R&S®FSWT

Test Receiver

TEMPEST measuring receiver with digital signal evaluation
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 permits 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 preamplifier in the base unit (5 HU). Twenty-one switchable filters with very low insertion loss suppress even strong out-of-band signals. With 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 by two digital/analog converters and fed to two analog outputs. The outputs are configured independently of the other instrument settings; the user observes the signals in parallel on an oscilloscope. Alternatively, the test receiver can save the I/Q data for offline analysis, in which case it transmits the data via the remote control interface to a PC for further processing.

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. This considerably facilitates on-site measurements, e.g. on ships.

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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
- Vector signal analyzer function with external R&S®VSE software
- < 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
R&S®FSWT
Test Receiver
Benefits and key features

Very high sensitivity even down to lower frequency limit
- Noise figure only 1.5 dB at 100 MHz
- < 0.4 dB total measurement uncertainty up to 8 GHz
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Low phase noise
- Low phase noise of –137 dBc (1 Hz) at 10 kHz from 1 GHz carrier
- 10 dB lower phase noise than previous instruments
▷ page 5

Integrated preselection with preamplifier
- Optional preselection and preamplifier in base unit
- Sensitivity close to the limits of the possible
▷ page 6

Analog outputs
- Two settable analog outputs with 250 MHz bandwidth for
  - Video voltage with linear and logarithmic scaling
  - AC coupled video
  - Power
  - AM, FM or φM
  - IF
  - I and Q
▷ page 7

Automation
- Automatic scan of preconfigured frequency bands
- For EMI measurements in line with MIL-STD-461
▷ page 8

Application for measuring analog modulation modes
- Demodulation of AM, FM and φM
- 500 MHz analysis bandwidth
- Consistent instrument settings across all measurement functions
▷ page 9

Vector signal analysis
- Flexible modulation analysis from MSK to 4096QAM
- Numerous standard-specific default settings
- Easy operation with graphical support
- Flexible analysis tools for detailed signal analysis make troubleshooting really easy
▷ page 10

Powerful analysis functions
- Measuring receiver and spectrum analyzer in one box
- Simultaneous display of up to four bargraph detectors
- Simultaneous use and display of multiple measurement applications
▷ page 11

Convenient operation – straightforward result display
- Configuration, measurements and analysis more intuitive than ever
  - Optimized user interface to complete tasks quickly
  - MultiView: clear display of a variety of measurement results
▷ page 12

Safety first
- Always up-to-date
- Keeping measurement results confidential
▷ page 13
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. When equipped with the optional preamplifier, for example, 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.

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<tr>
<th>Receive frequency</th>
<th>Noise figure</th>
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<tr>
<td>100 MHz</td>
<td>1.5 dB</td>
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<tr>
<td>1 GHz</td>
<td>2.2 dB</td>
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<td>2 GHz</td>
<td>2.9 dB</td>
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<td>4 GHz</td>
<td>2.8 dB</td>
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<td>7 GHz</td>
<td>3.7 dB</td>
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<td>10 GHz</td>
<td>6 dB</td>
</tr>
<tr>
<td>15 GHz</td>
<td>6 dB</td>
</tr>
<tr>
<td>22 GHz</td>
<td>8 dB</td>
</tr>
<tr>
<td>26.5 GHz</td>
<td>10 dB</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Carrier offset</th>
<th>10 kHz</th>
<th>100 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 GHz</td>
<td>–137 dBc (1 Hz)</td>
<td>–110 dBc (1 Hz)</td>
</tr>
<tr>
<td>10 GHz</td>
<td>–128 dBc (1 Hz)</td>
<td>–90 dBc (1 Hz)</td>
</tr>
</tbody>
</table>

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

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

The R&S®FSWT has two analog outputs that can be set independently of one another. Up to the maximum measurement bandwidth of 500 MHz, these 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

Analog outputs

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

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.
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 as the new receive frequency. This feature saves the user a lot of time during interactive measurements.
Vector signal analysis

The R&S®VSE-K70 option enables 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, 8FSK
  - MSK, GMSK, DMSK
  - BPSK, QPSK, offset QPSK, DQPSK, 8PSK, DBPSK, \(\pi/4\)-DQPSK, 3\(\pi/8\)-8PSK, 6\(\pi/8\)-DBPSK
  - 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM, 2048QAM, 4096QAM
  - 16APSK (DVB-S2), 32APSK (DVB-S2), 2ASK, 4ASK, \(\pi/4\)-16QAM (EDGE), \(\pi/4\)-8QAM (EDGE)

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

Easy operation with graphical support

The visualization of the demodulation stages and the associated settings is so clear that even beginners and infrequent users can find the correct settings. Based on the description of the signal to be analyzed (e.g. modulation format, continuous or with bursts, symbol rate, transmit filtering), the R&S®VSE-K70 option helps users quickly find useful settings.

Flexible analysis tools for detailed signal analysis make troubleshooting really easy

- Display choices for amplitude, frequency, phase, I/Q, eye diagram; amplitude, phase or frequency error; constellation or vector diagram
- Analysis of RF signals or analog and digital baseband signals
- Statistical evaluations
- Histogram representation
- 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 the analysis of complex signal combinations, short bursts or signal mix – capabilities that go beyond the scope of many signal analyzers
- Bit error calculation on known data sequences
- Equalizer helps in finding the optimum filter design

Demodulation of a 64QAM signal with frequency and group delay display of the equalizer together with numerical modulation accuracy results.
Powerful 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.
Convenient operation – straightforward result display

**Configuration, measurements and analysis 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, so that the user can 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 the associated tab activates the associated measurement application.

The MultiView tab simultaneously shows all active measurements. 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.
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.
# 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**: 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 100001, max. 1000001 in zero span
- **receiver**: max. 4000000

## Detectors
- **receiver**: max. peak, min. peak, RMS, average, AC video (pulse), AC video (sine)

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For data sheet, see PD 3607.0275.22 and www.rohde-schwarz.com
# Ordering information

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<th>Designation</th>
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<td><strong>Base unit</strong></td>
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<td>R&amp;S®FSWT26</td>
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## Warranty

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<td>Extended Warranty with Calibration Coverage, two years</td>
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About Rohde & Schwarz
The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radiomonitoring and radiolocation. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design
- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

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