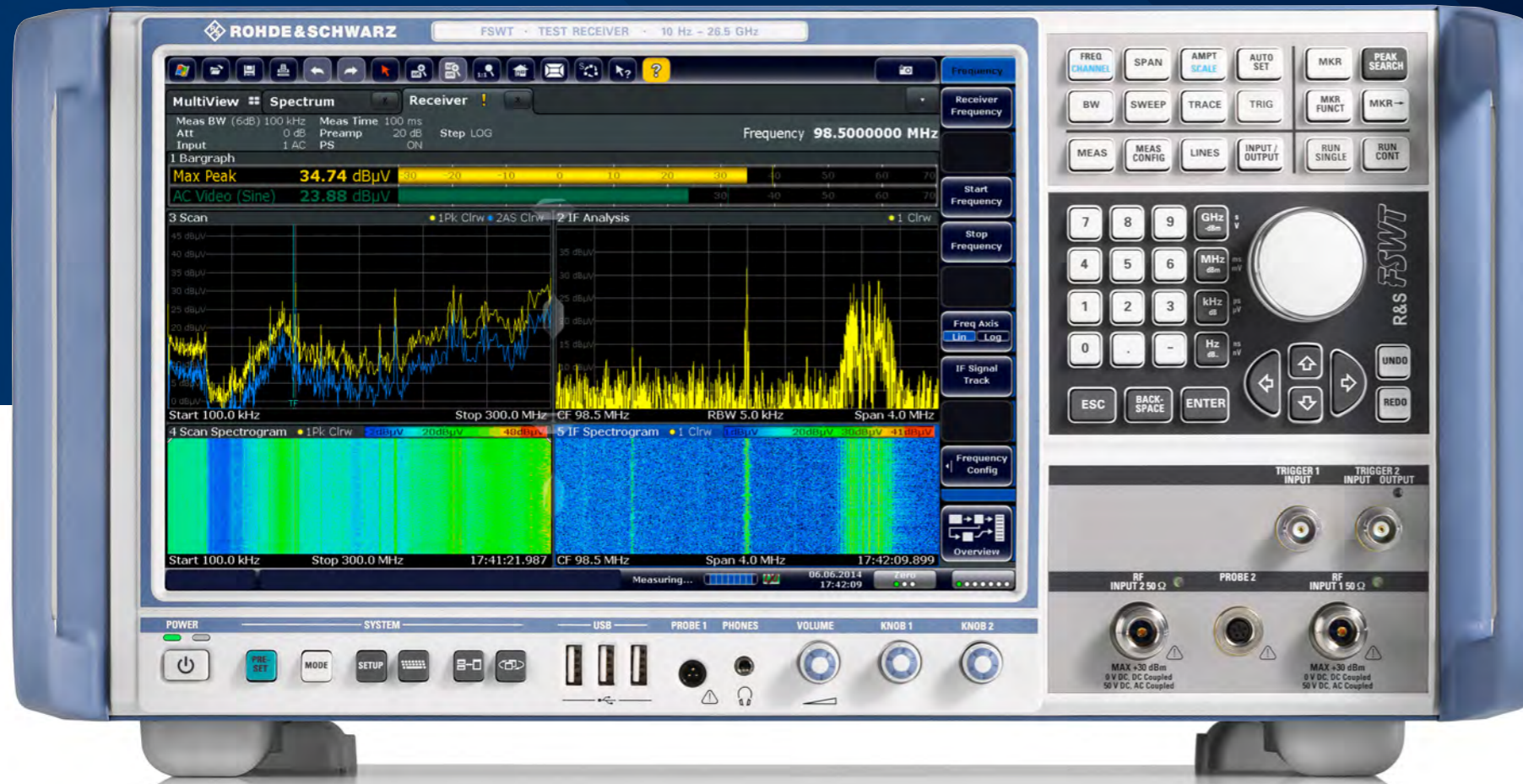
Optional measurement functions for digitally modulated signals keep the R&S®FSWT up-to-date for new requirements. Its large 12.1" touchscreen, clear diagrams and flat menus make the R&S®FSWT easy to operate; different measurements can be displayed simultaneously in separate windows. At a weight of up to 28 kg, the R&S®FSWT is easy to transport.

KEY FACTS

▶ Frequency range from 10 Hz to 26.5 GHz
▶ Low phase noise of −137 dBc (1 Hz) at 10 kHz from 1 GHz carrier
▶ Digital IF with signal analysis and measurement bandwidth of up to 500 MHz
▶ Two equivalent RF inputs
▶ Two settable analog outputs with 250 MHz bandwidth for video, demodulation, IF and I/Q
▶ Optional preselection and preamplifier in base unit
▶ Measuring receiver and spectrum analyzer in one instrument
▶ Optional video rastering function
▶ Optional vector signal analyzer and OFDM demodulator
▶ Real-time streaming of I/Q data with 500 MHz bandwidth
▶ < 0.4 dB total measurement uncertainty up to 8 GHz
▶ 12.1" (31 cm) touchscreen for convenient operation
▶ Simultaneous use and display of multiple measurement applications

BENEFITS

VERY HIGH SENSITIVITY EVEN DOWN TO LOWER FREQUENCY LIMIT

Its very high sensitivity allows the R&S®FSWT to maintain a sufficient offset from even low limit lines.

The R&S®FSWT achieves a noise figure of only 1.5 dB at 100 MHz receive frequency.

A direct signal path to the A/D converter reduces the inherent noise of the R&S®FSWT at up to 30 MHz receive frequency.

It also offers very good sensitivity in the audio and baseband frequency range and is by up to 20 dB better than conventional receivers and spectrum analyzers.

