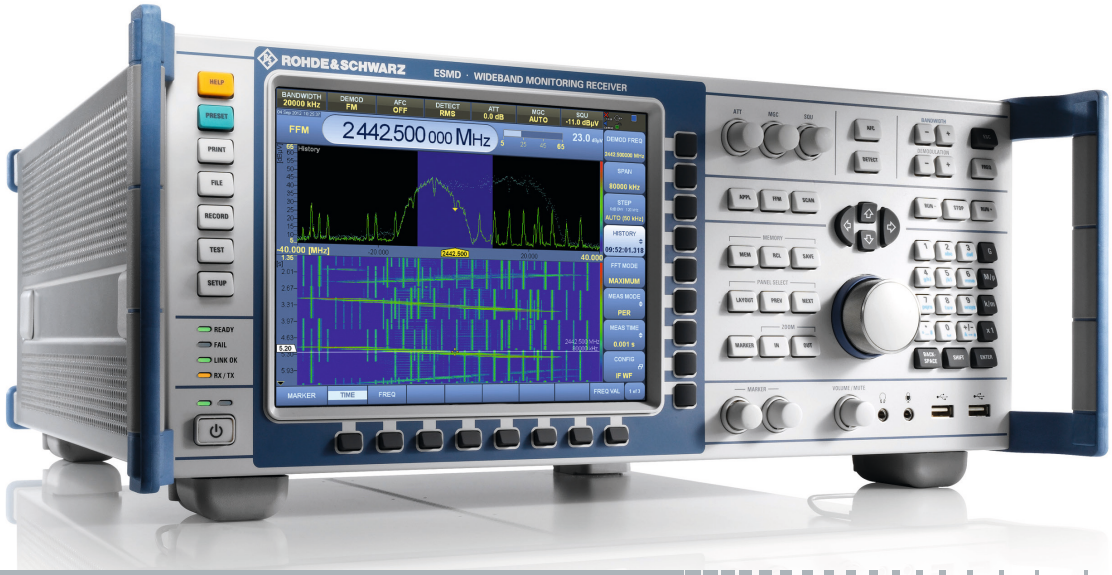
R&S®ESMD
Wideband Monitoring Receiver
Premium-class signal reception



ROHDE&SCHWARZ

Product Brochure | Version 10.01

R&S®ESMD Wideband Monitoring Receiver

At a glance

The R&S®ESMD wideband monitoring receiver was specially developed for signal search, radiomonitoring, radio detection and spectrum monitoring tasks. It performs ITU-compliant measurements and meets the requirements of security authorities and organizations. The receiver is ideal for both stationary and mobile/vehicular applications because it can be operated via the front panel or remotely controlled via LAN.

The R&S®ESMD features a wide frequency range (8 kHz to 40 GHz), outstanding receive characteristics, 80 MHz realtime bandwidth (base unit: 20 MHz) and a wealth of functions. Thanks to its sophisticated preselection stages, the receiver can be directly connected to a wideband monitoring antenna. This is an operating scenario that requires high large-signal immunity and high sensitivity, particularly in the presence of many strong signals.

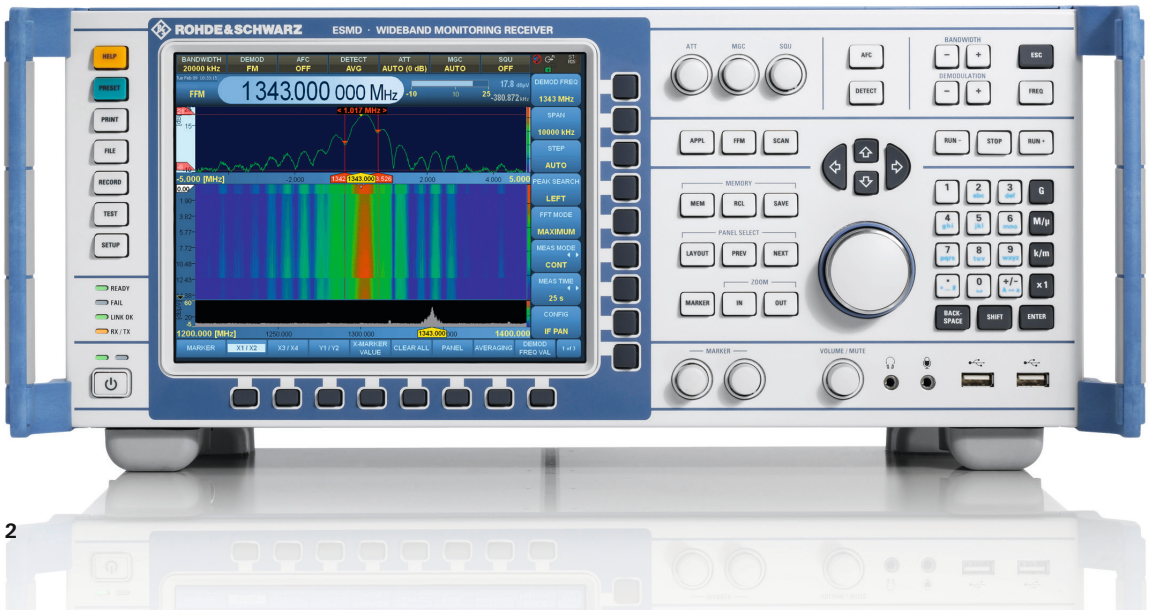
An upgrade kit is available to turn the monitoring receiver into a high-performance, single-channel direction finder.

Hardware-accelerated multichannel processing ensures data rate efficient transmission of up to 128 parallel channels via the 1 Gbit LAN interface (for example to a multichannel analysis system solution such as R&S®CA120).

All results are output via the receiver's LAN interface, including spectra (realtime operation and scan mode), waterfall (spectrogram), demodulated audio information, level measurement data and I/Q baseband data.

Key facts

- ITU-compliant measurements and applications for security authorities and organizations
- Wide frequency range: 8 kHz to 40 GHz (base unit: 20 MHz to 3.6 GHz)
- Up to 80 MHz realtime bandwidth (base unit: 20 MHz)
- Time domain analysis up to 20 MHz bandwidth
- Realtime event capture (REC) for I/Q recordings and realtime replay
- Various result displays
- Integration into customer-specific software packages from third-party suppliers thanks to open, documented remote control interface and data formats
- Internal recording and replay of spectra and waterfall data (for receivers with front panel operation or for external R&S®ESMD GUI software)
- Map display with GNSS position (for receivers with front panel operation or for external R&S®ESMD GUI software)



R&S®ESMD Wideband Monitoring Receiver

Applications

Nationwide networked system for ITU-compliant radiomonitoring

- Networking of radiomonitoring nodes of civil regulatory authorities, e.g. with R&S®ARGUS and suitable options
- Automatic identification of deviations between actual and predefined spectral values
- Guided measurements with R&S®ARGUS – even for inexperienced users
- Audio demodulation and processing

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Searching for interference sources in the air traffic control (ATC) band

- Fast detection and elimination of interfering signals to maintain security-critical aeronautical radiocommunications
- Monitoring of entire aeronautical radio band (approx. 20 MHz) within realtime spectrum
  - Easy detection of pulsed, frequency agile or sporadic interferers
- Audio monitoring of occupied channels to check audio transmission quality using the frequency scan

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Radiomonitoring for security authorities and organizations

- Networking of several receiving stations to create a temporary networked system, e.g. with R&S®RAMON and suitable options
- Multiple receiver concept: parallel search, detection and generation of content
- Central control station to ensure the operational success of security authorities and organizations

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Multichannel recording of security-critical voice communications

- Continuous recording of voice communications
  - Parallel transmission of up to 128 channels
  - 25 kHz/8.333 kHz bandwidth per channel (ATC band)
  - All parallel channels within receiver's realtime bandwidth
  - Data transmission using I/Q baseband data output on 1 Gbit LAN interface
  - AM demodulation and recording using a PC and software application, e.g. R&S®CA120 with suitable options
  - Recording of voice content as a digital audio file (*.wav)

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Signal analysis of a communications channel with unknown content

- Online signal analysis with live streaming over LAN interface, e.g. with R&S®CA100 and suitable options
  - Signal analysis and classification
  - Detection of modulation mode and transmission quality (eye diagram)
  - Extraction of signal content using bitstream analysis
- Offline signal analysis of recordings

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Interception of frequency hopping radios in tactical communications

- Neutralization (dehopping) of frequency hopping to protect against unwanted monitoring
- Complete documentation of I/Q baseband data stream
  - 80 MHz realtime bandwidth to cover the entire tactical communications band
  - Data transmission to recording medium via 10 Gbit LAN interface, e.g. with R&S®GX465
- Offline analysis of data stream, e.g. with R&S®GX410 and suitable options
  - Separation of different radios transmitting at the same time
  - Combination of individual frequency packets of the same radio (dehopping)

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Analysis of radar signals

- Determination of simple radar parameters using spectrum, waterfall and markers
  - Determination of center frequency, rotation time and pulse parameters
  - Measurement of signal level using wideband demodulation path
- Detailed analysis of radar parameters using the R&S®TPA technical pulse analysis software

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R&S®ESMD Wideband Monitoring Receiver

Benefits and key features

Frequency range from 8 kHz to 40 GHz

- One radiomonitoring receiver for "all" frequencies
- Base unit: 20 MHz to 3.6 GHz
  - R&S®ESMD-HF: option for HF signal reception down to 8 kHz
  - R&S®ESMD-SHF: option for SHF signal reception up to 26.5 GHz
- Same size, even with the above frequency options installed (19" width, 4 HU)
- R&S®MC40: external microwave downconverter for frequencies up to 40 GHz

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Integrated antenna switch

- Two separate inputs for HF (2) and VHF/UHF (3)
- One SHF input
- Automatic switching between antennas as a function of selected frequency, even during scanning
- Easy definition of antenna and cable parameters

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Powerful preselection: large-signal immunity and high sensitivity

- Reliable protection against overloading due to strong signals
- Outstanding sensitivity due to high-gain preamplifier stage
- Ideal monitoring receiver with wide dynamic range for all signal scenarios
- Smooth operation, e.g. with a wideband receiving antenna (responsible for high total signal load at receiver input)

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FFT signal processing with 80 MHz realtime bandwidth (base unit: 20 MHz)

- Realtime spectrum for detecting pulsed or frequency agile signals
- FFT signal processing for fine frequency resolution and high sensitivity
- FPGA implementation for top processing speed with fine resolution and sensitivity

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Extremely fast spectral scan (panorama scan) across entire frequency range

- Extremely fast FFT scan
- Fast spectrum overview with extremely fine resolution bandwidth
- Combination of spectral results and waterfall display
- Optimal determination of frequency range of interest from an unknown starting position

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Waterfall diagram for examination of signal history

- Three-dimensional display of spectrum over frequency, time and color-coded signal level
- History mode function to stop the waterfall and display a previous spectrum
- Outstanding visual presentation of pulsed or frequency agile signals
- Settable time resolution of waterfall (speed)

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Recording of spectra and waterfall data and replay of results

- Recording of spectra and waterfall data, e.g. on a USB flash drive
- Replay of recorded content for detailed evaluation of signals contained in spectrum
- Identical receiver and parameter settings in recording and replay modes
- For receivers with front panel operation or for external R&S®ESMD GUI software

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Map display with GNSS position

- Map display of current receiver location
- Selectable display of recorded results (e.g. spectra) relative to a position
- Map material based on OpenStreetMap (OSM)
- For receivers with front panel operation or for external R&S®ESMD GUI software

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Polychrome spectrum to distinguish superimposed, pulsed signals

- Display of time behavior (frequency of occurrence) of pulsed signals using color coding (for all realtime bandwidths)
- Settable occurrence frequency threshold
- Separate display of pulsed signals (superimposed in frequency, time and level)

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Video spectrum for display of subcarriers and transmission rates

- Spectrum display of demodulated signal
- Clear display of subcarriers, e.g. 19 kHz pilot tone
- Squared video spectrum to estimate the transmission rate (baud rate) of a digitally modulated signal
- Combination of spectral results and waterfall display

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Parallel signal processing of spectral path and demodulation path

- Two parallel signal processing paths for spectrum and demodulation
- Interference-free demodulation with parallel display of realtime spectrum and waterfall display
- Seamless I/Q baseband data stream for signal analysis
- Independent setting of bandwidth and center frequency

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Level measurements with "real" wideband detector

- Wideband level measurements up to 20 MHz bandwidth for sophisticated, digitally modulated signals

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Frequency scan and memory scan for audio demodulation on changing channels

- Frequency scan: continuous scanning of adjacent channels, automatic demodulation of channels where level exceeds squelch, e.g. in ATC band
- Memory scan: scanning of different radio services with variable step size and demodulation mode
- Convenient scanning for active signals and quick availability of audio content

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4+1 receivers in one instrument

- R&S®ESMD-DDC option: four additional demodulation channels
- Five software receivers in one instrument thanks to five demodulation channels (anywhere within realtime bandwidth)
- Output of demodulated data as separate data streams via LAN interface

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Time domain analysis up to 20 MHz bandwidth

- R&S®ESMD-ZS option: time domain analysis (zero span)
- Amplitude and instantaneous frequency display for detailed signal analysis
- Selection of a 20 MHz wide signal within the 80 MHz realtime bandwidth

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Open interfaces for remote control and data transmission

- Two 1 Gbit Ethernet LAN interfaces for receiver remote control and result processing using Rohde&Schwarz system software (e.g. R&S®ARGUS, R&S®RAMON, R&S®CA100)
- R&S®RX-10G option: retrofittable 10 Gbit Ethernet LAN interface
- Documented interface description for flexible programming and data processing, even with customer-specific software package

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Receiver remote control and data recording

- R&S®ESMD-Control software package for receiver remote control via 1 Gbit LAN interface
- Documentation of results on a PC (e.g. spectra or audio content), also for replaying recorded data for offline analysis

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Interfaces for up to 80 MHz wide I/Q data streaming

- R&S®ESMD-Control software package for receiver remote control via 1 Gbit LAN interface
- Documentation of results on a PC (e.g. spectra and audio content), also for replaying recorded data for offline analysis

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Multichannel signal detection and analysis in a networked system

- R&S®ESMD-SP option: hardware-accelerated multichannel processing of I/Q data streams via 1 Gbit LAN interface, e.g. for multichannel content recovery and detection of fixed frequency and frequency agile signals
- Further processing in a networked system, e.g. in combination with R&S®CA120 and suitable options
- Documented interface description for flexible programming and data processing, even with customer-specific software package