Receive frequency	Noise figure
100 MHz	1.5 dB
1 GHz	2.2 dB
2 GHz	2.9 dB
4 GHz	2.8 dB
7 GHz	3.7 dB
10 GHz	6 dB
15 GHz	6 dB
22 GHz	8 dB
26.5 GHz	10 dB

Noise figure for the various preamplifier stages
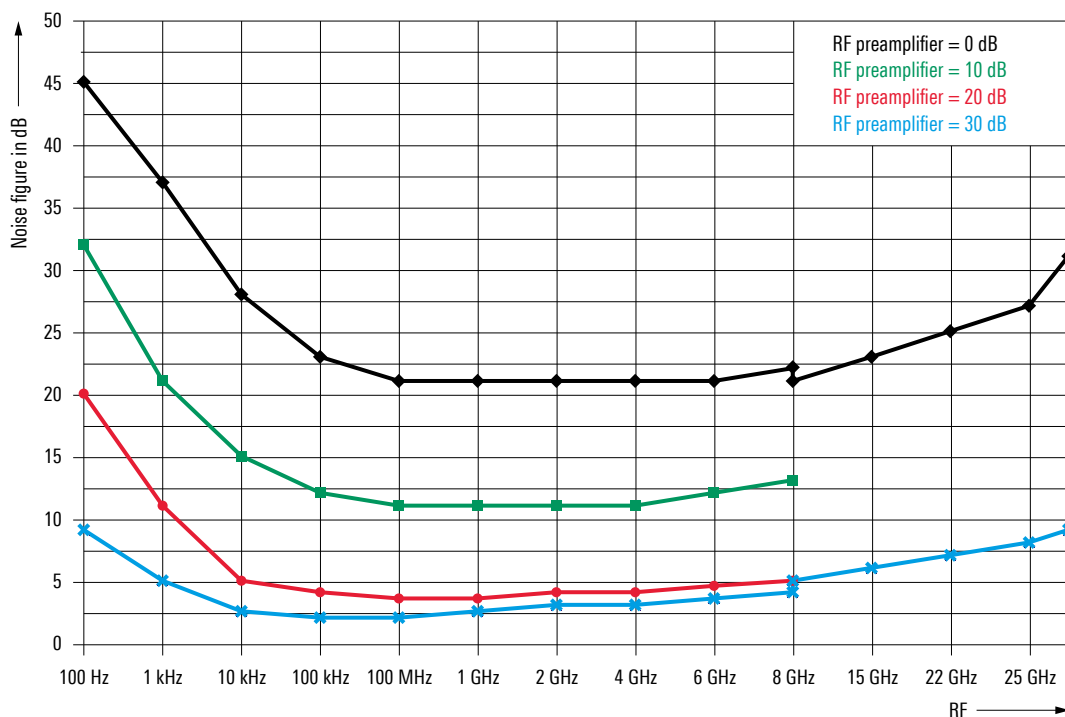
LOW PHASE NOISE

Low-level emissions must be analyzed even in the vicinity of strong signals. Only test receivers and analyzers with low phase noise, such as the R&S®FSWT, are up to the challenge.

The phase noise of the R&S®FSWT is more than 10 dB lower than that of previous instruments.

Carrier frequency	Phase noise	
Carrier offset	10 kHz	100 Hz
1 GHz	−137 dBc (1 Hz)	−110 dBc (1 Hz)
10 GHz	−128 dBc (1 Hz)	−90 dBc (1 Hz)

Comparison of phase noise at 1 MHz
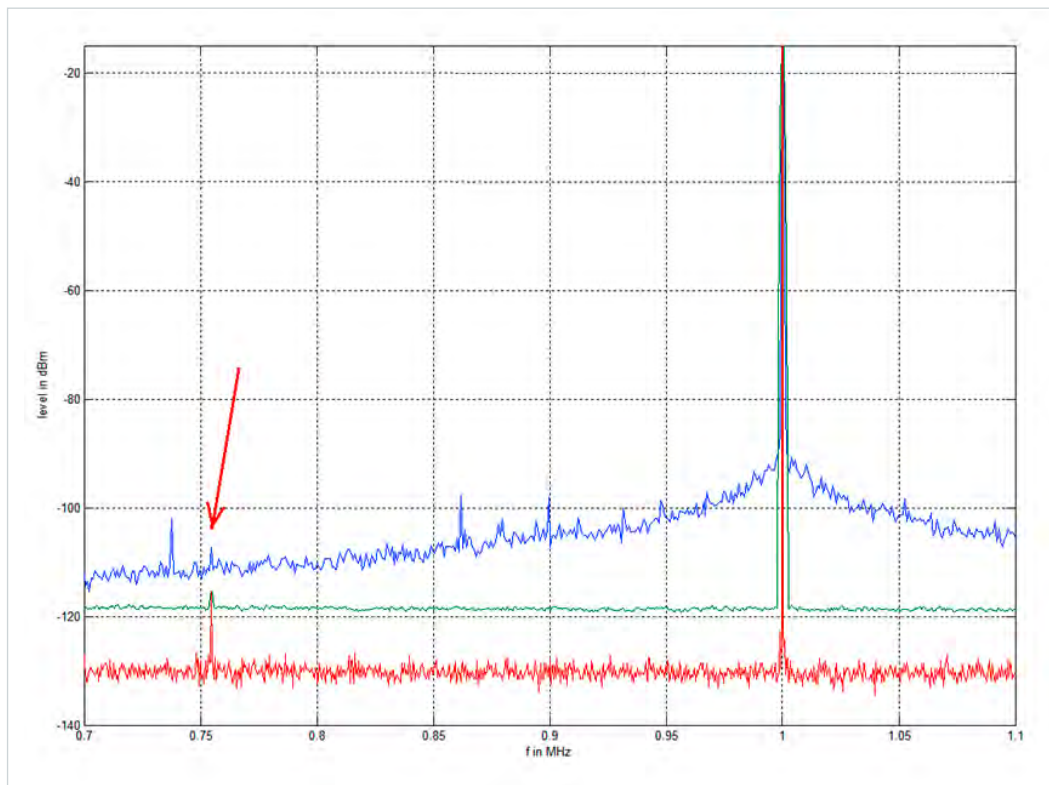
Blue: conventional analyzer with 10 kHz measurement bandwidth. Green: R&S®FSWT with 10 Hz measurement bandwidth.

Red: R&S®FSWT with 1 Hz measurement bandwidth.

The arrow points to a small signal that the R&S®FSWT can still display thanks to its low phase noise.

INTEGRATED PRESELECTION WITH PREAMPLIFIER

The optional preselection enables the R&S®FSWT to suppress strong out-of-band signals.

Unlike a spectrum analyzer, the R&S®FSWT maintains its very high sensitivity within the measurement bandwidth in these situations. The RF design places the preamplifier in the signal path after the preselector filters to prevent the preamplifier from being overloaded by strong out-of-band signals.

The receiver either activates the preselection automatically as needed for the current receive frequency, or the user sets the filters individually in a graphical dialog box.

Using the switchable preamplifier (10/20/30 dB gain), the R&S®FSWT achieves a sensitivity that is at the limits of the possible.

Dialog box for straightforward preselection and preamplifier setting
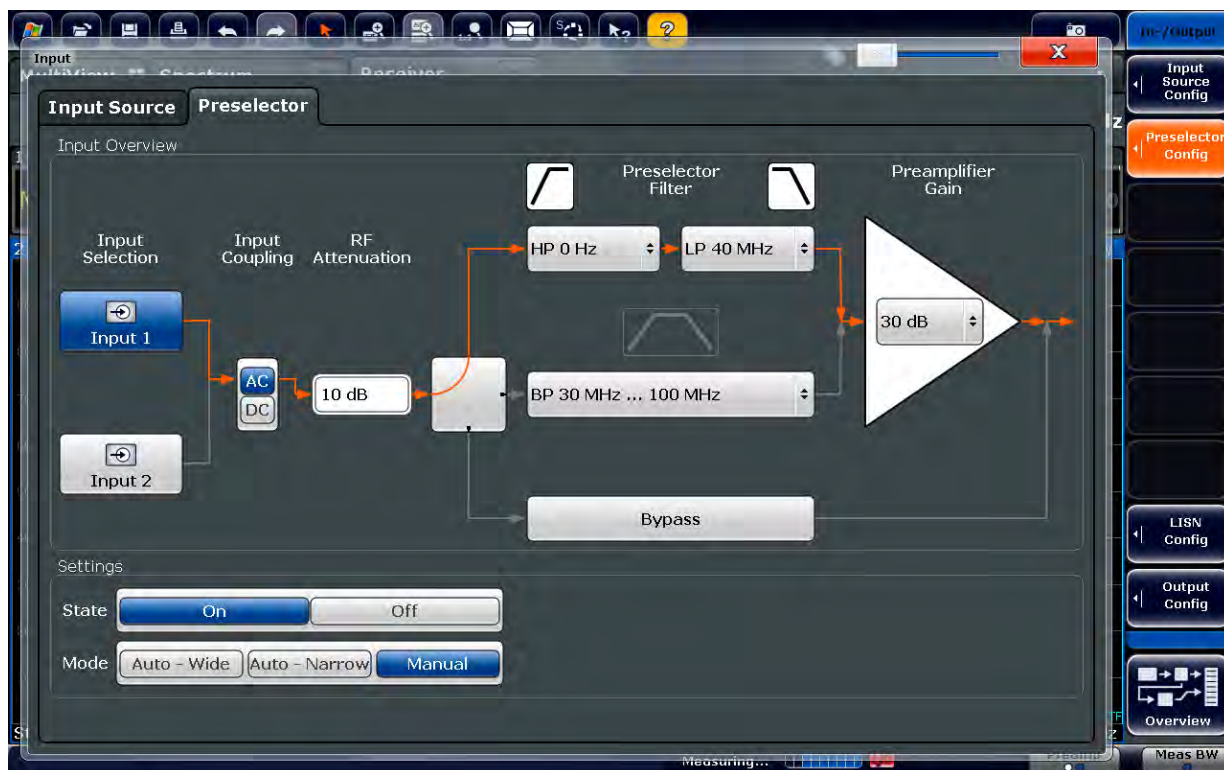
ANALOG OUTPUTS

The R&S®FSWT has two analog outputs that can be set independently of one another.

A typical test setup includes an oscilloscope, with which the user can observe the video voltage and attempt – through appropriate triggering – to estimate the information content in the measured emission.

Up to the maximum measurement bandwidth of 500 MHz, the two analog outputs continuously deliver a selection of the following signals:
▶ Video voltage
  – with linear scaling
  – with logarithmic scaling
▶ AC coupled video
▶ Power
▶ AM
▶ FM or PM
▶ IF
▶ I and Q

Rear panel of the R&S®FSWT with analog outputs
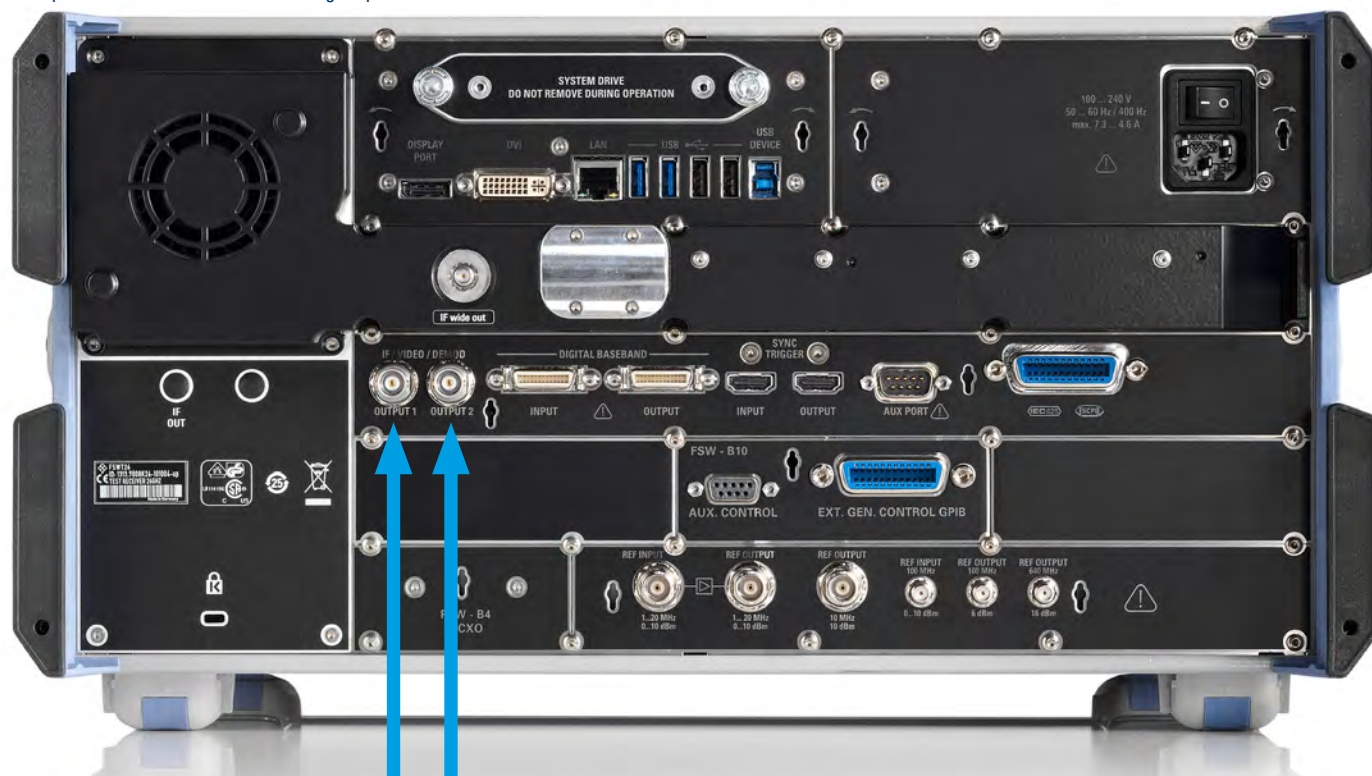
AUTOMATION

The automation of test sequences is gaining in significance over conventional manual measurement. The R&S®FSWT automatically scans preconfigured frequency bands. It then compares the results to limit lines and generates a list of the frequencies and levels of the signals that lie close to or over the limit line.