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ITU-compliant measurements in the receiver

- R&S®ESMD-IM option: ITU-compliant measurement of signal parameters for AM, FM and PM-modulated signals (e.g. modulation index, occupied bandwidth and phase deviation)
- Offline measurement of digitally modulated signals using the R&S®CA100IS software and suitable options (in line with ITU recommendation SM.1600)

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Detection of selective call services

- R&S®ESMD-SL option: detection of audio-based selective calls and listing of received selective call standards
- Result filtering in line with relevant standards

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DC operation (e.g. from vehicle battery)

- R&S®ESMD-DC option: DC power supply (12 V to 32 V DC)
- Space-saving vehicle installation

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System time synchronization using NTP server

- Time and date synchronization using an NTP server for simultaneous control of multiple receivers in a networked system
- Easy comparison of measurement results received by different stations

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TDOA ready with high-accuracy timestamps and GNSS synchronization of frequency and time

- R&S®ESMD-IGT2 option: synchronization of receiver frequency and time using internal GNSS module
- High-accuracy timestamps in I/Q baseband data stream, ideal for use in TDOA systems

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Recording and replaying of up to 80 MHz wide I/Q data

- Never miss an event: activation of recordings with flexible realtime event capture (REC)
- Signals as received from an antenna: all receiver functions available when replaying I/Q data
- Detailed display: replay of I/Q data with increased time resolution
- Realtime display of recorded data
- Bring RF to the lab: Stream wideband I/Q data to Rohde&Schwarz signal generators
- Use all functions with Rohde&Schwarz digital wideband storage devices

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Single-channel direction finder upgrade kit

- R&S®ESMD-DF option: upgrade to single-channel direction finder
- Direction finding of signals in frequency range up to 6 GHz
- Reliable DF results even in difficult environments (e.g. urban areas with up to 50 % reflection)
- Parallel direction finding of all emissions within 20 MHz realtime bandwidth

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Documentation of calibration values

- R&S®ESMD-DCV option: documentation of calibration values with calibration certificate from final production testing for a specific serial number
- Calibration label for instrument

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Nationwide networked system for ITU-compliant radiomonitoring

Networking of radiomonitoring nodes of civil regulatory authorities

To perform civil regulatory authorities' radiomonitoring tasks in line with ITU recommendations, all available receiving nodes must be networked. This includes both stationary and vehicular radiomonitoring stations. The R&S®ARGUS monitoring software is ideal for networking and remotely controlling nationwide radiomonitoring systems as well as small regional networks. Interference can be quickly and effectively located and eliminated, even in a frequency spectrum with steadily increasing occupancy (e.g. police radio, VHF radio, aeronautical radio, DECT, radio for security authorities and organizations, mobile phones and WLAN).

Continuous, networked monitoring is the only way to ensure smooth operations in dense radiocommunications traffic.

Automatic identification of deviations between actual and predefined spectral values

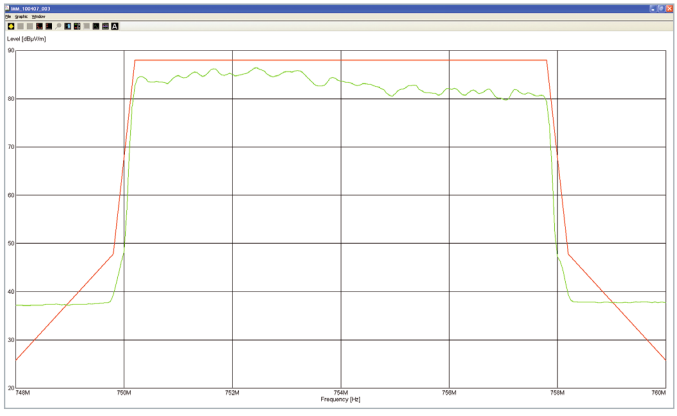
Deviations between actual spectral values and a predefined mask are automatically identified, allowing differences in the signal scenario to be quickly and conveniently detected. If one of the measurement parameters is outside the defined value range, the R&S®ARGUS software immediately generates an automatic alarm message. This type of user-friendly parameter identification is in line with ITU recommendations and can be used to identify interfering signals, detect unlicensed emissions, verify compliance with applicable licenses and much more.

Guided measurements with R&S®ARGUS – even for inexperienced users

One notable R&S®ARGUS feature is the "guided measurement" function. The user selects a measurement task (e.g. measurement of field strength or occupied bandwidth), and R&S®ARGUS automatically configures the appropriate parameters of the selected monitoring receiver. It also automatically selects the receiving antenna based on the selected frequency range and required polarization. This convenient function enables even inexperienced users to effectively operate the R&S®ESMD wideband monitoring receiver.

Audio demodulation and processing

Received and demodulated audio content is recorded and can be output online over the operator workstation's loudspeakers to ensure that different stations are monitoring the same signal. The impact of interferers on traffic channels transmitting audio content is also documented.



Spectrum of a DVB-T transmitter with a mask overlay.

Searching for interference sources in the air traffic control (ATC) band

Fast detection and elimination of interfering signals to maintain security-critical aeronautical radiocommunications

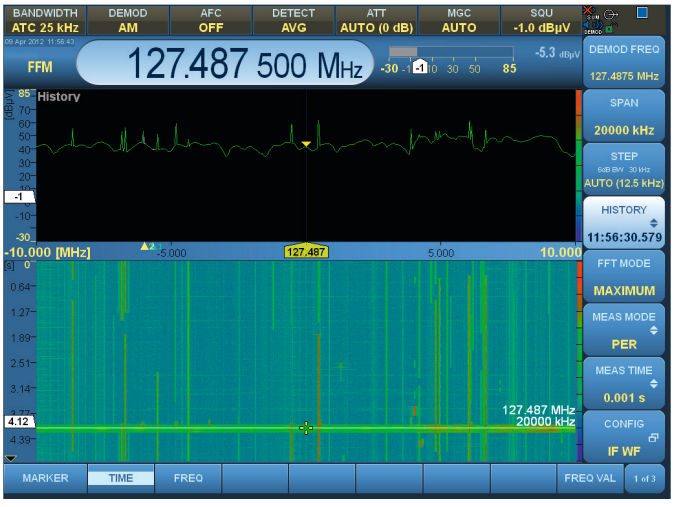
The ATC radio band contains all security-critical radiocommunications necessary to control national and international aircraft movements. Interference in this approx. 20 MHz wide frequency spectrum can quickly lead to critical situations. It is necessary to constantly monitor this frequency range in order to quickly detect and eliminate unauthorized emissions and wideband interference.

Monitoring of entire aeronautical radio band (approx. 20 MHz) within realtime spectrum

Thanks to its 20 MHz realtime processing, the R&S®ESMD is ideal for continuous monitoring of the ATC band. A combination of realtime spectrum and waterfall diagram allows users to easily detect even short-time emitters (e.g. PTT radios) and frequency agile signals (e.g. in frequency hopping modems). Sporadic wideband interference (e.g. caused by defective large format screens) is clearly displayed in the waterfall diagram, a fast and convenient way of showing the user where interference is causing problems.

Audio monitoring of occupied channels to check audio transmission quality using the frequency scan

The R&S®ESMD frequency scan constantly monitors all ATC channels for emissions. If channel occupancy is detected (level exceeds squelch), the receiver dwells on this channel for a preset period of time and outputs the demodulated audio information. This enables users to quickly and easily check if there is audible interference on one or more channels and initiate appropriate countermeasures.



Strong wideband interference is superimposed on the entire aeronautical radio band.

Radiomonitoring for security authorities and organizations

Networking of several receiving stations to create a temporary networked system

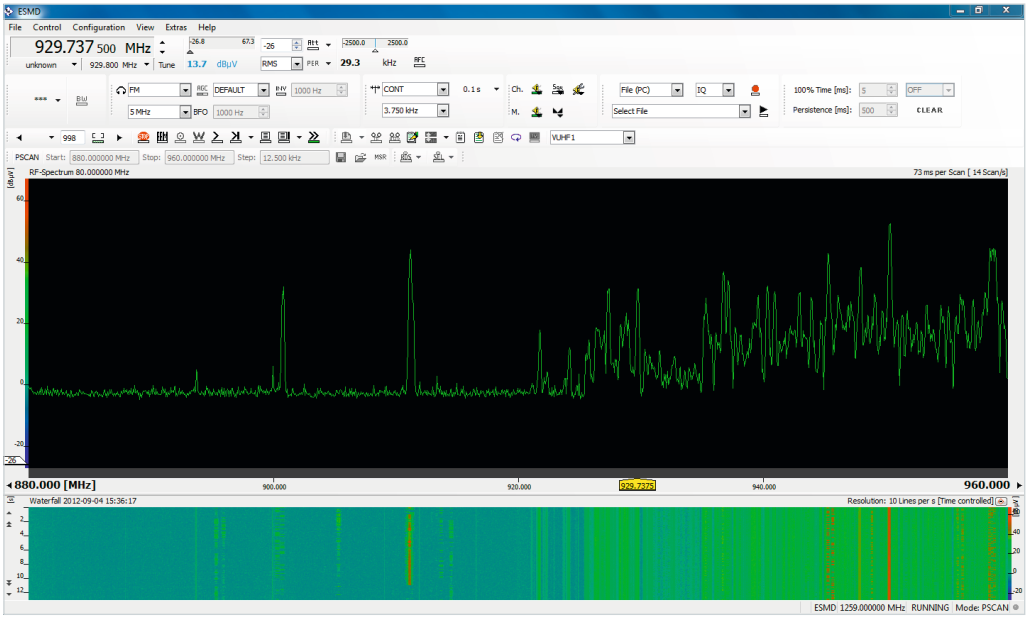
Monitoring station setups must be flexible in order to support local radiomonitoring tasks in both stationary and mobile applications. The R&S®RAMON radiomonitoring software was specially developed for networking receiving stations to create a temporary networked system. The software optimizes radiomonitoring of security-critical zones, for example by collecting spectra or demodulated audio content.

Multiple receiver concept: parallel search, detection and generation of content

In a typical system scenario, one or more fast search receivers are used to detect and display unknown emissions in the spectrum. If a receiver detects a signal of interest, R&S®RAMON passes it on to another receiver for demodulation and signal analysis. These receivers are operated in parallel in a networked system. As a result, the fast search receivers are not blocked by the time-consuming generation of data content. They are always available to search for new signals.

Central control station to ensure the operational success of security authorities and organizations

The R&S®RAMON software enables users to connect to different receiving nodes from a central control station. Depending on the operating scenario, users always receive information from the receiver that is closest to the signal source of interest. This is particularly important for security authorities and organizations because they often have to respond to changing transmitters.



Fast spectral scan of the GSM900 band with max. hold function and waterfall diagram.

Multichannel recording of security-critical voice communications

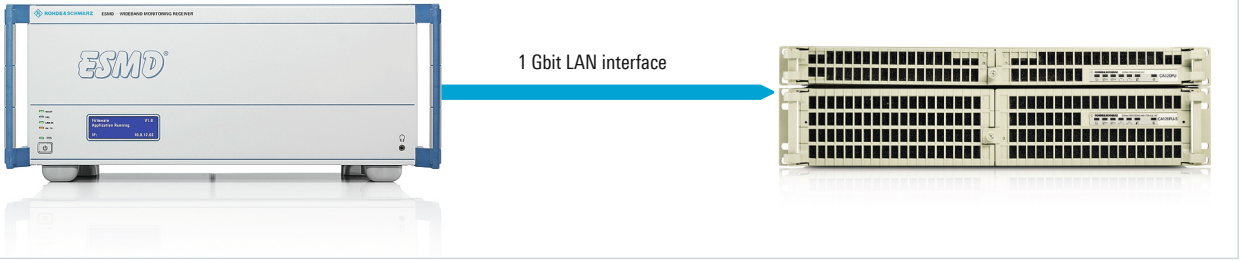
Continuous recording of voice communications

In many cases, it is useful to continuously record voice communications (e.g. aeronautical radiocommunications) for later use (e.g. for investigations after a plane crash). Spoken information is therefore constantly recorded. Since multiple channels are simultaneously occupied in the ATC band, all active channels must be demodulated and recorded in parallel.

Parallel transmission of up to 128 channels

The R&S®ESMD provides up to 128 parallel channels for the continuous recording of audio content (e.g. 25 kHz/8.333 kHz bandwidth per channel depending on the aeronautical radio bandwidth). All active channels are transmitted over the 1 Gbit LAN interface using I/Q baseband data. AM demodulation and recording of voice content as a *.wav file requires an external PC and additional software, such as the R&S®CA120 multichannel signal analysis software with appropriate options.