The R&S®FSWT-K53 FFT based scan option executes overview measurements much faster. The time savings may also be invested in a longer observation time to increase the probability of finding intermittent signals. The FFT is designed in line with the requirements of CISPR16-1-1 and MIL-STD-461 G. This avoids increased measurement uncertainties for CW and pulsed signals compared to the stepped scan.
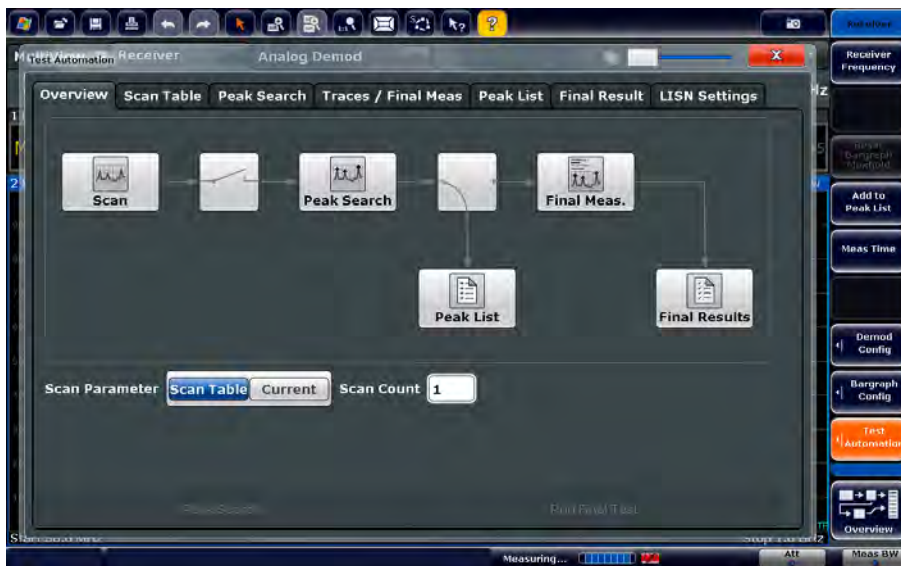
During the interactive final measurement, the receiver sets the detected frequencies sequentially, and the user evaluates the signals acoustically or by using the integrated analysis and measurement functions, such as analog demodulation. The R&S®FSWT accesses line impedance stabilization networks via a TTL port in order to check all phases automatically.

Its frequency range, selection of measurement bandwidths and sensitivity qualify the R&S®FSWT for EMI measurements in line with MIL-STD-461 and commercial standards.


Automation dialog box

Interactive final measurement with the option of more detailed investigation and evaluation of signals

APPLICATION FOR MEASURING ANALOG MODULATION MODES

The integrated measurement application demodulates AM, FM and φM. It shows the modulation versus time, the spectrum of the demodulated signal, the RF power versus time and the spectrum of the RF signal.

The analog demodulators use the full analysis bandwidth of 500 MHz. Users can couple instrument settings such as RF attenuation, preamplifier and measurement bandwidth to other measurement functions such as frequency scan and spectrum analysis, or they can configure them independently. This ensures the consistency of the instrument settings across different measurement functions and prevents invalid measurements.

Another very useful feature is coupled parameters. For example, if the user moves the marker to a signal of interest in the frequency scan, the analog demodulator will automatically set the marker frequency from the scan display as the new receive frequency in the analog demodulator.
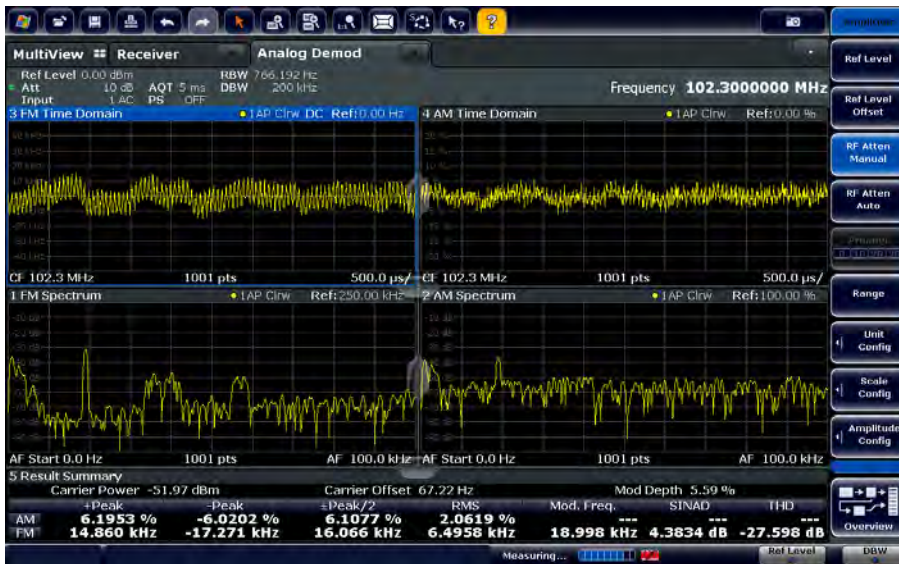
Analog demodulator with multiple result windows
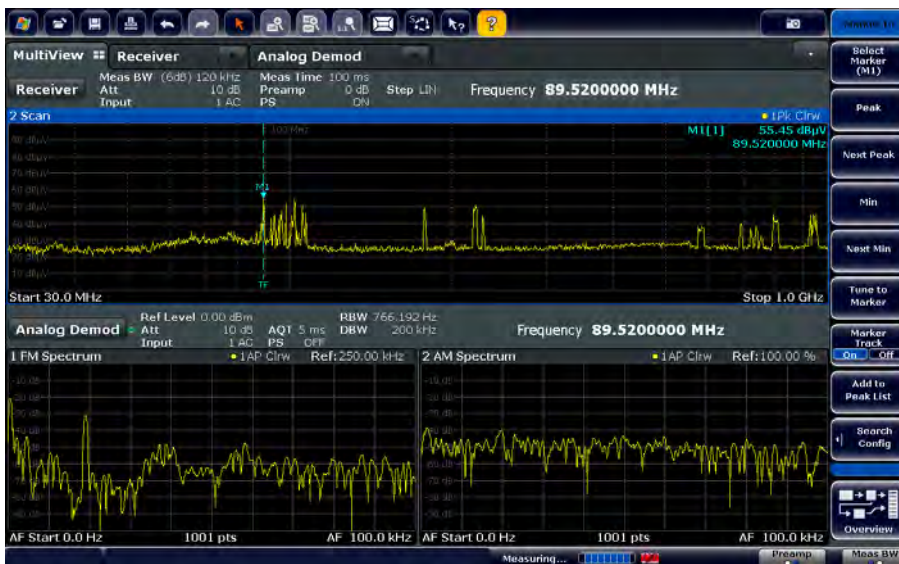
MultiView display: The marker for the previously measured frequency spectrum (top) is coupled with the receive frequency of the analog demodulator (bottom)