Parallel transmission of up to 128 channels to the R&S®CA120 multichannel signal analysis system



Signal analysis of a communications channel with unknown content

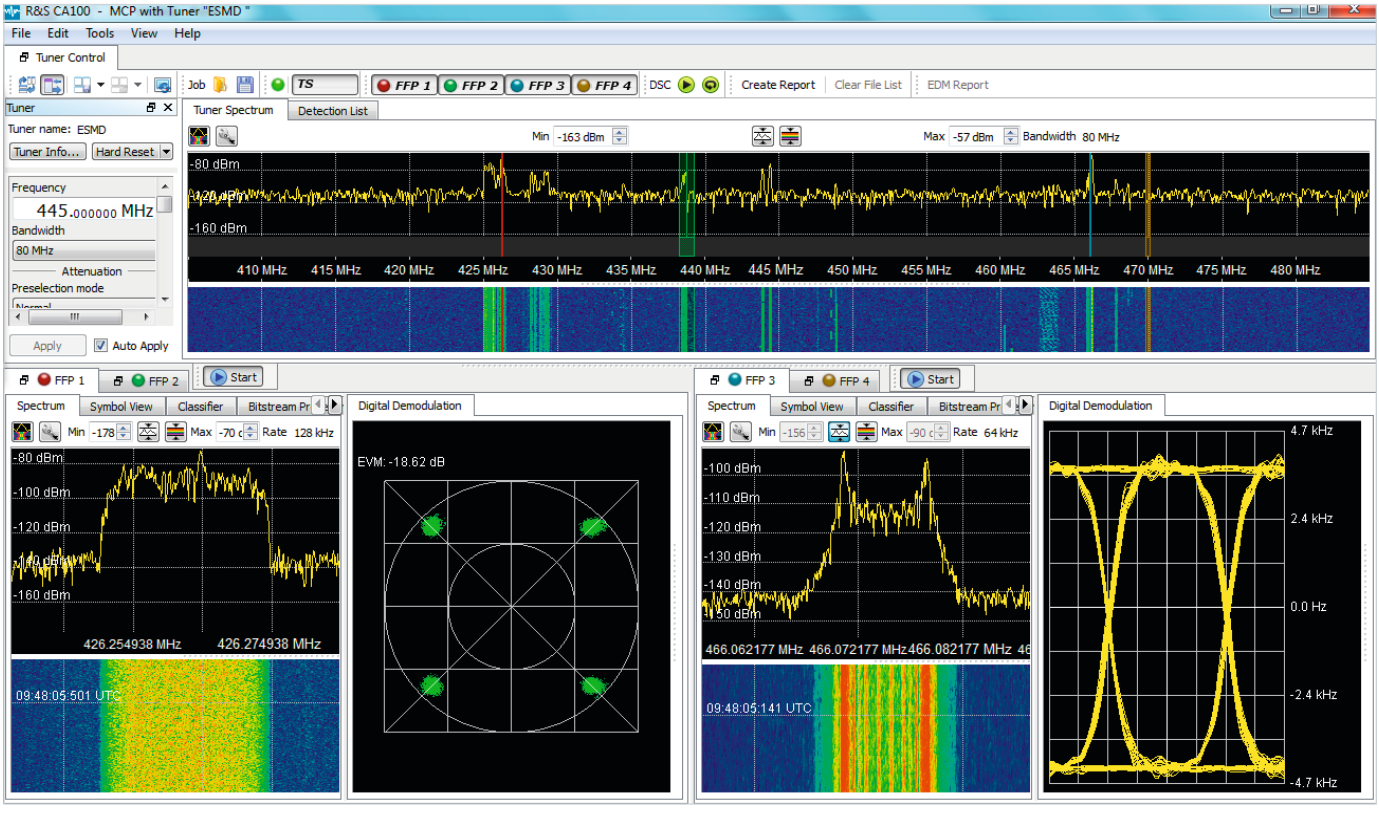
Online signal analysis with live streaming over LAN interface

The R&S®ESMD provides a continuous I/Q baseband data stream for online analysis of a max. 1 MHz signal channel over the 1 Gbit LAN interface. The R&S®CA100 software uses this data stream to analyze and classify the signal on an external PC. It recognizes modulation modes and displays transmission quality in an eye diagram, for example. Bitstream analysis allows users to extract the message content from the received signal.

If the wideband monitoring receiver is equipped with DDCs (R&S®ESMD-DDC option), the R&S®CA100 software can process up to four signals in parallel.

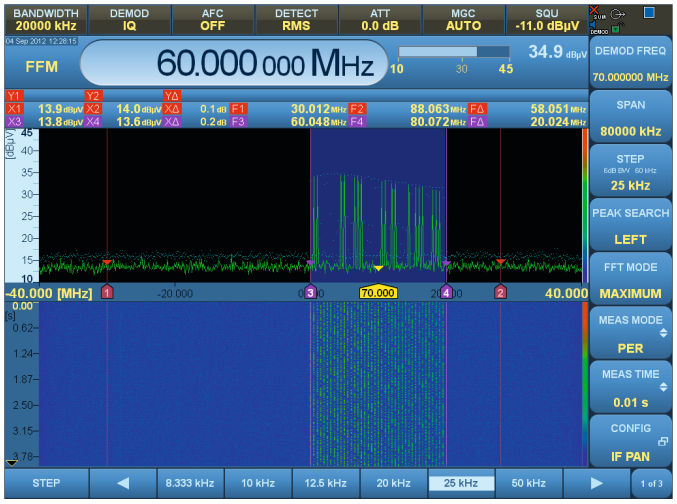
Offline signal analysis of recordings

The R&S®CA100 software can save data packets on a PC's hard disk for later detailed offline analysis. Complex signal forms are examined under different conditions to obtain more detailed analysis results.

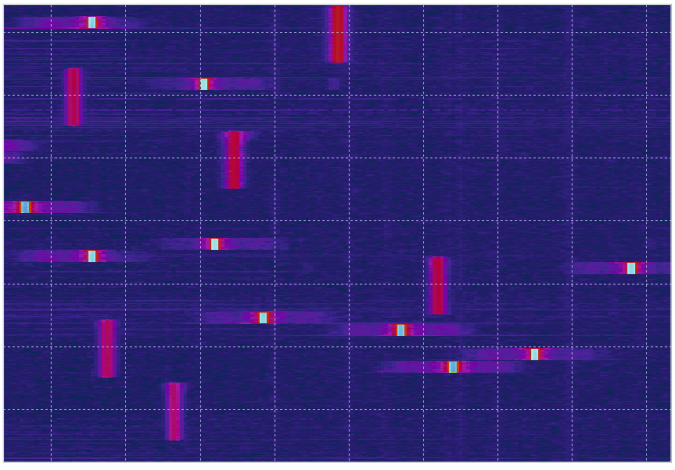


Online and offline signal analysis, from eye diagram to message content.

Interception of frequency hopping radios in tactical communications



Signal sequence of a frequency hopping radio: 2000 hops per second and 20 MHz hop bandwidth (coverage of the complete tactical band from 30 MHz to 88 MHz possible).



Detected burst signals from different emitters.

Neutralization (dehopping) of frequency hopping to protect against unwanted monitoring

Tactical radios often use frequency hopping (frequency hopping radios) to protect communications content against eavesdropping. Fast and practically random changing of the emission's center frequency makes it impossible for conventional radiomonitoring receivers to demodulate the emission content. As long as the frequency hops are within the R&S®ESMD receiver's realtime bandwidth, processing can take place offline using the I/Q baseband data stream and external software.

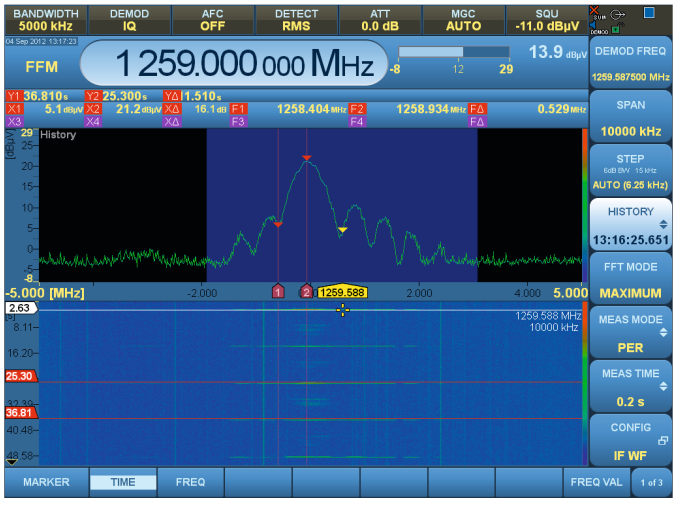
Complete documentation of I/Q baseband data stream

The R&S®ESMD I/Q baseband data stream of up to 80 MHz covers the entire tactical frequency band (approx. 60 MHz). All communications within this frequency range can be seamlessly fed to a recording medium. The R&S®GX465 digital wideband storage device records up to 80 MHz wide I/Q baseband data via the 10 Gbit LAN interface and provides the data packets for later offline analysis.

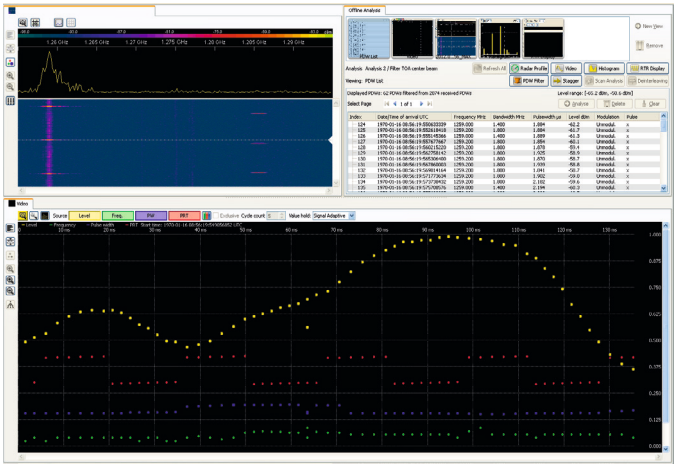
Offline analysis of data stream

During offline analysis, the information packets from different radios (transmitting at the same time) are sorted and put in the right time sequence (dehopping). After dehopping, the real transmitted information content in each radio data stream can be recovered. The data can be processed using signal analysis software such as R&S®GX410 R&S®AMLAB.

Analysis of radar signals



1259 MHz radar signal from Munich airport; determination of simple parameters using spectrum and waterfall.



Spectrum and waterfall display, list of detected pulses and intrapulse analysis scattergram of a selected radar signal.

Determination of simple radar parameters using spectrum, waterfall and markers

Simple radar signal measurements can be performed right on the R&S®ESMD receiver's front panel. Parameters such as the radar pulse center frequency are determined in the 80 MHz wide realtime spectrum; the signal power is measured with a wideband detector. With the appropriate span settings, pulse duration (determination of the first null in the spectrum) and pulse repetition rate (line spectrum) are determined using a marker. The speed of rotating radars (e.g. at airports) can be displayed in the waterfall diagram.

Detailed analysis of radar parameters using the R&S®TPA technical pulse analysis software

Radar signals can be analyzed in depth with the R&S®TPA technical pulse analysis software, which runs on a PC. The monitoring receiver is connected to the PC via the LAN interface. The radar signals are analyzed on the PC. The software includes the following functions, for example:

- Spectrograms with different time resolution to determine the radar's frequency agility and diversity
- Time domain analysis of the entire recording, selected parts of the recording or individual pulses
- Interpulse analysis to determine radar parameters such as pulse repetition rate, complex pulse sequence patterns and antenna rotation time

R&S®TPA detects pulses automatically and generates a list of pulse descriptor words (PDW) with the following parameters:

- Pulse center frequency
- Pulse bandwidth
- Time of arrival (TOA)
- Pulse duration
- Pulse repetition time (PRT)
- Amplitude
- Modulation flag (e.g. FMOP, PMOP, CW)
- I/Q data within pulse duration

This significantly reduces the data volume and speeds up parameter analysis by eliminating processing times. Parameters are displayed over time in the same diagram (pulse video).

Benefits and key features

Frequency range from 8 kHz to 40 GHz

Thanks to its wide frequency range (8 kHz to 26.5 GHz), the R&S®ESMD is the "receiver for all frequencies". The size of the R&S®ESMD (19" width, 4 HU) does not increase – even with all frequency options installed. The compact receiver can be placed on the desktop or installed in a 19" rack (e.g. for installation in vehicles).

The R&S®ESMD offers the following receiving frequency ranges:

- Base unit: 20 MHz to 3.6 GHz
- R&S®ESMD-HF option: 8 kHz to 32 MHz
- R&S®ESMD-SHF option: 3.6 GHz to 26.5 GHz

With the small size R&S®MC40 external microwave down-converter, the frequency range is increased up to 40 GHz.

Integrated antenna switch

Thanks to the integrated antenna switch, the receiver can be operated with multiple antennas. The following antenna inputs are available on the receiver's rear panel:

- Combined HF/VHF/UHF input (8 kHz to 3.6 GHz)
- Two separate HF inputs (8 kHz to 32 MHz)
- Two separate VHF/UHF inputs (20 MHz to 3.6 GHz)
- SHF input (20 MHz to 26.5 GHz)

The right antenna is automatically selected based on the frequency set in the receiver. Antennas and frequency ranges are defined using the receiver's menus. The antenna switching matrix is also controlled during scanning, eliminating the need for an external switching matrix and additional hardware and software.

R&S®ESMD is an easy-to-use tool to import or define frequency-dependent antenna correction sets for accurate field strength measurements. Additionally, a frequency-dependent cable attenuation (antenna to receiver) can be defined. So the full signal chain is used, when calculating and displaying field strength values.

Integrated antenna switching matrix

For simultaneous cabling to multiple receiving antennas (the second VHF/UHF input is omitted when the R&S®ESMD-SHF option is installed)

Powerful preselection: large-signal immunity and high sensitivity

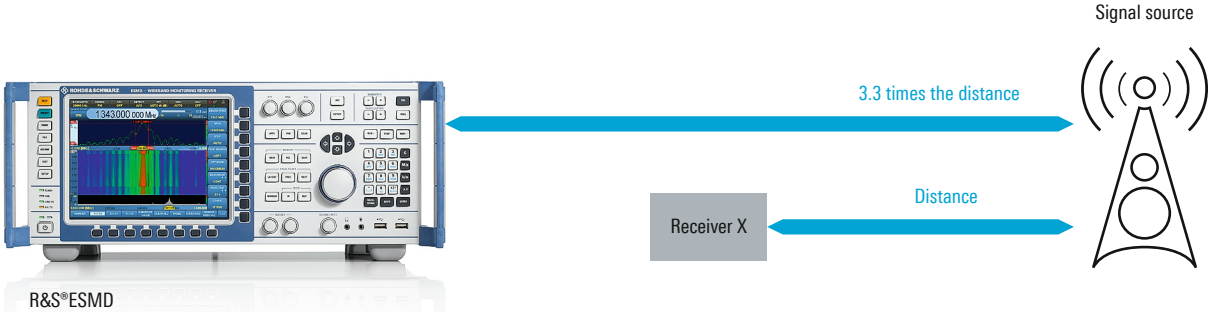
The R&S®ESMD receiver's powerful preselection stage reliably protects it against overloading due to strong input signals. The R&S®ESMD also features an internal high-gain preamplifier stage and offers excellent receiver sensitivity.

The resulting wide dynamic range makes the R&S®ESMD ideal for all signal scenarios.

Large-signal immunity and high sensitivity (in the same operating mode, e.g. normal mode) are absolutely necessary monitoring receiver characteristics in order to ensure smooth operation, e.g. with a wideband receiving antenna. Wideband antennas pose a significant challenge in the design of a monitoring receiver's frontend. It is often necessary to scan for weak signals while receiving multiple strong signals at a similar frequency.

The figure below shows the effect of a receiver with 10 dB higher sensitivity (compared with receiver X). To obtain a practicable comparison, the same or similar large-signal immunity is assumed for both instruments.

Powerful preselection



A 10 dB higher sensitivity means 3.3 times the distance to the signal source.
The signal remains visible on the receiver (assuming the same large-signal immunity for both instruments).

FFT signal processing with 80 MHz realtime bandwidth (base unit: 20 MHz)

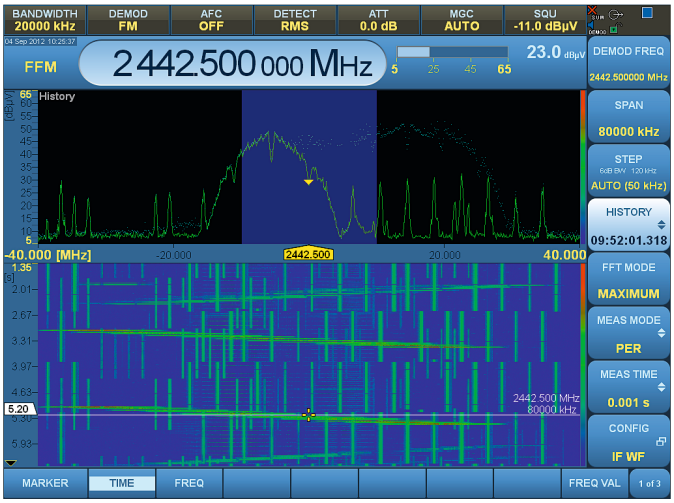
Realtime processing of the frequency spectrum is essential for detecting pulsed or frequency agile signals. FFT signal processing allows all spectral information to be displayed simultaneously. The realtime spectrum is calculated without sweeping or scanning and offers detection in realtime. The calculation time is negligible due to FPGA implementation.

FFT realtime processing also offers excellent frequency resolution plus very high sensitivity.

This combination of speed, frequency resolution and sensitivity makes the receiver ideal for a very wide range of applications. Users get detailed information about the frequency spectrum. Pulsed, time-variant and frequency agile signals are reliably detected and displayed in the spectrum or waterfall diagram. During realtime operation, signals can be demodulated in parallel, without interruptions.

The R&S®ESMD base unit features a realtime bandwidth of 20 MHz. The R&S®ESMD-WB and R&S®ESMD-ADC2 options expand the realtime bandwidth to 80 MHz. Depending on the requirements, the realtime spectrum span can be stepwise reduced to a minimum bandwidth of 1 kHz.

A detailed description of R&S®ESMD realtime processing is available in the "Realtime FFT processing in Rohde&Schwarz receivers" application brochure (PD 3606.8308.92).



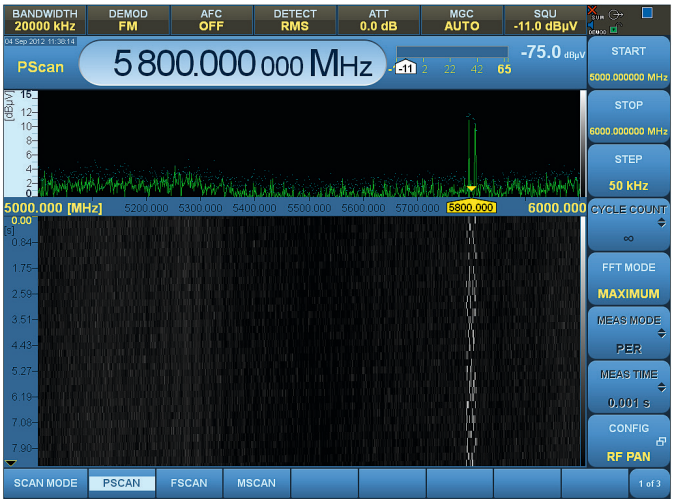
Strong activity in the 2.4 GHz ISM band caused by WLAN and Bluetooth® signals (superimposed in frequency and time; can be unambiguously identified using the realtime spectrum).

Extremely fast spectral scan (panorama scan) across entire frequency range

To search for signals outside the realtime bandwidth, the R&S®ESMD offers an extremely fast spectral scan function: the panorama scan (R&S®ESMD-PS option). This scan function is also based on FFT calculation for very high scan speed, extremely fine resolution and high sensitivity. Spectral results can be combined with the waterfall diagram. This is particularly useful when searching for pulsed or frequency agile signals. Signals cannot be demodulated during an ongoing scan.

The panorama scan is ideal for determining the frequency range of interest from an unknown starting position, for example based on the interference contained. The R&S®ESMD is then switched to realtime mode for in-depth analysis.

A detailed description of R&S®ESMD realtime processing is available in the "Realtime FFT processing in Rohde&Schwarz receivers" application brochure (PD 3606.8308.92).



Detection of a hopper signal in the 5.8 GHz ISM band using the fast spectral scan over the 1 GHz bandwidth.

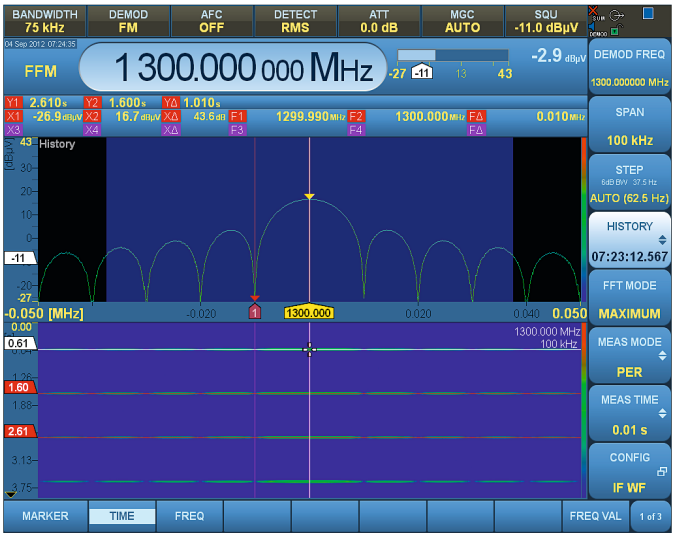
Waterfall diagram for examination of signal history

The waterfall diagram (spectrogram) provides a three-dimensional display of the spectrum over frequency, time and color-coded signal level.

This diagram is used to search for pulsed signals, frequency agile signals and signals that occur at statistically irregular intervals. The outstanding visual presentation of these signals in the waterfall diagram makes this display an indispensable tool for any intercept operator.

The user can set the time resolution in the waterfall (equivalent to speed), which must be adjusted to the current signal scenario. Using the history mode function, users can stop the waterfall and display the signal of interest as a still image on the screen, for example to perform more precise analyses using markers.

This function is included in the base unit.



In history mode, short-time signals are displayed as a still image and are easy to analyze using markers.

Recording of spectra and waterfall data and replay of results

For detailed evaluation of detected signals, a given spectral/waterfall scenario must be recorded (e.g. on a connected USB flash drive) to be able to replay the information later in the receiver (R&S®ESMD-IR option).

This makes it possible to evaluate detected events (e.g. up to 80 MHz wide realtime spectra or panorama scan spectra covering several GHz) by type and relevance. This function provides useful support when searching for interference or documenting a previously recorded signal, for example. In this way, a collection of relevant signals can be created for subsequent use.

Using this option, the demodulated audio content (or I/Q data for digitally modulated signals) in the corresponding spectrum can be recorded simultaneously. In replay mode, the source of the interference can be precisely identified by evaluating the impaired audio content and the corresponding spectrum in parallel.

For front panel operation, an additional internal solid state drive with 512 Gbyte capacity can be integrated, so hours or even days of data can be recorded without need of any external peripherals.

The R&S®ESMD-IR internal recording option is available for receivers with front panel operation (model .03) or for external R&S®ESMD GUI software.

Recorded signals from the 2.4 GHz ISM band are evaluated offline.

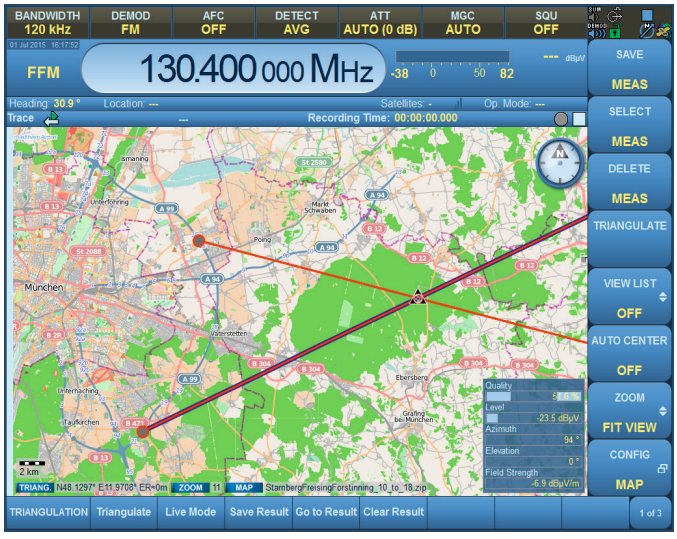
Map display with GNSS position

If the receiver is operated in nonstationary mode (e.g. vehicular operation) or in temporary transportable setups, a map display is useful for showing the current receiver position (R&S®ESMD-Map option).

The digital map (e.g. based on OpenStreetMap (OSM) maps) shows, for example, the points where values were measured, as well as direction information if bearings are available and the current position of the receiver.

The recorded measured values are displayed after selecting a specific point, e.g. the spectrum recorded at a certain intersection in an urban area. This function helps to identify interference so that the source of the problem can be promptly eliminated.

The R&S®ESMD-Map option is available for receivers with front panel operation (model .03) or for external R&S®ESMD GUI software.



The positions recorded during a drive test (including the bearing, if applicable) are shown on a map.

Polychrome spectrum to distinguish superimposed, pulsed signals

The polychrome spectrum display makes it possible to separate superimposed, pulsed signals that cannot be differentiated using conventional methods (e.g. spectrum, waterfall, max. hold).

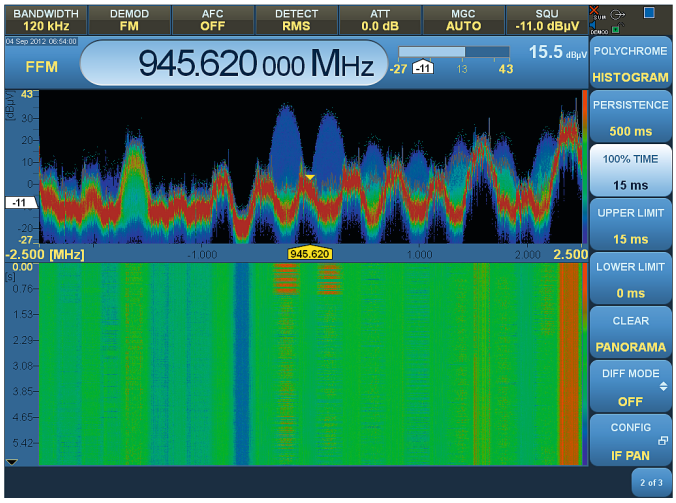
The difficulty with superimposed, pulsed signals is that they occur at the same time and frequency in the spectrum and possibly have a similar level.

To differentiate complex signal scenarios of this kind, the receiver analyzes the frequency of occurrence of each individual signal and displays the results over frequency in a color-coded diagram.

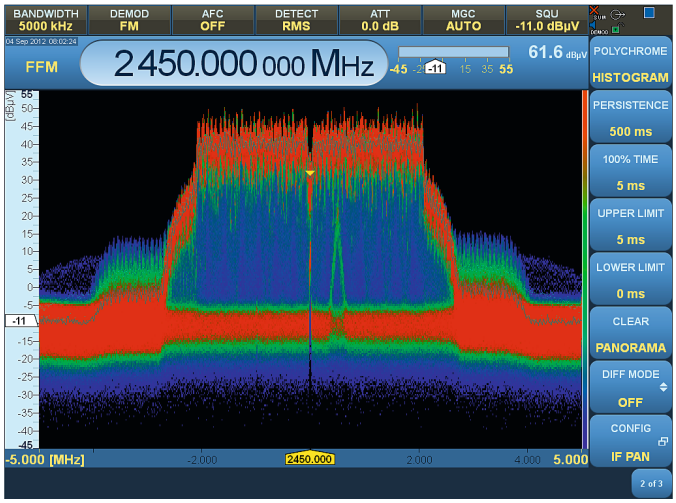
Signals shown in red occur more frequently than signals shown in green or blue. The occurrence frequency threshold can be predefined by the user and is shown on the receiver as the 100 % time.

The polychrome spectrum is very useful for signal separation, for example to identify pulsed interfering signals superimposed on pulsed wanted signals (GSM, DECT).

This function is included in the base unit.



Superimposed, pulsed signals (here: GSM900 downlink) are displayed in different colors based on how often they occur and can be more easily analyzed than in the max. hold view.



A low-amplitude pulsed signal (Bluetooth®) superimposed by a pulsed signal with higher amplitude (WLAN) can only be seen by using the polychrome spectrum.

Video spectrum for display of subcarriers and transmission rates

The video spectrum is used to display the demodulated received signal (RF carrier removed through demodulation). The remaining envelope (in the time domain) is displayed as a spectrum (in the spectral domain).

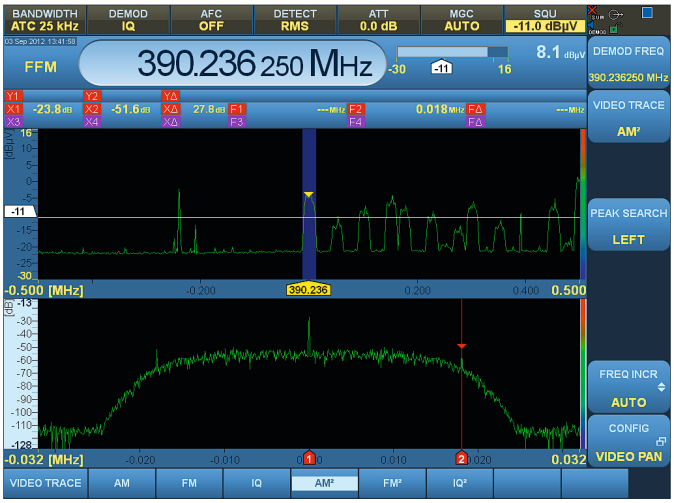
As a result, existing subcarriers, such as the 19 kHz pilot tone in FM radio signals, are presented in a clear, visually stable display.