VECTOR SIGNAL ANALYSIS APPLICATION

The R&S®FSWT-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
▶ 500 MHz signal analysis bandwidth

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

Clearly structured block diagram display

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®FSWT-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).

Flexible analysis tools for detailed signal analysis make setup 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 analyses of the measurement and error signal considerably help users find signal errors such as incorrect filtering and spurious emissions
► Flexible burst search for analyzing complex signal combinations, short bursts and signal mixes – capabilities that go beyond the scope of many signal analyzers
► The equalizer helps users find the optimum filter design

AM modulation hidden in a QAM modulated signal
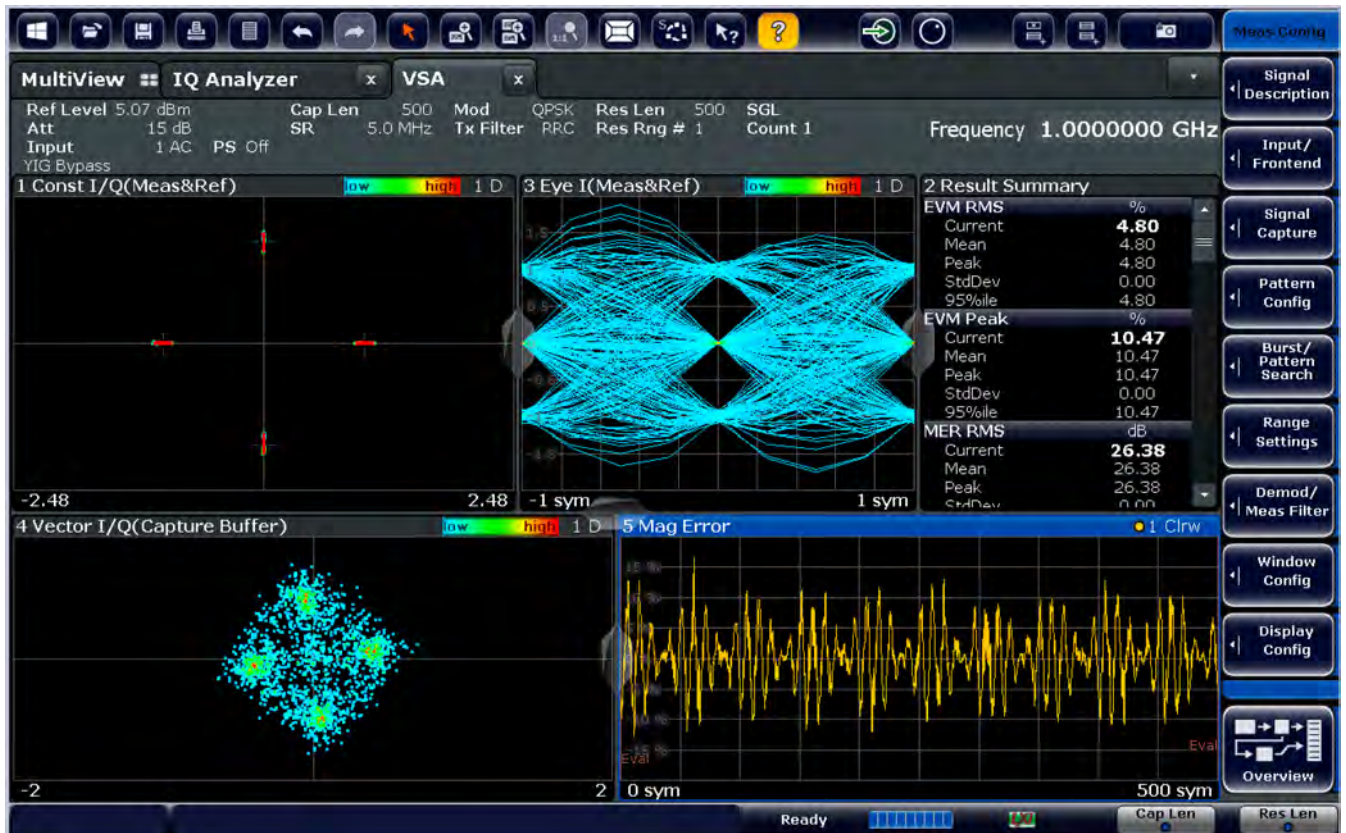
OFDM ANALYSIS

The R&S®FSWT-K96 OFDM analysis software makes it possible to perform modulation measurements on general OFDM signals. The OFDM demodulator is user-configurable and independent of standards.

The software analyzes OFDM signals that are either user-defined or compliant with standards such as IEEE 802.11a/g/n/ac (WLAN) and DVB-T. It also supports development engineers in analyzing proprietary signals in the initial phases of forthcoming OFDM standards. This includes the following:
▶ Wizard with a step-by-step guide for easy setup of the configuration file from a captured signal
▶ Support of OFDM and OFDMA
▶ Support of any PSK or QAM modulation format (up to 4096QAM)

User-configurable and independent of standards
The software offers a high degree of freedom regarding measurement parameters.