The squared video spectrum permits quick and easy analysis of digitally modulated signals. Due to the squaring, the received signal has peaks to the right and left of the center frequency. The spacing between the peaks and the center frequency is a measure of the rate at which a received digital channel is transmitted (baud rate). The existing transmission rate can be easily and conveniently estimated without additional software.

The video spectrum can be combined with the waterfall display.

This function is included in the base unit.

Display of the subcarriers of an FM radio signal using an FM-demodulated video spectrum (pilot tone: 19 kHz; RDS signal: 56 kHz from center frequency).



Transmission rate estimate of a TETRA signal using a squared video spectrum (signal peaks approx. 18 kHz from center frequency; transmission rate approx. 18 kBd).

Parallel signal processing of spectral path and demodulation path

After A/D conversion of the received signal, the R&S®ESMD splits up signal processing into two parallel paths: the spectral path and the demodulation path or level measurement path.

As a result, demodulation and level measurements on signals within the realtime spectrum can be performed simultaneously and while the realtime spectrum is being displayed.

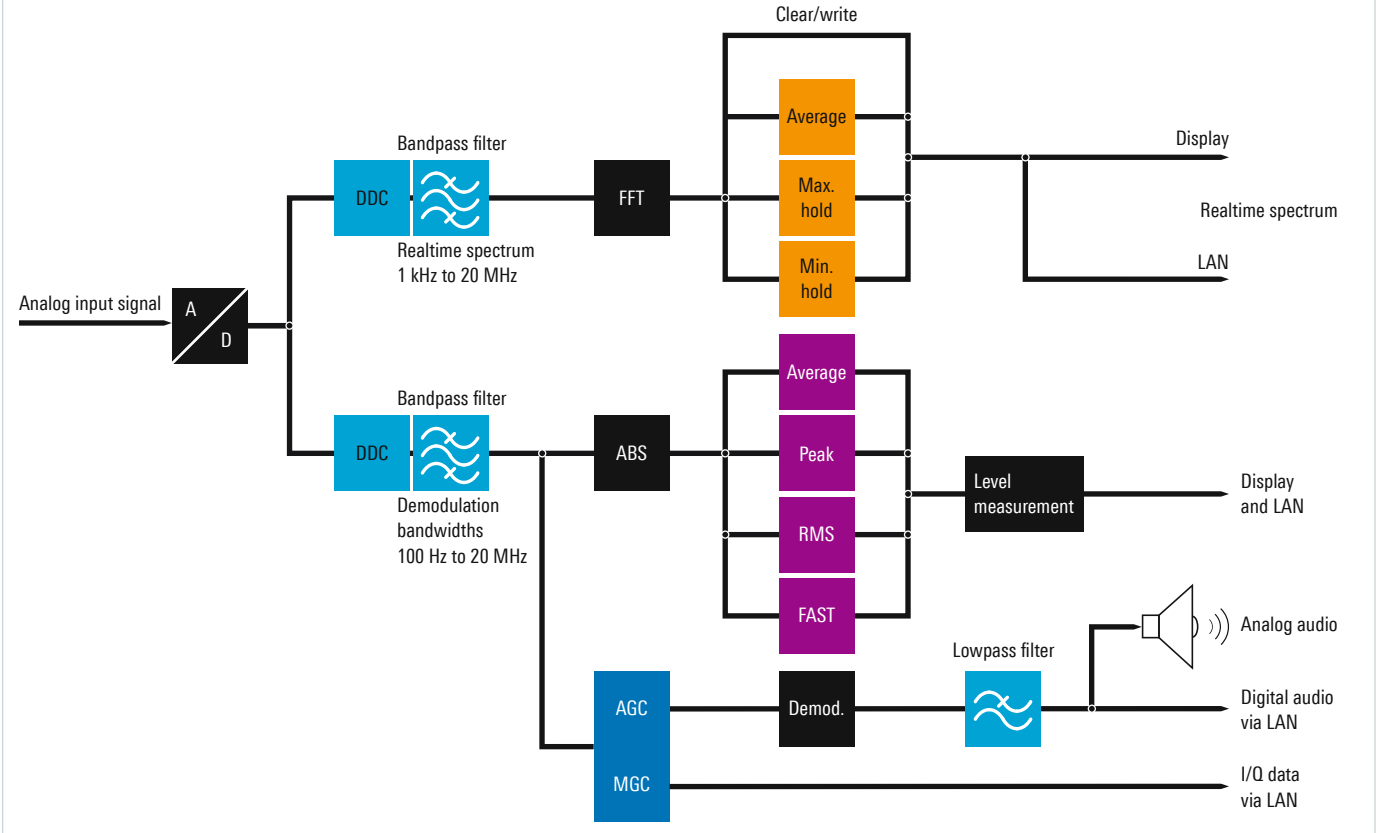
Audio signals are demodulated with interference-free audible content since the R&S®ESMD does not need to switch between spectral and audio processing.

A seamless I/Q data stream is available for I/Q baseband demodulation – a vital processing step for subsequent signal analysis with analysis software.

Parallel signal processing permits users to simultaneously work with different bandwidth settings: wideband for a spectral overview and narrowband for demodulation and level measurements of a specific signal within the realtime bandwidth.

The center frequency of the realtime spectrum and demodulator/level detector can be set independently of each other. Demodulation will only work if the frequency of the signal of interest is within the selected realtime spectrum.

Simplified diagram of digital signal processing in the base unit



Level measurements with “real” wideband detector

The level of received signals is measured using a “real” wideband detector instead of the calculated FFT spectrum. Results are no longer corrupted due to FFT windowing, and it is no longer necessary to postprocess the level value (e.g. using a correction table).

The detector processes signals extremely fast, and even the signal levels of short-time pulses (less than a few hundred nanoseconds) can be accurately measured.

The high measurement bandwidth of up to 20 MHz is ideal for measuring the signal level of modern, digitally modulated signals, such as:

- DVB-T (approx. 8 MHz)
- LTE (up to 20 MHz)

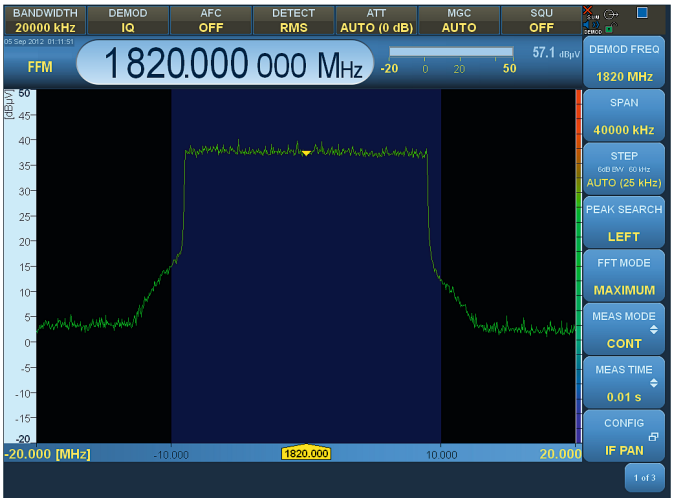
Frequency scan and memory scan for audio demodulation on changing channels

The frequency scan (FScan) and memory scan (MScan) modes included in the base unit can be used to check if certain radio services are occupied (level exceeds squelch) and, if emissions are detected, to dwell on this channel for a preset period of time, for example to output demodulated audio information.

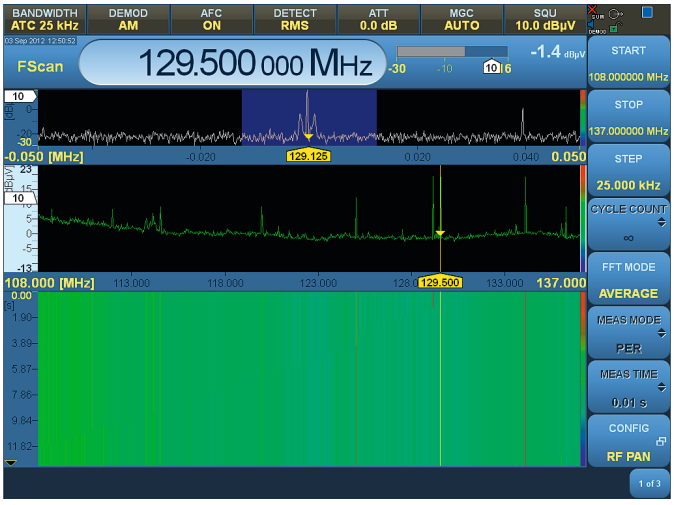
The frequency scan mode should be used to scan radio services with specific parameters, e.g. ATC radio bands with fixed channel spacing, bandwidth and demodulation mode.

Due to its flexibly parameterized memory locations, the memory scan is ideal for scanning several different radio services (e.g. ATC, PTT) in a single scan. Demodulation parameters and channel spacing are variably programmable.

Both scan modes allow users to conveniently search for active signals that are expected to occur in quick succession on different channels, and ensure that audio content is quickly available.



Uncorrupted level measurement of a wideband LTE signal using the wideband RMS detector.



For audio demodulation, the ATC radio band is examined in 25 kHz steps to detect signals that exceed the squelch level.

4+1 receivers in one instrument

Equipped with the R&S®ESMD-DDC and R&S®ESMD-ADC2 options, the R&S®ESMD has four parallel demodulation channels in addition to the demodulation path included in the base unit.

The demodulation path included in the base unit offers a maximum bandwidth of 20 MHz; the four additional paths provide a maximum of 1 MHz each. When these two options are installed, users have five independent software receivers in a single instrument.

The demodulated information of all five channels is processed as separate data streams via the LAN interface, e.g. as a *.wav data stream for audio data or as I/Q baseband data for analysis purposes.

The five demodulation channels can be placed anywhere within the selected realtime bandwidth and separately parameterized. Settable parameters include:

- Center frequency
- Bandwidth
- Demodulation mode
- Squelch value

Using the DDC function, users can process five signals in parallel and check them for content or absence of interference.

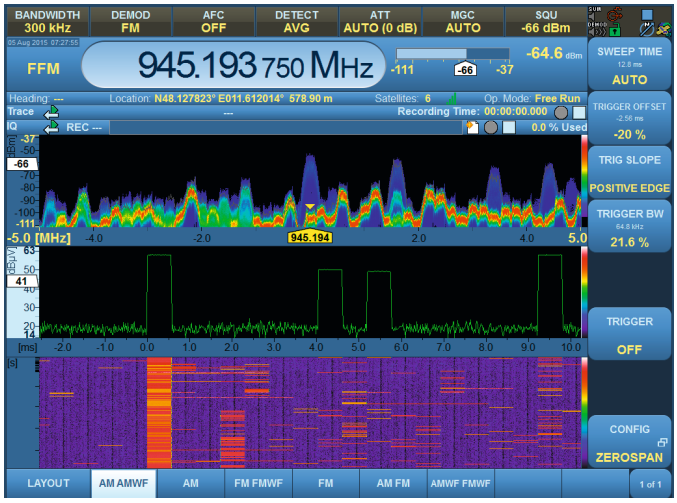
4+1 demodulation channels with different parameters within the realtime bandwidth.

Time domain analysis up to 20 MHz bandwidth

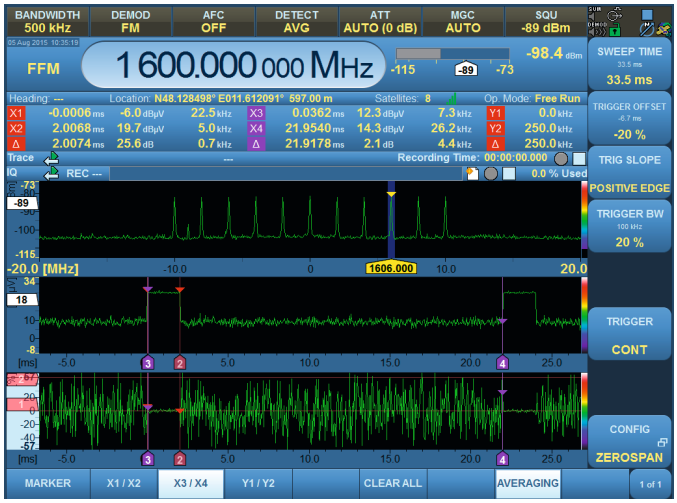
When used in combination with the R&S®ESMD-ZS zero span option, the R&S®ESMD provides a realtime display of signals up to 20 MHz bandwidth in the time domain. This is particularly useful for analyzing time division multiplex access (TDMA) signals such as Tetra, GSM or DECT. The set demodulation bandwidth also determines the bandwidth used to display the time domain. Because two separate paths are used for processing in the R&S®ESMD, the user interface displays both the realtime spectrum and the signal from the demodulation path in the time domain. The bandwidth and the center frequency for both channels can be selected independently of each other. The channel used for the time domain display can be positioned anywhere within the selected realtime bandwidth. This makes it possible for the user to examine individual channels for a transmission mode in the time domain while retaining an overview of multiple channels in the realtime spectrum and maintaining the receiver center frequency.

The user interface can display the amplitude, the instantaneous frequency or both simultaneously in the time domain. Both displays can optionally include a waterfall display to track changes in the signal over time.

This function is excellent for analyzing and measuring frequency hopping signals. Markers can be set on the x- and the y-axis in both time domain displays to measure intervals, amplitudes and frequency hops.



Display of the timeslot assignment in a GSM channel with waterfall display of the channel occupancy over time.



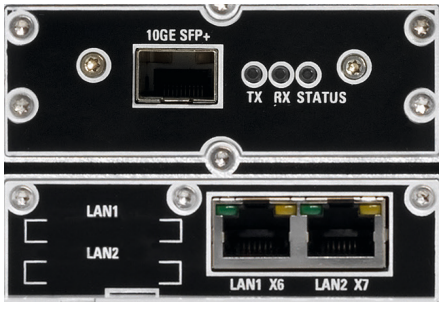
Measurement of a frequency hopping signal. The markers can also be used to measure intervals (center) and the instantaneous frequency (bottom).

Open interfaces for remote control and data transmission

The base unit is equipped with two 1 Gbit LAN interfaces to control the monitoring receiver from a remote operator workstation and to output measurement results. System and analysis software packages from Rohde&Schwarz, such as R&S®ARGUS, R&S®RAMON and R&S®CA100, access this interface to utilize all receiver functions.