User-definable OFDM parameters
▶ General OFDM parameters such as signal bandwidth, sample rate, FFT length, cyclic prefix length
▶ Preamble structure
▶ Position of the pilots and data carriers
▶ Modulation format of the data carriers
▶ Flexible assignment of cyclic prefix length (e.g. for LTE)

Configuration file wizard for quick extraction of all necessary parameters from a signal
The integrated wizard guides users through the process of creating a configuration file that describes the OFDM system. It allows users to extract the necessary parameters directly from a signal recorded by the R&S®VSE-K96 software and creates a matching configuration file. At the same time, it visualizes the structure of the signal.

Demodulated OFDM signal with 2048 carriers, 64 QAM, QPSK pilot.
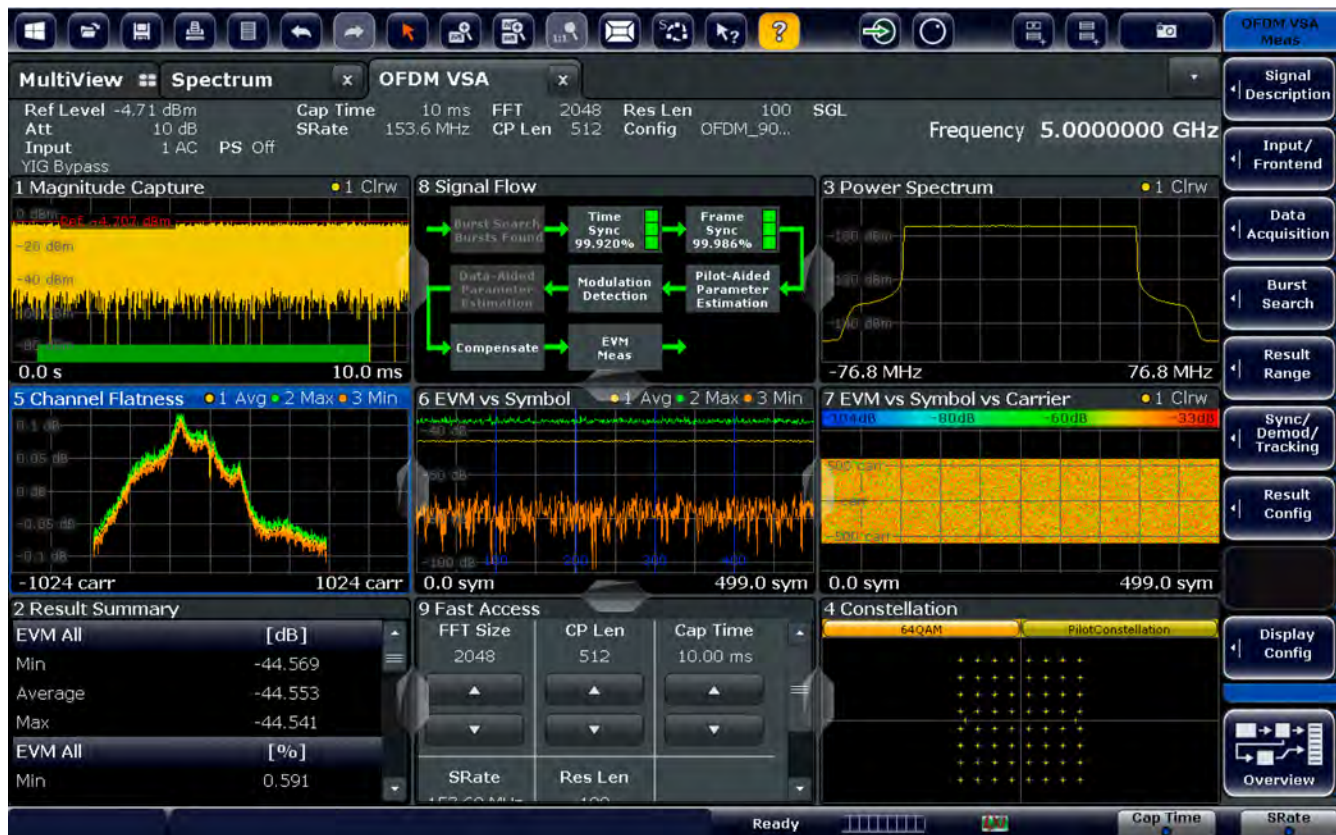
VIDEO RASTERING

PC monitors and video screens emit electromagnetic radiation, which may reveal the displayed content. The R&S®FSWT-K57 video raster option reconstructs this content on the screen of the R&S®FSWT.

The R&S®FSWT-K57 video raster option is a software application. It runs on the R&S®FSWT and is activated by keycode. There is no need for any additional external devices.

Key facts of the R&S®FSWT-K57option
► Software application running on the receiver – no external PC needed
► Processing I/Q data without time-consuming transfer to an external PC
► Using the full sensitivity and dynamic range of the R&S®FSWT
► High-precision time trigger
► Correlation function to automatically detect line rate
► Locking function to maintain a stable display
► Averaging algorithm to get a clearer image

Reconstructed test pattern

POWERFUL ANALYSIS FUNCTIONS

The R&S®FSWT offers numerous analysis functions.

▶ The IF analysis function simplifies the manual adjustment of the receiver. The user always sees the position of the signal of interest

▶ Simultaneous display of up to four bargraph detectors and up to six traces in the scan window

▶ Test setup consisting of a combination of antenna factors (transducers) in defined frequency ranges. Antenna gain and cable loss, for example, are automatically included in the measurement result

▶ The user saves limit lines in a separate library on the instrument. The R&S®FSWT automatically compares the frequency scan to the assigned limit line and generates a list of the frequencies of interest

▶ The R&S®EMC32 measurement software can be used to remotely control the R&S®FSWT. The software measures spectra, offers extensive analysis functions and generates informative test reports

▶ Thanks to the integrated measurement bandwidths and detectors, the R&S®FSWT also makes EMC measurements possible in line with military and commercial standards

▶ By adding the optional external generator control, the R&S®FSWT can be combined with a signal generator to form a simple scalar network analyzer, e.g. for checking cables and filters

IF analysis with spectrogram. The receiver is always tuned to the center of the displayed spectrum.
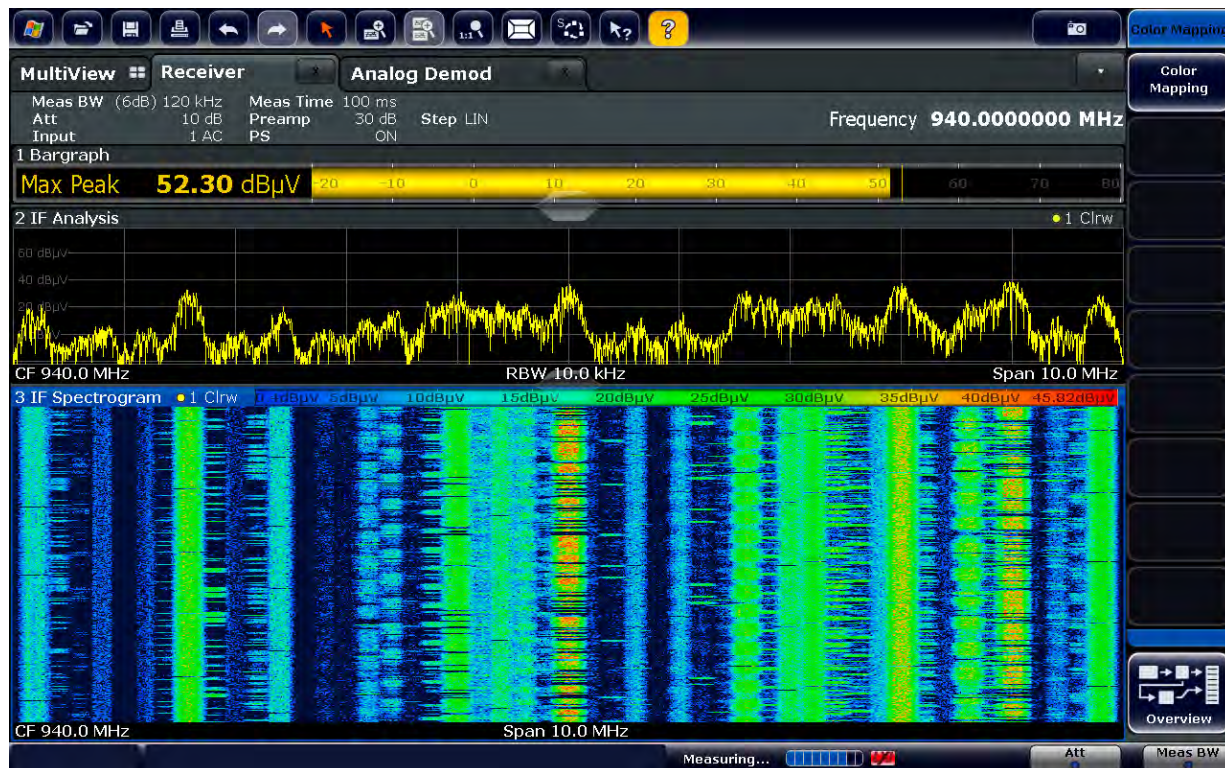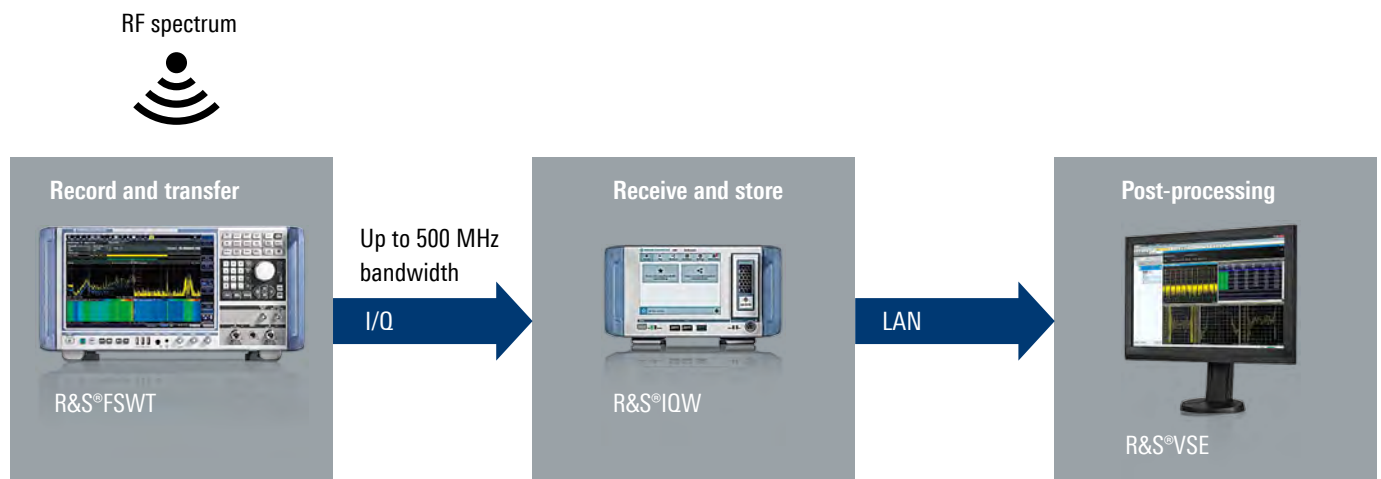
REAL-TIME STREAMING OF I/Q DATA

The R&S®FSWT26 provides two optional interfaces to seamlessly stream I/Q data in real-time.

The first interface (TVR290 standard)
gives access to the raw data of the 16-bit digital to analog converter with a maximum sample rate of 100 MHz. The second interface (QSFP+) provides data up to a sample rate of 600 MHz from the 12-bit analog to digital converter.

The R&S®IQW is a data recorder that directly connects to the R&S®FSWT (which is equipped with the FSWT-B517 option) and stores the measurement data. The R&S®VSE vector signal explorer software is the right tool for in-depth post-analysis (see figure below).

The most flexible solution for analyzing I/Q data is the optional R&S®FSWT-K552 custom digital baseband connection in combination with the R&S®FSWT-B517 wideband streaming interface. An external FPGA board supplied by the user and operated in an external PC is connected via QSFP+ to the R&S®FSWT.
supplies the IP core needed to set up the connection. The FPGA code to analyze the data is developed by the user to their specific demands without interaction or knowledge on the part of .

R&S®FSWT-B517 use case

RF spectrum

Record and transfer	Receive and store	Post-processing
R&S®FSWT	R&S®IQW	R&S®VSE

Up to 500 MHz bandwidth

I/Q

LAN

CONVENIENT OPERATION – STRAIGHTFORWARD RESULT DISPLAY

Configuration, measurements and analysis are more intuitive than ever.