The open interface description for remote control commands (in line with the SCPI standard) and the output data formats enable external system integrators to incorporate the receiver into third-party software solutions.

LAN interfaces for remote control and/or data transmission



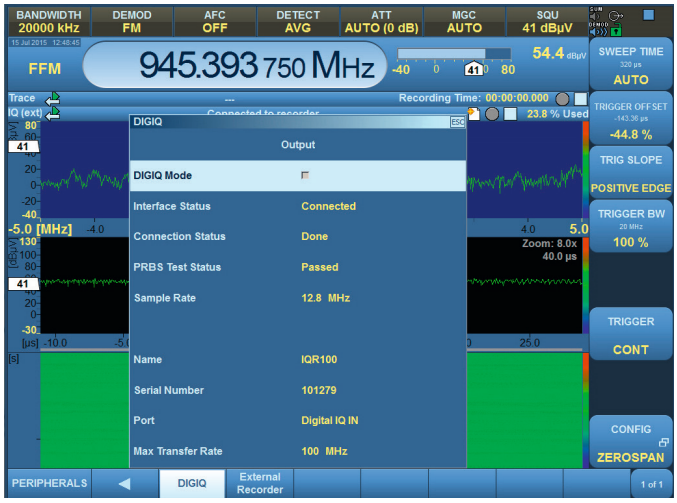
Two 1 Gbit LAN interfaces and an optional 10 Gbit LAN interface on the receiver's rear panel – for remote control and/or data transmission.

Interfaces for up to 80 MHz wide I/Q data streaming

The R&S®ESMD-DIQ option is an extremely powerful FPGA board. This board comes standard with the R&S®Digital I/Q Interface, which permits I/Q streaming in Rohde&Schwarz recording instruments (e.g. R&S®IQR) or vector signal generators (e.g. R&S®SMW). Using the R&S®Digital I/Q Interface, the R&S®ESMD transmits I/Q data up to its full bandwidth of 80 MHz. The R&S®ESMD detects compatible Rohde&Schwarz instruments connected to the R&S®Digital I/Q Interface.

Via the 10 Gbit LAN interface (R&S®RX-10G option), the R&S®ESMD can transmit I/Q baseband data from the instrument and also replay it in realtime from a storage device [1]. The R&S®ESMD operates as in normal receive mode even though it uses recorded data. All measurement and analysis functions provided by the R&S®ESMD in fixed frequency mode remain available [2]. This means that the center frequency and demodulation bandwidth of the receiver can be moved freely within the boundaries of the replayed recording. Copper or fiber-optic cables can be used to connect the 10 Gbit LAN interface to the external storage device (e.g. R&S®GX460 with a maximum I/Q bandwidth of 40 MHz or R&S®GX465 with a maximum I/Q bandwidth of 80 MHz). When connected to an R&S®GX465, the R&S®ESMD controls the storage device. The user controls the recording and replay of I/Q data via the user interface of the R&S®ESMD, while the R&S®ESMD controls the storage device in the background.

[1] In conjunction with the R&S®ESMD-DIQ option.
[2] Exceptions: recording and replay of GNSS data and in DF mode.



Status report for an R&S®IQR100 connected to the R&S®Digital I/Q Interface.

An R&S®ESMD with R&S®ESMD-DIQ and R&S®RX-10G options controls an R&S®GX465, both for recording and for realtime replay of I/Q data.

Receiver remote control and data recording

The base unit comes with the R&S®ESMD-Control software package for remotely controlling the receiver over the 1 Gbit LAN interface. All functions are available, from tuning the receiver to a center frequency and parameterizing the realtime spectrum to starting the fast spectral scan. R&S®ESMD-Control records all results, including spectra, waterfall, demodulated audio information and I/Q baseband data, to the remote controller's hard disk.

It is possible to replay recorded data for offline analysis (I/Q data processing, e.g. with R&S®CA100 or MATLAB®).

The R&S®ESMD-Control software package provides a point-to-point connection between a PC and a receiver. The R&S®RAMON software extends the functionality to create a system solution (e.g. connecting several users to one receiver).

Multichannel signal detection and analysis in a networked system

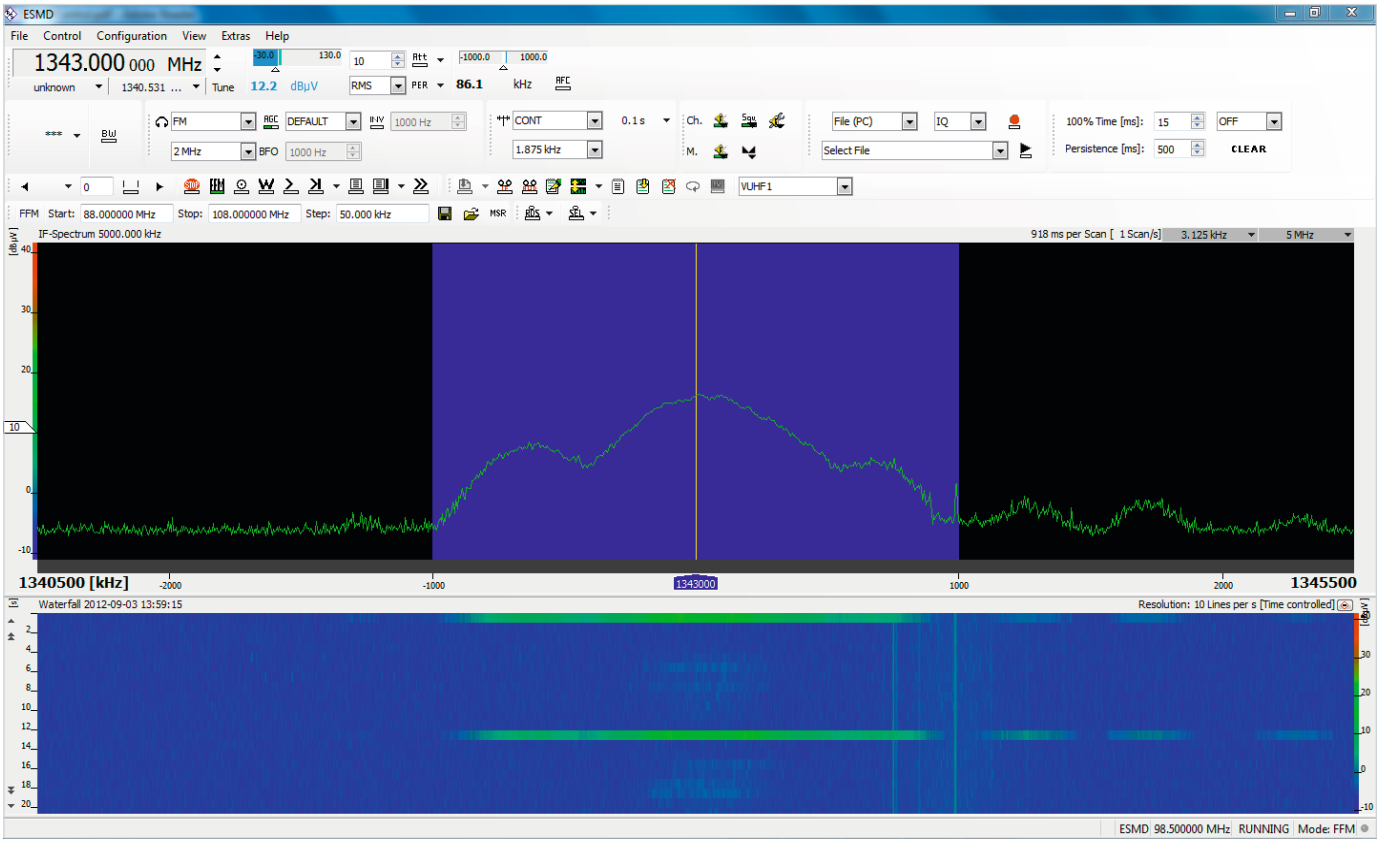
Equipped with the R&S®ESMD-SP hardware-accelerated signal processing option, the R&S®ESMD supports parallel multichannel signal detection and analysis. The following high-performance signal processing functions are implemented in field programmable gate array (FPGA) technology:

- Multichannel signal extraction: R&S®ESMD-DDCE
- Calculation of high-resolution spectra: R&S®ESMD-HRP
- Detection of frequency agile signals: R&S®ESMD-ST

The R&S®CA120 multichannel signal analysis system ideally complements the R&S®ESMD when equipped with the following options:

- Multichannel signal extraction: R&S®CA120MCP, R&S®CA120FFP
- Detection of fixed frequency signals: R&S®CA120DSC
- Detection of frequency hopping signals: R&S®CA120ST

Thanks to the detailed interface description, system integrators can directly access the receiver data streams for processing in their own external systems.



Realtime spectrum and waterfall display of a radar signal from Munich airport.

Parallel multichannel output of up to 128 channels
Within the receiver's realtime bandwidth, up to 128 channels (manually set by the user) with a maximum bandwidth of 30 kHz each or 32 channels with a maximum bandwidth of 300 kHz each can be simultaneously output over the 1 Gbit Ethernet interface. As a result, a large number of signals are available as an I/Q baseband data stream that can be processed in external systems (R&S®ESMD-DDCE option).

Equipped with the R&S®CA120MCP and R&S®CA120FFP options, the R&S®CA120 multichannel signal analysis system processes the extracted signals online and supports multichannel content recovery in a signal scenario with many signals through audio demodulation, classification, demodulation/decoding and recording.

Detection of fixed frequency signals
Within the receiver's realtime bandwidth, a high-resolution spectrum is calculated (R&S®ESMD-HRP option). An extremely high resolution is essential for later detection of fixed frequency signals (continuous or pulsed signals). The spectra are output on the 1 Gbit Ethernet interface for further processing.

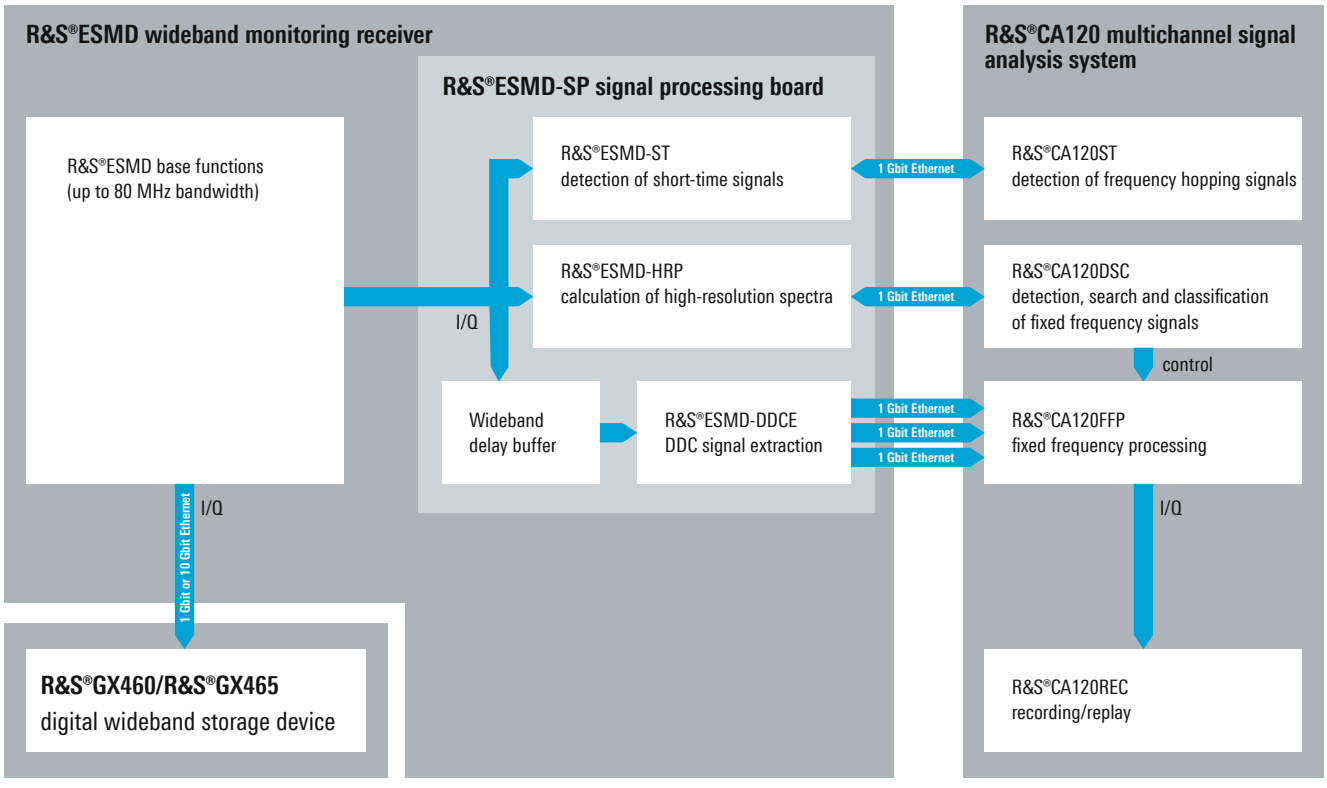
Equipped with the R&S®CA120DSC option, the R&S®CA120 multichannel signal analysis system automatically detects fixed frequency signals. The automatically computed detection threshold adapts independently to the noise floor characteristic that varies within a frequency range. The suppression of specific signals or entire frequency ranges can be set in a user-editable list.

Equipped with the R&S®CA120DSC option, the R&S®CA120 multichannel signal analysis system assigns the results to signals, manages lists of active and inactive signals and uses the parallel multichannel data output to process detected signals, providing optimal support for signal search and signal monitoring.

Detection of frequency hopping signals
The R&S®ESMD-ST option allows automatic detection of frequency hopping signals within the receiver's realtime bandwidth. It delivers a result for each detected short-term signal that matches user-defined selection criteria. The results are output on the 1 Gbit Ethernet interface for further processing.

By measuring, classifying and sorting the results, the R&S®CA120 multichannel signal analysis system with the R&S®CA120ST and R&S®CA120PS options optimally supports the detection and monitoring of frequency hopping signals.