Optimized user interface to complete tasks quickly

The large rotary knob always controls the receive frequency, as long as no other data entry field is open. A small rotary knob adjusts the loudspeaker or headset volume. Two other small rotary knobs can be programmed to control user-defined instrument parameters, such as measurement bandwidth and RF attenuation. Even external multimedia controllers can be used by connecting their control elements to instrument functions. Signals of interest can be investigated manually by directly accessing the most important instrument settings.

Block diagrams reflecting the signal flow can be operated via the touchscreen, allowing the user to access all functions via straightforward dialogs. Consistent, flat menu structures make it easy for users to find their way around. For example, the preselection can be completely configured in a single dialog box. Dialog boxes are transparent so that the signal of interest is always visible. All frequently used control functions are assigned to hardkeys. The toolbar provides quick access to global functions such as zoom or save for measurement data and screen content.

MultiView: clear display of a variety of measurement results

The MultiView function enables the R&S®FSWT to clearly display multiple results simultaneously on its 12.1" touchscreen. For example, the R&S®FSWT can display the frequency spectrum in one measurement window, while a second measurement window can be used to analyze AM and FM modulation with different settings. Clicking a tab activates the associated measurement application.

The MultiView tab shows all active measurements simultaneously. The multichannel sequencer determines whether and how often all measurement windows are measured sequentially. The individual measurement applications can be run with independent instrument settings or with coupled parameters, such as measurement bandwidth or preamplifier settings. This permits nearly parallel processing of different measurement applications. Measuring signals at different frequencies and in different applications previously called for a time-consuming, step-by-step approach, i.e. measurements had to be performed one after the other. The new functionality now makes it possible to run different measurement applications virtually simultaneously and view all results at a glance.

SAFETY FIRST

Always up-to-date

The test receiver's firmware can be updated using a USB storage device or the LAN port. Free firmware updates can be downloaded from the internet.

Keeping measurement results confidential

The confidentiality of user-specific measurement results can be ensured by replacing the internal solid state disk (SSD) with a second, neutral SSD (R&S®FSWT-B18 option). The R&S®FSWT can then be sent in for calibration, repair or any other purpose without any confidential measurement data leaving the lab.

Instrument-specific adjustment data is maintained and stored in the instrument separately from and independently of user data. The SSD can be removed easily by undoing two screws at the rear of the instrument.

For more stringent security requirements, write protection for the SSD is also available (R&S®FSWT-K33 option). All write processes are buffered in RAM and deleted when the instrument is switched off.

To remove the SSD (white), undo the two screws
(photo shows similar instrument)

SPECIFICATIONS IN BRIEF

Specifications in brief			
Frequency range	R&S®FSWT26	10 Hz to 26.5 GHz	
Aging of frequency reference		1×10^{-7}/year	
	with R&S®FSW-B4 option	3×10^{-8}/year	
Measurement bandwidths			
	6 dB filter	1 Hz to 500 MHz	
	video filter	1 Hz to 500 MHz	
	I/Q demodulation bandwidth	500 MHz	
Noise figure with preamplifier	10 kHz < f < 1 GHz	< 4 dB	
	f < 8 GHz	< 6 dB	
	f < 26.5 GHz	< 12 dB	
Phase noise			
10 kHz offset from carrier	500 MHz carrier frequency	typ. –140 dBc (1 Hz)	
	1 GHz carrier frequency	typ. –137 dBc (1 Hz)	
	10 GHz carrier frequency	typ. –128 dBc (1 Hz)	
Third-order intercept (TOI)	f < 1 GHz	typ. +30 dBm	
	f < 3 GHz	typ. +25 dBm	
	f < 8 GHz	typ. +20 dBm	
	f > 8 GHz	typ. +15 dBm	
Total measurement uncertainty	f < 8 GHz	0.37 dB	
Analog outputs			
Bandwidth	IF	200 MHz	
	video	250 MHz	
	AM, FM, φM	500 MHz	
Analog measurement demodulator	demodulation modes	AM, FM, φM	
	demodulation bandwidth	100 Hz to 500 MHz	
	analysis displays	modulation versus time, modulation spectrum, RF spectrum	
Number of sweep points	analyzer	selectable from 101 to 100 001, max. 1 000 001 in zero span	
	receiver	max. 4 000 000	
Detectors	receiver	max. peak, min. peak, RMS, average, AC video (pulse), AC video (sine)	

ORDERING INFORMATION

Designation	Type	Order No.
Base unit		
Test receiver, 10 Hz to 26 GHz	R&S®FSWT26	1313.7008K26
Hardware options		
OCXO precision reference frequency	R&S®FSW-B4	1313.0703.02
External generator control	R&S®FSW-B10	1313.1622.02
Digital baseband interface	R&S®FSWT-B17	1325.2470.02
Digital I/Q 40G streaming interface	R&S®FSWT-B517	1338.6305.02
Spare solid state disk (removable hard disk)	R&S®FSWT-B18	1322.9874.02
RF preamplifier, 100 kHz to 26.5 GHz	R&S®FSWT-B23	1321.6113.26
RF preselection and RF preamplifier, 100 kHz to 26.5 GHz	R&S®FSWT-B223	1321.6142.26
Software options		
USB mass memory, with write protection	R&S®FSW-B33	1313.3602.02
SSD write protection	R&S®FSWT-K33	1325.2487.02
FFT scan	R&S®FSWT-K53	1338.6292.02
Video rastering	R&S®FSWT-K57	1338.4725.02
Vector signal analysis	R&S®FSWT-K70	1338.7560.02
Multi-modulation analysis [1]	R&S®FSWT-K70M	1350.5970.02
BER PRBS measurements [1]	R&S®FSWT-K70P	1350.5986.02
OFDM demodulator	R&S®FSWT-K96	1338.7576.02
Custom digital baseband connection	R&S®FSWT-K552	1338.6311.02
External software		
Base software (requires R&S®FSPC)	R&S®VSE	1320.7500.06
Vector signal analysis (requires R&S®VSE and R&S®FSPC)	R&S®VSE-K70	1320.7522.06
External accessories		
Low-noise active antenna system	R&S®AM524	4015.7001.02

Warranty		
Base unit		3 years
All other items [2]		1 year
Options		
Extended warranty, one year	R&S®WE1	
Extended warranty, two years	R&S®WE2	
Extended warranty with calibration coverage, one year	R&S®CW1	Please contact your local sales office.
Extended warranty with calibration coverage, two years	R&S®CW2	
Extended warranty with accredited calibration coverage, one year	R&S®AW1	
Extended warranty with accredited calibration coverage, two years	R&S®AW2	