R&S®ESMD with R&S®CA120 and R&S®GX460/R&S®GX465 in a networked system



ITU-compliant measurements in the receiver

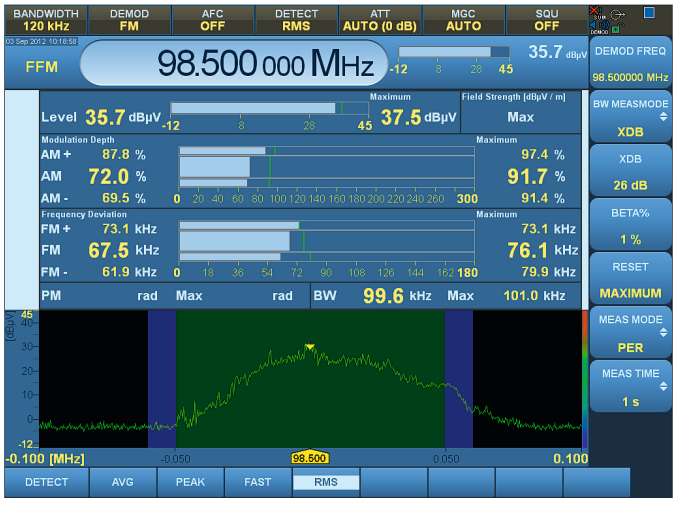
The R&S®ESMD-IM option can be used to perform ITU-compliant measurements on signal parameters for AM, FM and PM-modulated signals. The modulation index, occupied bandwidth and phase deviation can be determined, for example. The minimum and maximum values as well as the average values over a user-defined measurement period are displayed. The R&S®ESMD-IM option covers the following ITU recommendations:

- ITU-R SM.377 (frequency and frequency offset measurements)
- ITU-R SM.378 (field strength measurements)
- ITU-R SM.328 (determination of modulation modes)
- ITU-R SM.443 (bandwidth measurements)
- ITU-R SM.1880 (determination of spectral occupancy, with remote control PC and R&S®ARGUS software package)

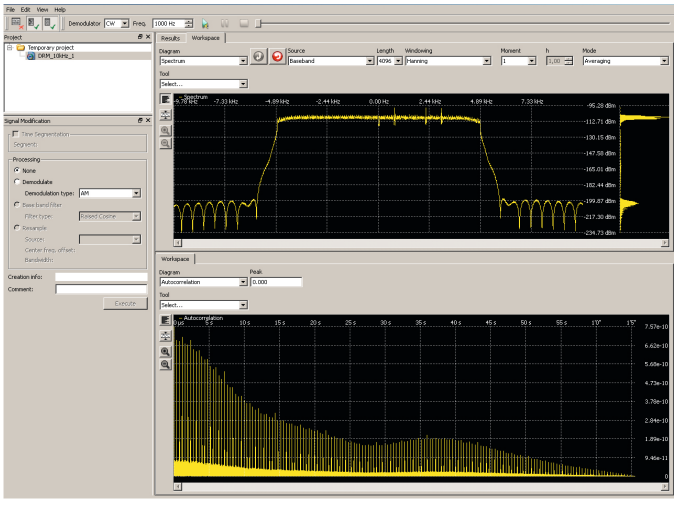
For offline measurement of digitally modulated signals in line with ITU-R SM.1600, the R&S®CA100IS option can be added to the R&S®CA100 software solution (requires an additional PC).

The R&S®ESMD fulfills the following ITU hardware recommendations:

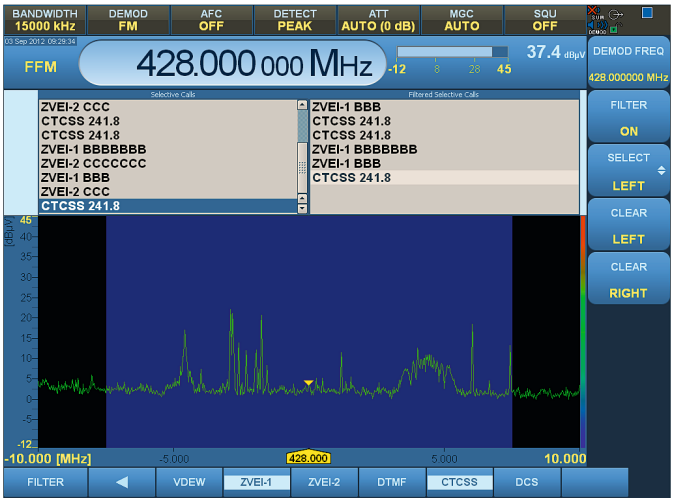
- ITU-R SM.1836 (measurements of IF filter edge steepness)
- ITU-R SM.1837 (IP3 measurements)
- ITU-R SM.1838 (noise figure measurements)
- ITU-R SM.1840 (sensitivity measurements)



Modulation and bandwidth measurement results at a glance.



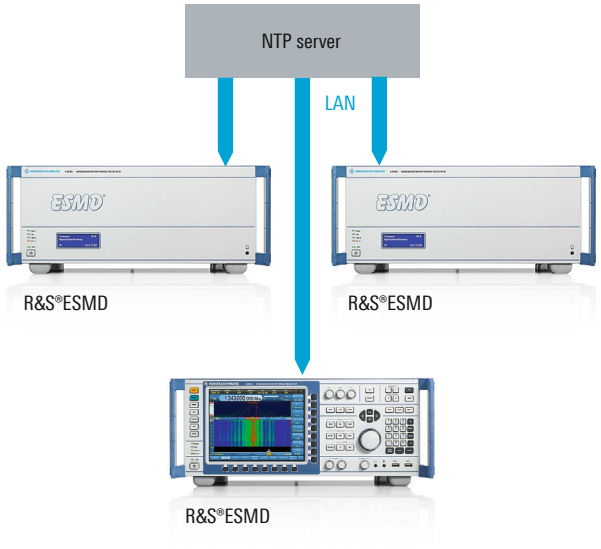
Offline measurement of a Digital Radio Mondiale (DRM) signal in line with ITU-R SM.1600.



Display of detected selective call standards in an overview list (left column); filtering by relevance possible (right column).

DC port for connecting the R&S®ESMD to the vehicle's on-board power supply

An NTP server distributes time and date information to the receivers in the system via a network connection



Detection of selective call services

The R&S®ESMD-SL option is available for detecting active selective call services. The receiver automatically scans all emissions within the demodulation bandwidth and displays detected selective call services. The results can be filtered based on relevance. The following selective calls are detected, for example:

- DTMF
- CCIR
- CTCSS
- ZVEI-x

This function is of particular importance for regulatory authorities that use sampling to monitor the proper use of specific allocated call services.

DC operation (e.g. from vehicle battery)

The R&S®ESMD receives its power directly from a DC source, such as a vehicle battery. Thanks to its wide input voltage range from 12 V to 32 V DC, the receiver can be operated on both car and truck batteries. The R&S®ESMD-DC option is installed directly in the receiver; no additional space is required for in-vehicle installation. A fully equipped R&S®ESMD (up to 300 W power consumption) then runs on the DC power supply.

System time synchronization using NTP server

An NTP server distributes the system time to all devices in the networked system. Synchronization takes place automatically every time when the receiver starts up, or can be manually triggered by an SCPI command issued by the user or a software application running on the network. The internal device time and date are synchronized to the received NTP time. The accuracy depends on the quality of the NTP server and LAN infrastructure and is typically in the millisecond range. Cyclic synchronization of device time and date prevents drifting differences in the internal time references of multiple receivers in the network.

The synchronized timebase makes it easier to compare measurement results received by different stations (e.g. spectrum, audio). As a result, it is possible to identify and assign results with identical timestamps. It is also possible to document when a specific signal, e.g. an interfering signal, was received.

TDOA ready with high-accuracy timestamps and GNSS synchronization of frequency and time

The R&S®ESMD system time is set and synchronized via the (internal or external) GNSS module's NMEA protocol. GNSS information, e.g. position and date, is available at the LAN interface.

The internal R&S®ESMD 10 MHz reference frequency is synchronized using a pulse per second (PPS) signal from the GNSS module. Depending on the GNSS module used, the accuracy of the internal reference frequency can be significantly improved to fulfill all ITU frequency accuracy requirements ($\leq 1 \times 10^{-9}$) for radiomonitoring receivers:

- Typ. 1×10^{-10} (with external GPS module, standard quality)
- Typ. 1×10^{-12} (with internal GNSS module, R&S®ESMD-IGT2 option)

The receiver's high-accuracy timestamp in the I/Q output data stream is also derived from the information in the GNSS module. The accuracy of the timestamp is typically in the microsecond range (with external GPS module) or in the nanosecond range (with internal GNSS module, R&S®ESMD-IGT2 option).

The timestamps in the I/Q baseband data stream of the R&S®ESMD permit TDOA[3] applications via LAN. The R&S®ESMD functions as a receiving node in the sensor network. Time accuracy depends on the receiver's antenna input and is independent of the receiver settings, which significantly simplifies the setup of correction tables for a TDOA system. The tables only need to contain system parts such as antennas, cable lengths and signal distribution, and not all receiver settings. This greatly simplifies the TDOA system integrator's job.

The time accuracy in the baseband data stream (when using the internal GNSS module) leads to extremely reliable radiolocation results in the TDOA network.

Detailed display of GPS data and GPS operating mode.

[3] TDOA: time difference of arrival.

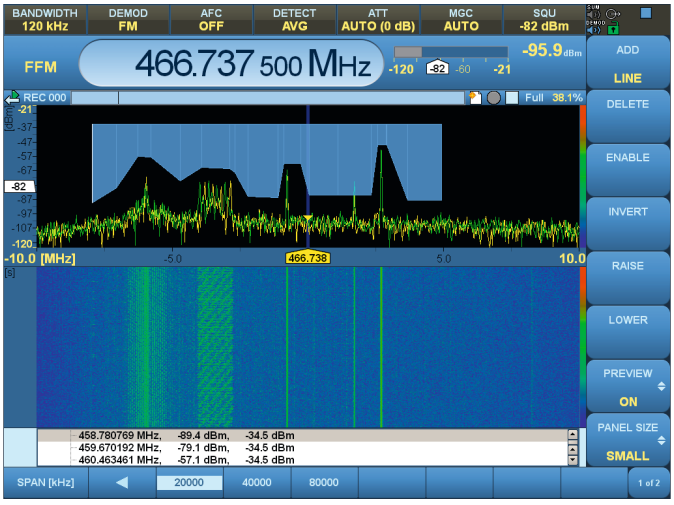
Recording and replaying of up to 80 MHz wide I/Q data

Never miss an event: activation of recordings with flexible realtime event capture (REC)

Rare, short-time signals are difficult to record and analyze. Yet these signals are of significant interest. The R&S®ESMD-RR option includes a configurable realtime event capture (REC) that can be used to activate I/Q data recording over up to 80 MHz. The R&S®ESMD records only events defined as relevant by the user. The user decides how the defined masks are used. Either the trigger is activated when a signal enters or leaves the predefined mask, or the trigger remains active as long as a signal is within the mask. As a result, the R&S®ESMD reliably detects even events in the nanosecond range.

Signals as received from an antenna: all receiver functions available when replaying I/Q data

Equipped with the R&S®ESMD-RR option, the R&S®ESMD records I/Q data up to the full 80 MHz bandwidth and stores it in the internal memory. The recorded data is played from memory directly on the instrument. All receiver functions are available when replaying I/Q data (demodulation of analog modulated signals, setting of DDCs and ITU-compliant measurements). The user sets all parameters as if in live mode. All changes are immediately adopted without additional calculation time, as if the signal was directly received from an antenna. I/Q data replay is limited only by the recording bandwidth and time limits. The recorded I/Q data can be stored on external storage media (e.g. USB flash drive) and later loaded into an R&S®ESMD for subsequent analysis.



Easy editing of realtime event capture (REC) in the live spectrum.

Detailed display: replay of I/Q data with increased time resolution

When analyzing digital signals, radar pulses and short-time emissions, users are interested in the time behavior of the signal. When replaying I/Q data, the time resolution in the waterfall diagram can be increased down to the nanosecond range per line. The R&S®ESMD is therefore able to display even very short events with high resolution and provide a detailed overview of the spectral signal characteristics.

Realtime display of recorded data

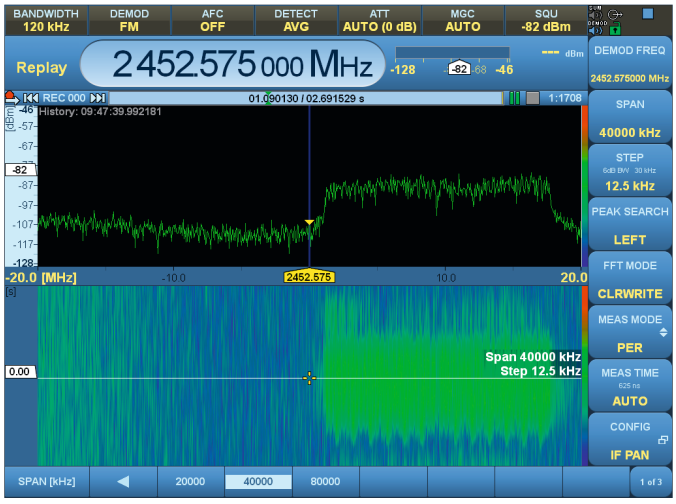
Recorded data is replayed in realtime in the receiver. No wait or delay time is required for redisplaying recorded signals, e.g. after parameter changes. This ensures maximum user convenience.

Bring RF to the lab: Stream wideband I/Q data to Rohde&Schwarz signal generators

With the R&S®ESMD-DIQ option, live streaming of digital I/Q data to Rohde&Schwarz signal generators is possible. Especially the R&S®SGT100A vector RF source is fully supported. It can directly be operated via the R&S®ESMD without an additional GUI. This allows easy generation of an adjustable analog IF covering the full 80 MHz realtime bandwidth for further processing. In connection with a digital wideband storage device, this function can be used to bring recorded real environmental RF scenarios (e.g. a cluttered communications channel) to the lab that could be used for testing and development.

Use all functions with Rohde&Schwarz digital wideband storage devices

Functions that come along with internally recorded I/Q data such as realtime display, utilization of all measurement functions, realtime event capture and replay with increased time resolution are usable with R&S®GX460 and R&S®GX465 digital wideband storage devices also. Instead of recording and replaying seconds of internally stored I/Q data, this can be expanded to last for hours.



Waterfall diagram of WLAN pulse with a resolution of 625 nanoseconds per line.

Maximum recording capacity of the internal memory

Span	Max. record length
2 MHz	approx. 2.5 min
10 MHz	approx. 42 s
40 MHz	approx. 10 s
80 MHz	approx. 5 s

Single-channel direction finder upgrade kit

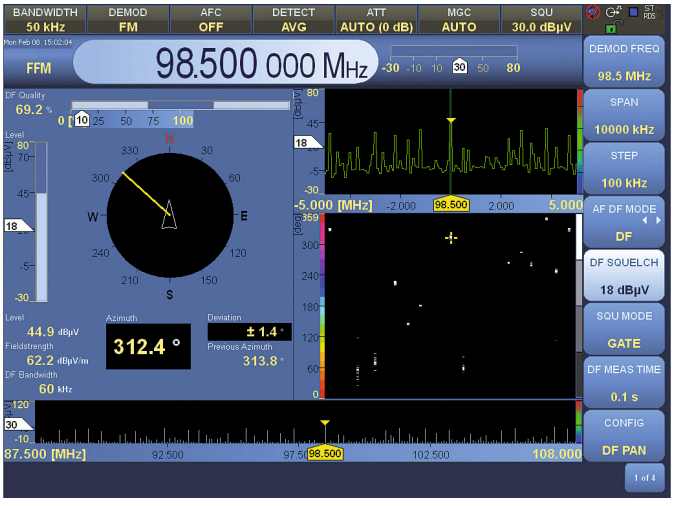
When equipped with the R&S®ESMD-DF option, the R&S®ESMD becomes a single-channel direction finder with a realtime bandwidth of up to 20 MHz. Simultaneous direction finding of all emissions within the realtime bandwidth has many advantages:

- Simultaneous direction finding and display of all occupied channels, e.g. in the aeronautical or maritime radio bands
- DF measurements on wideband signals (e.g. DVB-T) with high channel resolution, display of DF result as average value calculated from many individual bearings (to compensate for frequency-dependent bearing fluctuations)
- Reliable DF results for frequency agile transmitters (hoppers or chirp signals)

Depending on the antennas used, these options can be used to take the bearings of frequencies between 8 kHz and 6 GHz. In the HF range, the Watson-Watt direction finding method is used. The special advantage of this method is that small DF antennas can be deployed. The R&S®ESMD is ideal for taking bearings during mobile operation in vehicles.

In the VHF/UHF range, the R&S®ESMD uses the correlative interferometer DF method. In contrast to simple amplitude comparison methods, the instrument offers significantly higher DF accuracy up to class A/B in line with the ITU spectrum monitoring handbook 2002.

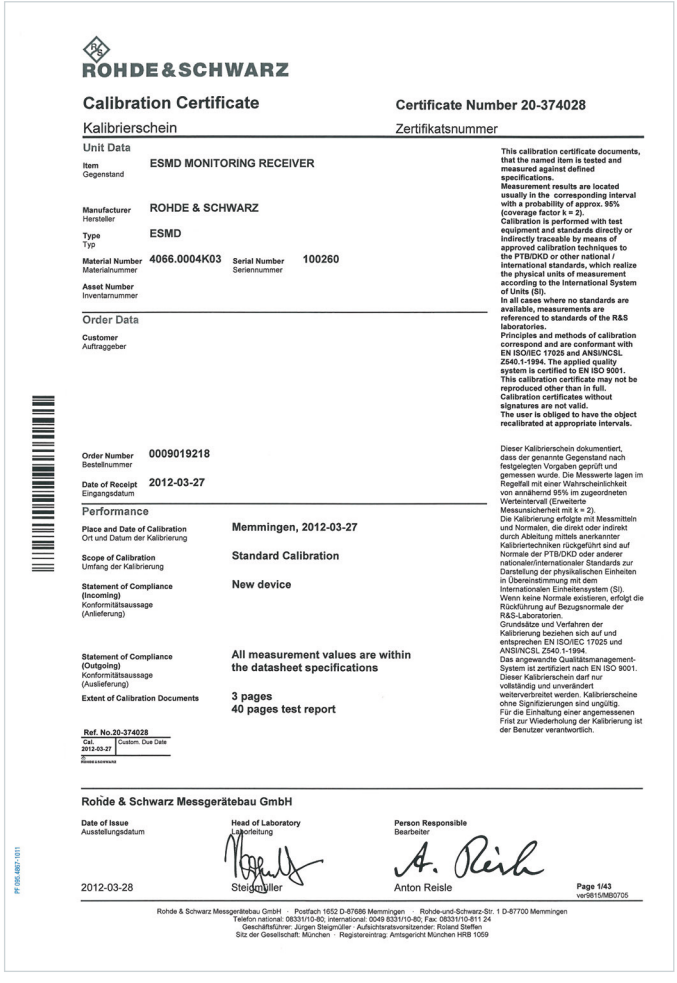
Most interferometer direction finders on the market use at least two receivers. With the R&S®ESMD, the two receive paths are coherently linked in the DF antenna using a patented Rohde & Schwarz method. There is no need for a second interception processing channel that is customarily found in interferometer direction finders.



DF result shown using a DF compass rose and azimuth diagram.

Documentation of calibration values

The R&S®ESMD-DCV option provides the user with the calibration certificate (documentation of calibration values) for a specific instrument according to serial number. During final production testing, the instrument's measurement values are compared with the permissible limits (min./max.). The DCV report demonstrates the instrument's compliance with specifications. The document comes with a removable label for the instrument that clearly indicates the compliance period.



ROHDE&SCHWARZ

Calibration Certificate — **Certificate Number 20-374028**

Kalibrierschein — Zertifikatsnummer

Unit Data

Item / Gegenstand: ESMD MONITORING RECEIVER

Manufacturer / Hersteller: ROHDE & SCHWARZ

Type / Typ: ESMD

Material Number / Materialnummer: 4066.0004K03 — Serial Number / Seriennummer: 100260

Asset Number / Inventarnummer:

Order Data

Customer / Auftraggeber:

Order Number / Bestellnummer: 0009019218

Date of Receipt / Eingangsdatum: 2012-03-27

Performance

Place and Date of Calibration / Ort und Datum der Kalibrierung: Memmingen, 2012-03-27

Scope of Calibration / Umfang der Kalibrierung: Standard Calibration

Statement of Compliance (Incoming) / Konformitätsaussage (Auslieferung): New device

Statement of Compliance (Outgoing) / Konformitätsaussage (Auslieferung): All measurement values are within the datasheet specifications

Extent of Calibration Documents: 3 pages
40 pages test report

Ref. No.20-374028
Cal. 2012-03-27 | Customary Due Date

This calibration certificate documents, that the named item is tested and measured against defined specifications.
Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor k = 2).
Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national / international standards, which realize the physical units of measurement according to the International System of Units (SI).
In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories.
Principles and methods of calibration correspond and are conformant with EN ISO/IEC 17025 and ANSI/NCSL Z540.1-1994. The applied quality system is certified to EN ISO 9001.
This calibration certificate may not be reproduced other than in full.
Calibration certificates without signatures are not valid.
The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit k = 2).
Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien.
Grundsätze und Verfahren der Kalibrierung beziehen sich auf und entsprechen EN ISO/IEC 17025 und ANSI/NCSL Z540.1-1994.
Das angewandte Qualitätsmanagement-System ist zertifiziert nach EN ISO 9001.
Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Signifizierungen sind ungültig.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Rohde & Schwarz Messgerätebau GmbH

Date of Issue / Ausstellungsdatum: 2012-03-28
Head of Laboratory / Laborleitung: Steigmüller
Person Responsible / Bearbeiter: Anton Reisle

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Geschäftsführer: Jürgen Steigmüller · Aufsichtsratsvorsitzender: Roland Steffen
Sitz der Gesellschaft: München · Registereintrag: Amtsgericht München HRB 1059

PF 085.4827.1011

Documentation of calibration values; example of an R&S®ESMD-DCV calibration certificate (cover sheet).

Specifications in brief

Specifications in brief		
Frequency		
Frequency range, receive mode	base unit	20 MHz to 3.6 GHz
	with R&S®ESMD-HF option	8 kHz to 3.6 GHz
	with R&S®ESMD-SHF option	20 MHz to 26.5 GHz
	in combination with R&S®MC40	20 MHz to 40 GHz
	with R&S®ESMD-HF and R&S®ESMD-SHF options	8 kHz to 26.5 GHz
	in combination with R&S®MC40	8 kHz to 40 GHz
IF bandwidths		
Bandwidth	demodulation, level and offset measurement (3 dB bandwidth), 34 filters	100/150/300/600 Hz, 1/1.5/2.1/2.4/2.7/3.1/4/4.8/6/9/12/15/30/50/120/150/250/300/500/800 kHz, 1/1.25/1.5/2/5/8/10/12.5/15/20 MHz
Demodulation		
Demodulation modes	all IF bandwidths	AM, FM, φM, pulse, ISB, I/Q, analog TV
	IF bandwidths ≤ 9 kHz	LSB, USB, CW, ISB
Realtime spectrum (IF panorama)		
FFT IF panorama		gap-free, dynamically overlapping FFT
		operating mode: automatic or variable with selectable frequency resolution 0.625/1.25/2.5/3.125/6.25/12.5/25/31.25/50/62.5/100/125/200/250/312.5/500/ 625 Hz, 1/1.25/2/2.5/3.125/5/6.25/8.333/10/12.5/20/25/50/100/200/500 kHz, 1 MHz, 2 MHz
Span	base unit	1/2/5/10/20/50/100/200/500 kHz, 1/2/5/10/20 MHz
	with R&S®ESMD-ADC2 and R&S®ESMD-WB options	additionally 40 MHz and 80 MHz
Spectrum display		clear/write, average, max. hold, min. hold, histogram, pulse
Scan characteristics		
Memory scan		10 000 programmable memory locations
	speed	up to 1200 channels/s
Frequency scan		user-selectable start/stop frequency and step size
	speed	up to 1500 channels/s
Panorama scan	with R&S®ESMD-PS option	RF spectrum with user-selectable start/stop frequency and step size 100/125/200/250/500/625 Hz, 1/1.25/2/2.5/3.125/5/6.25/8.333/10/12.5/20/25/50/100/200/500 kHz, 1 MHz, 2 MHz
	speed	in-band up to 400 GHz/s
		in-band up to 1300 GHz/s, with R&S®ESMD-WB option

Ordering information

Designation	Type	Order No.
Wideband Monitoring Receiver, without front panel control	R&S®ESMD	4066.0004.02
Wideband Monitoring Receiver, with front panel control	R&S®ESMD	4066.0004.03
Documentation of Calibration Values	R&S®ESMD-DCV	4066.4780.02
Options		
HF Frequency Range Extension, 8 kHz to 32 MHz	R&S®ESMD-HF	4066.4100.02
SHF Frequency Range Extension, 3.6 GHz to 26.5 GHz [1]	R&S®ESMD-SHF	4066.4200.02
Panorama Scan	R&S®ESMD-PS	4066.4500.02
Internal Recording	R&S®ESMD-IR	4079.7960.02
Map Display	R&S®ESMD-Map	4079.7977.02
ITU Measurement Software	R&S®ESMD-IM	4066.4400.02
Zero Span	R&S®ESMD-ZS	4079.7983.02
Selective Call Analysis	R&S®ESMD-SL	4066.4600.02
Multifunction Board	R&S®ESMD-ADC2	4079.7925.02
80 MHz IF Panorama Bandwidth [2]	R&S®ESMD-WB	4066.4645.02
Digital Downconverter [2]	R&S®ESMD-DDC	4066.4545.02
Direction Finder Upgrade Kit	R&S®ESMD-DF	4066.4300.02
DF Error Correction	R&S®ESMD-COR	4066.4745.02
DC Power Supply	R&S®ESMD-DC	4066.4000.12
Wideband I/Q Data Streaming Board [2]	R&S®ESMD-DIQ	4079.8109.02
10 Gbit Ethernet Interface (without transceiver module) [3]	R&S®RX-10G	4074.7604.04
40 Gbit I/Q Interface	R&S®RX-40G	4093.2404.02
Internal GNSS Module (GPS, Glonass, BeiDou)	R&S®ESMD-IGT2	4079.8209.02
Record and Replay [2]	R&S®ESMD-RR	4079.7954.02
Internal SSD [4]	R&S®ESMD-SSD	4079.7048.02
Options for hardware-accelerated signal processing (in combination with R&S®CA120)		
Signal Processing Board	R&S®ESMD-SP	4066.4268.02
DDC Signal Extraction [5]	R&S®ESMD-DDCE	4079.7760.02
High-Resolution Panorama Spectrum [5]	R&S®ESMD-HRP	4079.7902.02
Detection of Short-Time Signals [6]	R&S®ESMD-ST	4079.7883.02
Accessories		
Microwave Converter 40 GHz [7]	R&S®MC40	4098.6008.02
Digital Wideband Storage Device (up to 40 MHz IFBW recording)	R&S®GX460	4094.8006.02
Digital Wideband Storage Device (up to 80 MHz IFBW recording)	R&S®GX465	4100.4002.02
19" Rack Adapter	R&S®ZZA-411	1096.3283.00
Optical Cable, for 10 Gbit, incl. two optical transceivers, length: 20 m	R&S®GX460-OCG	4094.8641.02
Copper Cable, for 10 Gbit, incl. two transceivers, length: 5 m	R&S®GX460-CCG	4094.8635.02

[1] Upgrade must be performed in factory.
[2] Only one R&S®ESMD-ADC2 is required.
[3] Only one R&S®ESMD-DIQ is required.
[4] Requires R&S®ESMD model .03 with front panel control.
[5] One R&S®ESMD-ADC2 and one R&S®ESMD-SP are required.
[6] R&S®ESMD-DDCE is required.
[7] R&S®ESMD-SHF is required.

Service options	
Extended Warranty, one/two/three/four year(s)	Please contact your local Rohde&Schwarz sales representative.
Extended Warranty with Calibration Coverage, one/two/three/four year(s)	

Your local Rohde&Schwarz expert will help you determine the optimum solution for your requirements.
To find your nearest Rohde&Schwarz representative, visit
www.sales.rohde-schwarz.com

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- Long-term dependability

Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. 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.

www.rohde-schwarz.com

Sustainable product design

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

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

Rohde&Schwarz training

www.training.rohde-schwarz.com

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PD 5213.9863.12 | Version 10.01 | July 2019 (sk)
R&S®ESMD Wideband Monitoring Receiver
Data without tolerance limits is not binding | Subject to change

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